

IFIP AICT 551

Petter Nielsen

Honest Christopher Kimaro  
(Eds.)



# Information and Communication Technologies for Development

## Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D

15th IFIP WG 9.4 International Conference  
on Social Implications of Computers  
in Developing Countries, ICT4D 2019  
Dar es Salaam, Tanzania, May 1–3, 2019  
Proceedings, Part I

1  
Part I

 Springer

## Editor-in-Chief

*Kai Rannenberg, Goethe University Frankfurt, Germany*

## Editorial Board Members

TC 1 – Foundations of Computer Science

*Jacques Sakarovitch, Télécom ParisTech, France*

TC 2 – Software: Theory and Practice

*Michael Goedicke, University of Duisburg-Essen, Germany*

TC 3 – Education

*Arthur Tatnall, Victoria University, Melbourne, Australia*

TC 5 – Information Technology Applications

*Erich J. Neuhold, University of Vienna, Austria*

TC 6 – Communication Systems

*Aiko Pras, University of Twente, Enschede, The Netherlands*

TC 7 – System Modeling and Optimization

*Fredi Tröltzsch, TU Berlin, Germany*

TC 8 – Information Systems

*Jan Pries-Heje, Roskilde University, Denmark*

TC 9 – ICT and Society

*David Kreps, University of Salford, Greater Manchester, UK*

TC 10 – Computer Systems Technology

*Ricardo Reis, Federal University of Rio Grande do Sul, Porto Alegre, Brazil*

TC 11 – Security and Privacy Protection in Information Processing Systems

*Steven Furnell, Plymouth University, UK*

TC 12 – Artificial Intelligence

*Ulrich Furbach, University of Koblenz-Landau, Germany*

TC 13 – Human-Computer Interaction

*Marco Winckler, University of Nice Sophia Antipolis, France*

TC 14 – Entertainment Computing

*Rainer Malaka, University of Bremen, Germany*

## **IFIP – The International Federation for Information Processing**

IFIP was founded in 1960 under the auspices of UNESCO, following the first World Computer Congress held in Paris the previous year. A federation for societies working in information processing, IFIP's aim is two-fold: to support information processing in the countries of its members and to encourage technology transfer to developing nations. As its mission statement clearly states:

*IFIP is the global non-profit federation of societies of ICT professionals that aims at achieving a worldwide professional and socially responsible development and application of information and communication technologies.*

IFIP is a non-profit-making organization, run almost solely by 2500 volunteers. It operates through a number of technical committees and working groups, which organize events and publications. IFIP's events range from large international open conferences to working conferences and local seminars.

The flagship event is the IFIP World Computer Congress, at which both invited and contributed papers are presented. Contributed papers are rigorously refereed and the rejection rate is high.

As with the Congress, participation in the open conferences is open to all and papers may be invited or submitted. Again, submitted papers are stringently refereed.

The working conferences are structured differently. They are usually run by a working group and attendance is generally smaller and occasionally by invitation only. Their purpose is to create an atmosphere conducive to innovation and development. Refereeing is also rigorous and papers are subjected to extensive group discussion.

Publications arising from IFIP events vary. The papers presented at the IFIP World Computer Congress and at open conferences are published as conference proceedings, while the results of the working conferences are often published as collections of selected and edited papers.

IFIP distinguishes three types of institutional membership: Country Representative Members, Members at Large, and Associate Members. The type of organization that can apply for membership is a wide variety and includes national or international societies of individual computer scientists/ICT professionals, associations or federations of such societies, government institutions/government related organizations, national or international research institutes or consortia, universities, academies of sciences, companies, national or international associations or federations of companies.

More information about this series at <http://www.springer.com/series/6102>


Petter Nielsen · Honest Christopher Kimaro (Eds.)


# Information and Communication Technologies for Development

Strengthening  
Southern-Driven Cooperation  
as a Catalyst for ICT4D

15th IFIP WG 9.4 International Conference  
on Social Implications of Computers  
in Developing Countries, ICT4D 2019  
Dar es Salaam, Tanzania, May 1–3, 2019  
Proceedings, Part I

*Editors*

Petter Nielsen   
University of Oslo  
Oslo, Norway

Honest Christopher Kimaro   
University of Dar es Salaam  
Dar es Salaam, Tanzania

ISSN 1868-4238                      ISSN 1868-422X (electronic)  
IFIP Advances in Information and Communication Technology  
ISBN 978-3-030-18399-8              ISBN 978-3-030-18400-1 (eBook)  
<https://doi.org/10.1007/978-3-030-18400-1>

© IFIP International Federation for Information Processing 2019, corrected publication 2020

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

The publisher, the authors and the editors are safe to assume that the advice and information in this book are believed to be true and accurate at the date of publication. Neither the publisher nor the authors or the editors give a warranty, expressed or implied, with respect to the material contained herein or for any errors or omissions that may have been made. The publisher remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

This Springer imprint is published by the registered company Springer Nature Switzerland AG  
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

## Preface

This book is a collection of papers presented at the 15th International Conference on Social Implications of Computers in Developing Countries (IFIP WG 9.4 2019 Conference) held in Dar es Salaam, Tanzania, May 1–3, 2019. The theme of the conference, “Strengthening Southern-Driven Cooperation as a Catalyst for ICT4D,” sought to stimulate and encourage critical discussions on the different facets of Southern-driven cooperation, its promises, potential for creating a better world, and the challenges we face in achieving the promised potential.

With the proliferation of ICT-related projects to support development, countries from the south are now emerging as important innovators and actors in the global development and adoption of ICT for community and economic growth. A good example is how Kenya and Tanzania have been leading the world with mobile payments for several years. The mobile payment services have supported micro financing and transformed economic activities and lives within the local communities and beyond. Such impacts offer an exciting setting for reverse innovation whereby lessons learned in ICT4D could offer rich insights for information systems research in general. Furthermore, strengthening a southern-driven cooperation promotes ICT initiatives and research carried out in and by developing countries. The conference, therefore, aimed at offering context-rich theories, methodologies and practical guidance on the use of ICTs to empower local communities.

Toward this goal, a request for track proposals was issued. After the evaluation we arrived at 11 tracks and two workshops, namely, Early Feedback to Early Career Researchers and the PhD Day Workshop. Only the research papers (97 full papers and two short papers) are included in this collection. The paper tracks were: Digital Platforms for Development; FinTech and Development; ICT4D for the Indigenous, by the Indigenous and of the Indigenous; Recognizing African Expression of Tech; Harnessing Agriculture; Land Administration and Public Financial Management for ICT4D; ICT for Displaced Population: How it helps, How it hurts; Communities, ICT-Enabled Networks, and Development; Pushing the Boundaries—New Research Methods, Theory and Philosophy in ICT4D; Southern-Driven Human–Computer Interaction; Locally Developed Process and Method Innovations in ICT4D; Sustainable ICT; Informatics, Education and Learning in a Turbulent World—“Doing the Safari Way.”

We received a total of 185 qualified papers from 46 countries, which were then sent for peer review. A double-blind peer review process was followed with each paper receiving an average of two reviews. The rigorous review process comprised 328 reviews, 248 of which came from 171 external reviewers. Of the 185 reviewed contribution, 99 were accepted and presented at the conference and are thus included in this collection.

For a large event like this conference to happen, a considerable effort by numerous individuals is required. We begin by thanking all the Program Committee members, the

local arrangements chairs, and 171 additional reviewers for their enormous efforts in reviewing the submitted papers. We also express gratitude to all the sponsors: the IFIP WG 9.4 ([ifipwg94.org](http://ifipwg94.org)), International Network for Postgraduate Students in the area of ICT4D (IPID, [ipid.se](http://ipid.se)), University of Oslo (UiO), College of ICT (CoICT) of the University of Dar es Salaam, Tanzania Telecommunication Corporation Limited (TTCL), UNICEF Tanzania, and several others. It was a great pleasure to hold the IFIP WG 9.4 2019 Conference in Dar es Salaam, Tanzania.

May 2019

Petter Nielsen  
Honest Christopher Kimaro

# Organization

## General Chairs

Nerey H. Mvungi                      University of Dar es Salaam, Tanzania  
Sundeep Sahay                      University of Oslo, Norway

## Program Committee Chairs

Petter Nielsen                      University of Oslo, Norway  
Honest C. Kimaro                      University of Dar es Salaam, Tanzania

## Steering Committee

Mussa Kissaka                      University of Dar es Salaam, Tanzania  
Prosper Mafole                      University of Dar es Salaam, Tanzania  
Wilfred Senyoni                      University of Oslo, Norway  
Honest Kimaro                      University of Dar es Salaam, Tanzania  
Nerey Mvungi                      University of Dar es Salaam, Tanzania  
Abdulla Ally                      University of Dar es Salaam, Tanzania  
Joel Mtebe                      University of Dar es Salaam, Tanzania  
Petter Nielsen                      University of Oslo, Norway  
Ellen Kalinga                      University of Dar es Salaam, Tanzania  
Kwame Ibwe                      University of Dar es Salaam, Tanzania  
Libe Massawe                      University of Dar es Salaam, Tanzania  
Abdi Abdalla                      University of Dar es Salaam, Tanzania  
Sundeep Sahay                      University of Oslo, Norway

## Program Committee

John Sören Pettersson                      Karlstad University, Sweden  
Brian Nicholson                      Manchester Business School, UK  
Prosper Mafole                      University of Dar es Salaam, Tanzania  
Petter Nielsen                      University of Oslo, Norway  
Johan Sæbø                      University of Oslo, Norway  
Wilfred Senyoni                      University of Oslo, Norway  
Nima Shidende                      University of Dodoma, Tanzania  
Devinder Thapa                      University of Agder, Norway  
Arunima Mukherjee                      University of oslo, Norway  
Antonio Diaz Andrade                      Auckland University of Technology, New Zealand  
Ellen Kalinga                      University of Dar es Salaam, Tanzania  
Abdi Talib                      University of Dar es Salaam, Tanzania  
Suzana Brown                      SUNY, South Korea



Terje Sanner	University of Oslo, Norway
P. J. Wall	Trinity College Dublin, Ireland
Elizabeth Maina	Kenyatta University, Kenya
Mikko Ruohonen	Tampere University, Finland
Reima Suomi	University of Turku, Estonia
Faheem Hussain	Arizona State University, USA
Rehema Baguma	Uganda Technology and Management University, Uganda
Marita Turpin	University of Pretoria, South Africa
Harminder Singh	Auckland University of Technology, New Zealand
Amber Young	University of Arkansas, USA
Angsana Techatassanasoontorn	Auckland University of Technology, New Zealand
Richard Heeks	The University of Manchester, UK
Jose Abdelnour-Nocera	University of West London, UK
Javier Osorio	Las Palmas de Gran Canaria University, Spain
Nicholas Blessing Mavengere	Tampere University, Finland
Stan Karanasios	RMIT University, Australia
Gertjan Van Stam	Nelson Mandela Metropolitan University, South Africa
Paul Van Asperen	University of Twente, The Netherlands
Kirstin Krauss	University of South Africa, South Africa
Faraja Igira	Institute of Finance Management, Tanzania
Emmanuel Eilu	Makerere University, Uganda
Machdel Matthee	University of Pretoria, South Africa
Rita Orji	Dalhousie University, Canada
Laura Hosman	Arizona State University, USA
Sandip Sarkar	University of Arkansas, USA
Ebenezer Laizer	University of Turku, Estonia
Rohan Bennett	Swinburne University, Australia
Tegawendé F. Bissyandé	University of Luxembourg, Luxembourg
Mussa Kissaka	University of Dar es Salaam, Tanzania
Honest Kimaro	University of Dar es Salaam, Tanzania
Nerey Mvungi	University of Dar es Salaam, Tanzania
Abdulla Ally	University of Dar es Salaam, Tanzania
Joel Mtebe	University of Dar es Salaam, Tanzania
Kwame Ibwe	University of Dar es Salaam, Tanzania
Libe Massawe	University of Dar es Salaam, Tanzania
Sundeep Sahay	University of Oslo, Norway
Omar Hamad	Zanzibar University, Tanzania

# Contents – Part I

## Communities, ICT-Enabled Networks, and Development

The Ins and Outs of Participation in a Weather Information System . . . . .	3
<i>Bidisha Chaudhuri and Linus Kendall</i>	
eHealth in Zimbabwe, a Case of Techno-Social Development. . . . .	15
<i>Trymore Chawurura, Ronald Manhibi, Janneke van Dijk, and Gertjan van Stam</i>	
ICT Use in the Context of Electricity Access in a Developing Country: A Choice Framework Analysis . . . . .	27
<i>Arlene Bailey, Aldrie Henry-Lee, Yhanore Johnson-Coke, Richard Leach, Anthony Clayton, Matt Gee, and Oliver Browne</i>	
An Inquiry into IT Governance in Healthcare Organizations in Uganda . . . . .	39
<i>Michael Kizito</i>	
Exploring an Impact Sourcing Initiative for a Community of People with Disabilities: A Capability Analysis . . . . .	51
<i>Karsten Eskelund, Richard Heeks, and Brian Nicholson</i>	
System Use and User Satisfaction in the Adoption of Electronic Medical Records Systems: A Case of DHIS2 Tracker Implementation in Tanzania . . .	63
<i>Immaculate Ayebazibwe, Honest C. Kimaro, and Jens J. Kaasbøll</i>	
Contemporary Challenges in Street Trader-Customer Interaction Through Mobile Devices in Dodoma, Tanzania . . . . .	76
<i>Joel Rumanyika, Matti Tedre, Mikko Apiola, Solomon Sunday Oyelere, and Nasibu Rajabu Mramba</i>	
Value Co-creation in Design of mHealth Applications for Maternal Healthcare Service Delivery . . . . .	89
<i>Hawa Nyende</i>	
A Framework for Understanding the Empowerment Effects of Telecentres on Rural Communities in Developing Countries . . . . .	104
<i>Sellina Khumbo Kapondera, Roberta Bernardi, and Niki Panteli</i>	
Leveraging Digital Health Platforms in Developing Countries: The Role of Boundary Resources . . . . .	116
<i>Brown Msiska, Petter Nielsen, and Jens Kaasboll</i>	

ICT Enabled Peace Network: Case Study of Conflict Early Warning System in Kenya . . . . .	127
<i>Arunima Mukherjee and Festus Mukoya</i>	
E-Commerce Institutionalisation in Mozambique: Enablers and Barriers . . . . .	140
<i>Fernanda Matsinhe and Salah Kabanda</i>	
The Influence of Telecentres on the Economic Empowerment of the Youth in Disadvantaged Communities of South Africa . . . . .	152
<i>Samkelo Lutho Booï, Wallace Chigona, Priscilla Maliwichi, and Khaya Kunene</i>	
Peer Networking and Capacity Building for Child Protection Professionals – Lessons from “ChildHub” . . . . .	168
<i>Sendrine Constant, Balwant Godara, Thierry Agagliate, Nihaalini Kumar, and Amara Amara</i>	
Investigating the Implementation of ICT Tool to Electoral Process in Nigeria. . . . .	181
<i>Aishatu Shuaibu, Salihu Dasuki, and Muhammadou Kah</i>	
<b>Digital Platforms for Development</b>	
A Multi-level Perspective on Digital Platform Implementation and Impact: The Case of EasyTaxi in Colombia . . . . .	195
<i>Juan Erasmo Gomez-Morantes, Richard Heeks, and Richard Duncombe</i>	
Exploring Tensions of Global Public Good Platforms for Development: The Case of DHIS2. . . . .	207
<i>Brian Nicholson, Petter Nielsen, Johan Saebo, and Sundeep Sahay</i>	
Software Platforms for Inclusive Innovation . . . . .	218
<i>Terje Aksel Sanner and Petter Nielsen</i>	
The Role of Digital Platforms in Disrupting Agricultural Value Chains in Developing Countries . . . . .	231
<i>Bookie Ezeomah and Richard Duncombe</i>	
Sharing Economy Digital Platforms and Social Inclusion/Exclusion: A Research Study of Uber and Careem in Pakistan . . . . .	248
<i>Fareesa Malik and Zujaja Wahaj</i>	
Strategies for Standardizing Health Information Analysis: Flexible Standards Revisited. . . . .	260
<i>Olav Poppe, Johan Ivar Sæbø, and Jørn Braa</i>	

An Institutional Perspective on the Adoption of Open Dashboard for Health Information Systems in Tanzania . . . . .	272
<i>Wilfred F. Senyoni, Honest C. Kimaro, Jørn Braa, and Claud Kumalija</i>	
Tracing the Impact of the City of Cape Town’s Open Data Initiative on Communities and Development . . . . .	284
<i>Mbongeni Hlabano and Jean-Paul Van Belle</i>	
Exploring Hybridity in Digital Social Entrepreneurship . . . . .	295
<i>Silvia Masiero and M. N. Ravishankar</i>	
What Motivates ICT4D Champions? . . . . .	307
<i>Jaco Renken</i>	
Digital Platforms in the Global South: Foundations and Research Agenda . . .	319
<i>Kari Koskinen, Carla Bonina, and Ben Eaton</i>	
Scaling Across Functional Domains: A Case of Implementing an Electronic HIV Patient Information System in Sierra Leone. . . . .	331
<i>Eric Adu-Gyamfi, Petter Nielsen, Johan Ivar Sæbø, and Zeferino Saugene</i>	
Mobile Phone Use for Empowerment and Well-Being of the Physically Challenged in Nigeria . . . . .	343
<i>Abdulrashid Iliya, Chidi G. Ononiwu, Muhammadou M. O. Kah, and Ago K. M. Quaye</i>	
Agile Software Development Practices in Egypt SMEs: A Grounded Theory Investigation . . . . .	355
<i>Amr A. Mohallel and Julian M. Bass</i>	
Experiences from a Development Project in Kenya – Baselines for Future Climate Information Systems . . . . .	366
<i>Jaakko Helminen, Balozi Bekuta Kirongo, Silvia Gaiani, Ezra Misaki, Mikko Apiola, and Erkki Sutinen</i>	
How South African University Information Systems Students Are Using Social Media. . . . .	378
<i>Yazeed Seedat, Sumarie Roodt, and Samwel Dick Mwapwele</i>	
Convergence of Technical and Policy Processes: A Study of Indonesia’s Health Information Systems . . . . .	390
<i>Taufiq Sitompul, Wilfred Senyoni, Jørn Braa, and Yudianto</i>	
IT and Government Corruption in Developing Countries: A Literature Review and Reframing . . . . .	402
<i>Atta Addo</i>	

The Contributions of WhatsApp to Social Inclusion: A Case of Internally Displaced Persons in Nigeria . . . . .	414
<i>Salihu Ibrahim Dasuki and Naima Hafiz Abubakar</i>	
Ride Hailing Regulations in Cali, Colombia: Towards Autonomous and Decent Work . . . . .	425
<i>Katherine M. A. Reilly and Luis H. Lozano-Paredes</i>	
Ex-Ante Analysis of Adoption of Introduced Chicken Strains Among Smallholder Farmers in Selected Areas of Tanzania. . . . .	436
<i>Rogers Andrew, Jeremia Makindara, Said H. Mbaga, and Roselyne Alphonse</i>	
Assessing User-Designed Dashboards: A Case for Developing Data Visualization Competency . . . . .	448
<i>Aprisa Chrysantina and Johan Ivar Sæbø</i>	
Is Inclusive Digital Innovation Inclusive? An Investigation of M-Shwari in Kenya. . . . .	460
<i>Wenxiu (Vince) Nan and M. Lynne Markus</i>	
Sinking Under Its Own Weight: Case of Aadhaar Mediated Entitlements in India . . . . .	472
<i>Arunima Mukherjee and Sundeep Sahay</i>	
Design Science Research Strengthened: Integrating Co-creation and Co-design . . . . .	486
<i>Calkin Suero Montero and Alsen Florian Kapinga</i>	
Institutional Shaping of Affordances: Implications on Information Use in Global Humanitarian Organizations. . . . .	496
<i>Marta Maria Vila-Pozo and Sundeep Sahay</i>	
Towards Holistic Mobile Climate Services for Farmers in Tambuu, Tanzania. . . . .	508
<i>Ville Myllynpää, Ezra Misaki, Mikko Apiola, Jaakko Helminen, Moammar Dayoub, Tomi Westerlund, and Erkki Sutinen</i>	
Anti-corruption Efforts in National ICT Policies: A Study of Policy Environments in Sub-Saharan Africa . . . . .	520
<i>Cecilia Strand and Mathias Hatakka</i>	
Integrating Electronic Medical Records Data into National Health Reporting System to Enhance Health Data Reporting and Use at the Facility Level . . . . .	532
<i>Bigten R. Kikoba, Ellen Kalinga, and Juma Lungo</i>	

Recommendations for M-Government Implementation in Developing Countries: Lessons Learned from the Practitioners . . . . .	544
<i>Tupokigwe Isagah and Maria A. Wimmer</i>	
Co-creating an ICT Artefact with Elderly Rural Women in Mafarafara: A Social Structuration Account . . . . .	556
<i>Ronel Smith, Marita Turpin, and Marlien Herselman</i>	
A Critical Analysis of the Implementation of Health Information Systems for Public Healthcare Service Delivery in Resource-Constrained Environments: A South African Study . . . . .	568
<i>Mourine Achieng and Ephias Ruhode</i>	
Acceptability and Use of Mobile Health Applications in Health Information Systems: A Case of eIDSR and DHIS2 Touch Mobile Applications in Tanzania . . . . .	579
<i>Jimmy T. Mbelwa, Honest C. Kimaro, and Bernard Mussa</i>	
The Experience of Chamwino Small-Scale Farmers on the Use of Smartphone in Farming Business, Tanzania . . . . .	593
<i>Ezra Misaki</i>	
Exploring the Effect of Mobile Apps on SMEs in Nigeria: A Critical Realist Study . . . . .	606
<i>Adedamola Tolani, Adebowale Owoseni, and Hossana Twinomurinzi</i>	
Evaluating mHealth Apps Using Affordances: Case of CommCare Versus DHIS2 Tracker . . . . .	619
<i>Amrit Chhetri, Mari Iversen, Jens Kaasbøll, and Chipso Kanjo</i>	
Investigating the Efficiency of ICT Infrastructure Utilization: A Data Envelopment Analysis Approach . . . . .	633
<i>Yinka Oyerinde and Felix Bankole</i>	
<b>ICT for Displaced Population and Refugees: How It Helps, How It Hurts</b>	
Mobile Technology for Record Keeping by Women Entrepreneurs in Tanzania: User Requirement Assessment . . . . .	649
<i>William Clifford Gomera, Jarkko Suhonen, Solomon Sunday Oyelere, and Alsen Florian Kapinga</i>	
Reimagining Refugee Identity Systems: A Sociological Approach . . . . .	660
<i>Shirin Madon and Emrys Schoemaker</i>	
‘When Will You Start Teaching the REAL Curriculum?’: Challenges and Innovations in Education for Rohingya Refugees . . . . .	675
<i>Azmina Karim and Faheem Hussain</i>	

Refugees and ICTs: Identifying the Key Trends and Gaps  
in Peer-Reviewed Scholarship. . . . . 687  
*Suzana Brown, Faheem Hussain, and Ali M. Masoumifar*

**Local Technical Papers**

Rate Adaptive Congestion Control Using Lookup Table Scheme  
to Enhance Quality of Experience. . . . . 701  
*Jane Lissah and Mercy Mbise*

Enhancing Faults Monitoring in Secondary Electrical  
Distribution Network. . . . . 712  
*Yona Andegelile, Godfrey Chugulu, Ally Bitebo, Hadija Mbembati,  
and Herald Kundaeli*

Handover Management in Femtocell LTE Networks Under Fast  
Varying Channels. . . . . 724  
*Catherine Protas and Kwame Ibwe*

Trends and Opportunities for Traffic Engineering Paradigms Across Mobile  
Cellular Network Generations. . . . . 736  
*Khadija Mkocha, Mussa M. Kissaka, and Omar F. Hamad*

Exploring the Impacts of Intrinsic Variables on Security Compliance  
Efficiency Using DEA and MARS. . . . . 751  
*Charlette Donalds, Kweku-Muata Osei-Bryson, and Sergey Samoilenko*

A Critical Review of Edge and Fog Computing for Smart  
Grid Applications. . . . . 763  
*Gilbert M. Gilbert, Shililiandumi Naiman, Honest Kimaro,  
and Burchard Bagile*

Information Security Culture Assessment of Small and Medium-Sized  
Enterprises in Tanzania. . . . . 776  
*Zainab Ruhwanya and Jacques Ophoff*

Correction to: A Framework for Understanding the Empowerment  
Effects of Telecentres on Rural Communities in Developing Countries. . . . . C1  
*Sellina Khumbo Kapondera, Roberta Bernardi, and Niki Panteli*

**Author Index. . . . . 789**

## Contents – Part II

### **Pushing the Boundaries - New Research Methods, Theory and Philosophy in ICT4D**

Southern Theories in ICT4D. . . . .	3
<i>David Kreps and Julian M. Bass</i>	
Combining Pragmatism and Critical Realism in ICT4D Research: An e-Resilience Case Example . . . . .	14
<i>Richard Heeks, Angelica V. Ospina, and P.J. Wall</i>	
Digital Development: Elements of a Critical ICT4D Theory and Praxis . . . . .	26
<i>Anna Bon and Hans Akkermans</i>	
Identifying Generative Mechanisms in a Mobile Health (mHealth) Project in Sierra Leone: A Critical Realist Framework for Retroduction . . . . .	39
<i>P.J. Wall, Dave Lewis, and Lucy Hederman</i>	
Capabilities and Affordances in the ICT4D Context: Similarities, Differences, and Complementarities. . . . .	49
<i>Devinder Thapa and Yingqin Zheng</i>	
A Framework to Explain the Relation Between ICT and Development: Combining Affordances and the Capability Approach . . . . .	60
<i>Mathias Hatakka, Øystein Sæbø, and Devinder Thapa</i>	
Method of Research in a We-Paradigm, Lessons on Living Research in Africa. . . . .	72
<i>Gertjan van Stam</i>	
Unpacking Empowerment in ICT4D Research . . . . .	83
<i>Priyanka Pandey and Yingqin Zheng</i>	
Adopting a Theory of Change Approach for ICT4D Project Impact Assessment - The Case of CMES Project. . . . .	95
<i>Yan Li and Manoj A. Thomas</i>	
Participatory Video, Giving Voice and Respect to the Epistemic Sovereignty of Communities in Rural Zimbabwe . . . . .	110
<i>Peter Makamba, Chido Matewa, Janneke van Dijk, Gertjan van Stam, and Peter Vhoko</i>	



Mechanisms Fostering the Misuse of Information Systems for Corrupt Practices in the Nigerian Public Sector. . . . . 122  
*Ibrahim Inuwa, Chidi Ononiwu, Muhammadou M. O. Kah, and Ago K. M. Quaye*

Rethinking Theory and Practice of ICT4D. An Analysis of the Discourse Embedded in the 2016 World Bank Report . . . . . 135  
*Calisto Kondowe and Wallace Chigona*

**ICT4D for the Indigenous, by the Indigenous and of the Indigenous**

Nexus Between Country Context and the Role of External Actors in the Formulation of National Information and Communication Technology Policies . . . . . 151  
*Gregory Kunyenje and Wallace Chigona*

Research in Africa for Africa? Probing the Effect and Credibility of Research Done by Foreigners for Africa . . . . . 168  
*Munyaradzi Mawere and Gertjan van Stam*

Decolonising Neo-Liberal Innovation: Using the Andean Philosophy of ‘Buen Vivir’ to Reimagine Innovation Hubs . . . . . 180  
*Andrea Jimenez and Tony Roberts*

Incorporating Indigenous Perspectives in Provision of E-government Services: The Case of Tanzania . . . . . 192  
*Bakari Mashaka, Neil McBride, and Kutoma Wakunuma*

Smart City for Development: A Conceptual Model for Developing Countries . . . . . 203  
*Luiz Antonio Joia and Alexander Kuhl*

Digital Technology for Preserving Cultural Heritage in Tonga . . . . . 215  
*Anau Mesui, Antonio Diaz Andrade, and Lena Waizenegger*

**Southern-Driven Human-Computer Interaction**

Socio-Technical HCI for Ethical Value Exchange: Lessons from India. . . . . 229  
*José Abdelnour-Nocera, Torkil Clemmensen, Morten Hertzum, Dineshkumar Singh, and Veerendra Veer Singh*

Usability Problems and Obstacles to Addressing Them in Health Information Software Implementations. . . . . 241  
*Magnus Li*

Human-Computer Interaction for Development (HCI4D): The Southern African Landscape . . . . .	253
<i>Judy van Biljon and Karen Renaud</i>	
A Local Perspective: Working an Agricultural Information Service into a Rural Community . . . . .	267
<i>Lars Rune Christensen, Hasib Ahsan, Mamunur Rashid, and Badal Kumar Das</i>	
Digital Wallets ‘Turning a Corner’ for Financial Inclusion: A Study of Everyday PayTM Practices in India. . . . .	280
<i>Tanmay Joshi, Sharmistha Swasti Gupta, and Nimmi Rangaswamy</i>	
Research in Progress: Holistic Climate Service Prototypes for Farmers in Tambuu, Tanzania. . . . .	294
<i>Ville Myllynpää, Jaakko Helminen, Ezra Misaki, Mikko Apiola, Jani Haakana, Tomi Westerlund, and Erkki Sutinen</i>	
Factors that Influence Workers’ Participation in Unhygienic Cyber Practices: A Pilot Study from Nigeria . . . . .	303
<i>Princely Ifinedo, Nigussie Mengesha, and Olumide Longe</i>	
Investigating the Adoption of an Integrated Hospital Information System in Rural Uganda: A Case of Kisiizi Hospital . . . . .	316
<i>Amos Baryashaba, Angella Musimenta, Samuel Mugisha, and Leonard Peter Binamungu</i>	
Using PESTELMO to Frame HCI Contextual Development in Developing Countries . . . . .	326
<i>Catherine G. Mkude and Maria A. Wimmer</i>	
<b>Sustainable ICT, Informatics, Education and Learning in a Turbulent World - “Doing the Safari Way”</b>	
Information Systems Education for Development: A Typology of ICT4D Pedagogies . . . . .	337
<i>Gwamaka Mwalemba</i>	
Data Science Postgraduate Education at University of Dar es Salaam in Tanzania: Current Demands and Opportunities . . . . .	349
<i>Betty Mbwilo, Honest Kimaro, and Godfrey Justo</i>	
The Role of Human Centered Design (HCD) and Challenge Driven Education in Enhancing the Innovation Capacity of Africa’s Young People: Case of Youth for Children (Y4C) Innovation Hub in Tanzania . . . . .	361
<i>Hellen Maziku, Joseph Cosmas, Norah Maki, Honest Kimaro, and Charles Otine</i>	

Towards Developing Interactive Content for Enhancing Life Skills Education in Tanzania: Possibilities and Pitfalls . . . . .	374
<i>Christian M. Budoya, Mussa M. Kissaka, and Joel S. Mtebe</i>	
Community-Centered, Project-Based ICT4D Education in the Field . . . . .	386
<i>Anna Bon, Jaap Gordijn, Hans Akkermans, Victor de Boer, André Baart, Cheah Wai Shiang, and Sze San Nah</i>	
Building Sustainable Collaborations and Academic Networks in Low Income Countries: Case of Master Programmes . . . . .	398
<i>Jens Kaasbøll, Chipo Kanjo, and Honest Kimaro</i>	
Information and Communication Technology in Mathematics Education – Integration Readiness in Tanzania Higher Education Institutions . . . . .	409
<i>Mzomwe Yahya Mazana, Calkin Suero Montero, and Solomon Sunday Oyelere</i>	
eLearning in an African Place: How ‘Alien’ eLearning Models Are Failing Many in Africa . . . . .	421
<i>Munyaradzi Mawere and Gertjan van Stam</i>	
Developing Multimedia Enhanced Content to Raise HIV/AIDS Awareness to Children . . . . .	433
<i>Patricia Makuru, Fatuma Simba, and Ellen Kalinga</i>	
<b>Author Index . . . . .</b>	<b>445</b>

# **Communities, ICT-Enabled Networks, and Development**



# The Ins and Outs of Participation in a Weather Information System

Bidisha Chaudhuri<sup>1</sup> and Linus Kendall<sup>1,2</sup>(✉)

<sup>1</sup> International Institute of Information Technology, 26/C, Hosur Road, Electronics City Phase 1, Electronic City, Bengaluru 560100, Karnataka, India  
bidisha@iiitb.ac.in, me@linuskendall.com

<sup>2</sup> Sheffield Hallam University, Howard Street, Sheffield S1 1WB, UK

**Abstract.** In this paper our aim is to show even though access to technology, information or data holds the potential for improved participation, participation is wired into a larger network of actors, artefacts and information practices. We draw on a case study of a weather information system developed and implemented by a non-profit organisation to both describe the configuration of participation, but also critically assess inclusion and exclusion. We present a set of four questions - a basic, practical toolkit - by which we together with the organisation made sense of and evaluated participation in the system.

**Keywords:** Participation · Participatory development · Rural and agricultural development · Open development

## 1 Introduction

The question of participation has long been debated in the development discourse [6, 7, 9]. Participation in this context means exercise of agency of presumed beneficiaries in setting and implementing goals of development initiatives [16]. Although not a recent concept in the development vocabulary, emphasis on participatory approaches rose in prominence from the 1980s onward as a critique of top-down modernization approaches in defining development priorities, solutions, or metrics [5, 10, 11, 21]. Failure of earlier approaches brought two main points to focus; firstly that development initiatives need to place local realities at the centre, where local people are not mere recipients of but rather active participants in shaping development; secondly, moving from depoliticised, technocratic implementation of project goals to transforming power relations [5, 11]. However, participatory approaches in development faced backlash in early 2000 for reducing participation into another metric without much meaning for either empowerment or transformation of local communities [7, 18, 23, 28]. The main questions that drives these critiques are: Does more participation mean more development? How do we measure the quality of participation? How do we understand the contested spaces of participation in relation to the broader institutional and structural underpinning of popular agency? [8, 16]. Emerging from these critiques is the positioning of participation within the interface of structure and agency and the lived spaces within which participation takes place [9, 16]. This shifts the focus to practices of

development instead of its outcome. In this paper we look at participation in relation to Information and Communication Technologies (ICTs) in development initiatives.

ICTs have been a critical part of development initiatives under the rubric of ICTs for Development (ICT4D) since late 1980s [14]. The assumption that development in the information age will depend on access to ICTs and the education to use it (digital literacy) dominated until early 2000 [4, 20]. However, the focus on access and the associated agenda to mend the digital divide across geographies and communities received serious criticism for neglecting structural factors shaping access to and meaningful engagement with digital technologies post access [26, 27]. Gradually, the discussion within development theories around ICTs moved from digital divide to digital inclusion. Digital inclusion typically addresses issues of access, skills, resources, infrastructure and social positions [15, 27]. Overall, the discourses in ICTD moved from access to participation [26, 27]. However, failure to account for the notion of participation continues to concern both development researchers and practitioners. Two major concerns we identify as prominent in ICTD literature are: how to examine participation and how to evaluate its implications for development initiatives. A subset of ICT4D literature that have substantially engaged with the concept of participation is that of open development [1]. The term open started to be used as a prefix for a variety of terms such as knowledge, data, science, innovation and more importantly for development itself since early 2000 [25]. Open development can be defined as the free (both in access and cost terms), networked, non-discriminatory sharing of digital (information and communication) resources towards a process of positive social transformation [24]. Openness suggests potential for ICT-mediated social interactions to create more flexible social structures by creating more spaces of participation and collaboration [24]. But Singh and Gurumurthy [22] argue, “open ICT4D frameworks seems to overlook the ever-present dimension of power manifest in new forms of networked relationships. The outward appearance of access, participation, and collaboration can mask less desirable social and political outcomes undermining equity and social justice” (p. 176). Smith and Seward [25] suggest a practice-based framework of openness as social praxis dividing it into processes of open production, distribution and consumption - they argue, “even the most well-intentioned participation process discriminates against some, and there are some costs associated with accessing and using content, even if it is just ones time”. Access, use and contribution all face social, economic, political or cultural barriers [25].

Beyond practices, we propose to critically analyse ICTs most constituent element, information itself. Many argue that ICTs are responsible for overload of information, information reductionism, and decontextualisation of information [2, 3, 12]. When we think about access to ICTs we often end up obscuring the politics embedded in the information itself. Participation gets intricately related to the politics of information as it again highlights the social and structural factors shaping individual action or agency. For example, Mulder et al. [19] in their analysis of crowd-sourced Big Data for inclusive humanitarian response argues that “all data, including Big Data, are socially constructed artefacts that reflect the contexts and processes of their creation” (p. 1). Data (or information) are neither raw nor objective and are in fact, dependent on social and cultural impediments [13]. Therefore, who collects data, who participate in data (information) making, who mediates access to information are as ever more important

questions to understand how people gets to excise their choices and voices in shaping development agenda with or without ICTs.

Based on the above discussion, we argue that there are two important dimensions of participation in and through ICTs. First, the practices that are built around ICTs and second, the content of information that drive ICTs. In this paper, we set out to address these complex questions about notion of participation in development by observing everyday practices around an information system as deployed under a development initiative in West Bengal, India. The information system we have studied is a system to generate weather forecasts and agricultural advisories for small-scale farmers. While there are existing weather forecast services for farmers in India provided by the Indian Meteorological Department (IMD) these faced two main problems. On the one hand they would provide forecasts for a much too large area, making them inaccurate for specific farmers, and on the other hand, the forecasts would not be easily accessible by small scale farmers in remote villages. In response, a system was designed to disseminate forecasts based on locally collected data that allowed preparation of accurate, meso-scale forecasts combined with relevant agricultural advice. The implementing agency for the project was a medium sized non-profit organisation which had for a long time been based in the region. The focus of the non-profit lay on the sustainability of farming livelihoods - both from an economic and ecological standpoint - focusing on organic farming and agroecology. Our aim is to show even though access to technology, information or data holds the potential for improved participation, participation is wired into a larger network of actors, artefacts and practices. To be able to do this, we have developed a simple toolkit intended to be a practical approach by which to analyse and deconstruct participation. We use this toolkit in our work with the organisation to support them in conceptualising participation within the project.

## 2 A Practical Toolkit for Participation

As the above studies indicate, we see that participation is far from straight forward and truly unfolds only in everyday practices. In order to capture this complexity of participation we propose a framework based on four main and interrelated questions. In developing these questions, we draw on Smith's and Seward's open production, distribution and consumption as types of practices taking place around an information system.

*What constitutes information or data in the system?* This concerns two processes; firstly, what information is considered important enough to be part of information platform/system (IS), secondly, what form does information take on a system/platform or in other words in what form the selected information is presented. We argue that information-making and its subsequent curation displays the socially constructed nature of information and denotes what sort of structural limits are imposed on its potential use.

*Whose agency is realized in the becoming of information or data?* This question addresses the issue of in- and exclusion in the production, distribution and consumption of information. We ask which actors play what role at each level of information

processes and how each of these actors are positioned in the larger society beyond the IS.

*How is this agency realized through everyday practices?* Here the question is invoked to understand the context of participation in an IS. In a way we propose to look at participation, not as a matter of degree but of kind. We focus on the quality of participation in and around the IS, to what extent such participation is a function of participants own volition, and whether participation has implications for their existing social positions and social practices.

*For whom and in what do we address participation or lack thereof?* This question stems from the assumption that participation is always ensconced in the relations of power. Improved participation may not mean much unless we ask who is participating in what. For example, are women participating more in unpaid work? Does more participation of men in public spaces mean less participation by women in the same space? We need to ask how we address and challenge existing processes of participation in an iterative way that does not presume any direct, linear and non-differentiated development of participation.

### 3 Methodology

In order to study the way participation unfolded throughout the project we based our methodology on a multi-method case study approach [29]. We employed participant observation, semi-structured interviews, informal conversations, focused group discussions, photo documentation at various sites as well as collection of work materials and project documentation. We began the first phase of our research with discussions with organisations head office staff in Kolkata. After these interviews, we conducted preliminary visits to the two districts where the system was deployed - Purulia and Bankura. During these visits, which took place in June 2016, we engaged in two rich picture drawing workshops with field office staff [17]. Drawing rich pictures with staff was a useful approach for our mapping purposes, helping us to identify both the actors as well as locations, challenges and issues faced in the system. At the same time, it provided us with an overview of how the system operated in practice and the information flows that took place through it. It helped us select the villages to focus on as we gathered data about their involvement in the system. As the boundaries of the system in terms of geographical locations were ill-defined, and it was intentionally broadly accessible, it was impossible to gauge the exact extent of the system in terms of the number of villages covered or number of users. The implementing organisation, however, specifically targeted 40 villages (18 in Purulia, 22 in Bankura). We decided to limit our case to Purulia. From the 18 villages in that district we selected five. To select the five villages included in our research, we assessed the level of engagement by all villages with the system. To define level of engagement we listed the different ways in which the village was engaged with the system. Firstly, through access to the various artefacts that made up the system - automated weather stations, manual data collection units and blackboards used for information dissemination. Secondly, we looked human-mediated participation with the system in village group meetings, interaction



between field workers and villagers, and the presence of village volunteers. We chose three villages with a high degree of access to the artefacts of the system along with many forms of participation, one village with limited forms of participation as well as limited access to the artefacts and finally one village with many forms of participation but with limited access to artefacts. While the first three villages were intended to be our main focal points for understanding the system's impact, the second two villages were chosen to allow for comparing the role of participation and access to artefacts as well as to represent the diversity of roles the system might play in different villages.

We sought to observe changes in the way people learned and interacted with the system over time and therefore we conducted monthly, repeated visits to villages over 6 months. Visits to the project area involved interviews lasting up to an hour with field office staff, as well as both individual interviews and group discussions in the chosen villages. In each village, we initially spoke to the people formally tasked with managing the system and then adopted the "snowball" sampling method to target various actors using or operating the system. We held group interviews with women's and men's groups in the village as well as attended regular group meetings. Interviews with individual villagers included the *majhis* of each village, who are the traditional authorities. While we sought to conduct individual semi-structured interviews, we also found that informal conversations and impromptu group discussions were valuable sources of information. This work was documented through field journals as well as recordings and photography where possible. Interviews were repeated at least two times, in some cases up to four times, capturing how involvement with the system changed over six months. Starting from 2018 we participated in development of the project on the basis of the understandings that our toolkit provided. This sought to address some of the challenges to participation identified through the initial study a new geographical location.

## 4 Artefacts, Actors and Practices

Below we present the case study through its artefacts, actors and practices. Building our analysis around who is involved and what their practices around the IS are is the foundation for being able to move on to apply our toolkit or framework in analysing the system.

### 4.1 Artefacts

The main artefact produced as part of the system's information flow is the weather forecast and the agricultural advisory. The weather forecasts contain a five day forecast - covering rainfall, temperature and wind. The associated agricultural advisory contains recommendations with regards to irrigation, harvesting, potential pest attacks and remedies and other cropping practices. The agricultural advisory is written on the basis of the forecast, combining both activities related to the season as well as the specific weather patterns for the next five days. For dissemination, the agricultural advisory and weather forecasts are printed on A3 sheets of paper as well as written by hand on blackboards installed throughout participating villages. They are also be sent out via

SMS to selected farmers. As part of generating data for the forecasts, other artefacts are involved. At three locations in the area automated weather stations (AWSs) have been installed. These continuously log data on rainfall, temperature, humidity, wind speed and direction. There are also manual weather stations in several participating villages. These consist of a rain gauge as well as a device to measure humidity and temperature.

## 4.2 Actors

On the village level, there are the farmers who are the primary intended beneficiaries of the system. In each village there is also a volunteer who is responsible for collecting manual weather data as well as disseminating forecasts to the village. These volunteers were sometimes farmers themselves and in other cases they were young people who had enough schooling to know how to read and write. On the block level, are the field workers of the non-profit organisation. These field workers are involved in organising the collection of data from the automated weather stations as well as receiving the forecasts and advisories, printing them and disseminating them to the village volunteers. The field workers would communicate thus collected weather information to the meteorologist. Located at the head office of the organisation, in Kolkata, are the project staff. They communicated with the agricultural experts and the meteorologist to gather data and provide it to the field workers. The final actors - the agricultural expert and meteorologist - were both external to the organisation. The meteorologist was based in another non-profit organisation in another state in India and the agricultural expert in an agricultural university.

## 4.3 Practices

There were four main practices involved in the running of the system. Following Smith and Seward, we can think of these as part of production, dissemination and consumption practices. The first two practices relate to the production of information in the system. The first practice covered collecting observed weather data and involved the meteorologist, village level volunteers as well as field staff. Village volunteers would keep a daily notebook of temperature, humidity and rainfall using equipment provided by the organisation. On a weekly basis, this information would be photocopied by the field worker who would then enter it into an Excel sheet. The field worker would also travel to the automated weather stations to download data from them. These manual and automated observations would then be sent to the meteorologist. The second practice when it comes to production was generating the forecasts and agricultural advisory. The meteorologist would collect weather data and combine it with data sourced from the Indian Meteorological Department (IMD) to feed into a weather forecasting model. From the output of this model he would generate a 5 day forecast. This 5 day forecast would be framed in simplified terms as deemed relevant by the meteorologist. He would then forward it to the agricultural expert, who would write an advice based on the current cropping season and the specific weather forecast. The project staff in Kolkata would then receive both the forecast and advice. However, since the agricultural expert would mostly term his recommendations on basis of conventional agricultural practice, the project staff in Kolkata would then translate it

into organic recommendations - for instance recommending application of organic pest repellents rather than synthetic pesticides. The third practice was the dissemination of forecasts and advice. Here the village volunteers played a key role. While initially the organisation intended to primarily rely on SMS for dissemination this turned out to be unworkable for multiple reasons, primarily because of difficulties encoding Bengali writing in ways which the - often low-cost - feature phones used by farmers in the area could display. Therefore, they relied on print outs of the forecasts and reports to be pasted in various locations in the villages. Furthermore, each village had a blackboard which the village volunteers regularly updated with forecasts and reports. The blackboards were located in village squares and other gathering points allowing farmers to access and view the reports. Finally, farmers would hold regular group meetings. At these, the volunteers would present and discuss the latest forecasts and how the farmers may respond to them. This last dissemination practice also relates to consumption of the data. Partly, farmers would participate actively in the consumption process by discussing the advice and forecasts given, and combine it with their own knowledge and experience. There was also a fourth practice that involved the feedback and evaluation of the generated forecast. The weather data collected manually by the volunteers, as well as that collected automatically by the automated weather station would be used to evaluate the accuracy of the forecasts at the village level. Additionally, field workers were intended to regularly collect feedback from the farmers on their perception of the forecasts and advisories.

## **5 Understanding Participation**

As discussed above, there were several participatory elements of the project. Not only were villagers and farmers groups engaged in the production of data within the system - form of crowdsourcing - they were also actively involved in dissemination and consumption of the generated forecasts and advisory. However, simply providing opportunities or spaces for participation is insufficient without a further analysis of patterns of inclusion/exclusion. We therefore turn now to applying the four questions we presented as a practical toolkit in the beginning of this paper.

### **5.1 What Constitutes Information?**

We note that what constitutes information within the system was largely framed through the non-profit's objectives of enabling their view of sustainable agricultural development. The choice of weather forecasts as important information was based on the organisation's focus and framing of the project as adaptation to climate change.

In observing the development of the programme, we noted that even within the organisation there were disagreements as to what was important information. While initially more senior training staff were involved in analysing and framing the agricultural advisory texts, they were later excluded. It turned out that the concept of specific and targeted - primarily reactive - agricultural advice was difficult to combine with the more holistic view of agroecology that emphasised proactive approaches and long-term farm development as the main approach to handling issues faced by farmers.

Another issue related to the fact that the advice was generated by an agricultural expert far removed from the field site. This meant that he sometimes provided advice ill-suited to the specific crops and cropping practices of the farmers involved in the project. His idea of what crops to focus on was based on the major cash crops of the region - not necessarily the crops of greatest relevance to small and marginal farmers. Furthermore, he would often include advice based on mainstream, non-organic practices. Project team members would respond to these difficulties by editing the recommendations, sometimes making them very generic as they lacked access to specific, weather-linked, remedies based on organic practice. Many of the farmers found the edited advisory lacking, as they claimed they could not identify with it because “they were not organic farmers” or did not have access to the necessary inputs. Furthermore, even though project staff would alter the type of crops discussed in the advisory, the advisory would still primarily emphasise major crops such as rice or vegetables. The choice to focus on agricultural practices and on major crops, meant that other needs were not specifically addressed. We observed how field workers would adjust and invent new recommendations based on the weather forecasts when presenting them to different groups. For example, when discussing with the womens groups they would rather talk about the forecast in the context of livestock management or house construction – two areas that fell under the responsibility of women in the villages. Likewise, other livelihood activities undertaken by the villagers - such as daily labour in construction work in towns (for which the forecast was used by some villagers) - were comparatively neglected in the planning and development of the system.

When it came to the forecasts themselves, these were adapted by the meteorologist who designed them to provide less data so as not to be confusing. He also ensured that meteorological terms were matched with local terms. This, however, made the reports more generic and occasionally led to difficulties for the farmers in telling what specifically they referred to. Other important information in the system was the weather data collected by the villagers and field workers through manual and automated weather stations. In combination with this data, feedback on the weather forecasts was collected occasionally, though the organisation found it difficult to gather this in a systematic way. However, we observed that several villagers involved in this collection had both rich information about the weather as well as combined the data they collected, the provided forecasts and data, as well as their traditional knowledge of weather to create their own understanding and predictions. This kind of mash-up information was largely invisible to the implementing organisation in Kolkata or the experts located elsewhere.

## **5.2 Whose Agency Is Realized in the Becoming of Information or Data?**

The participation of various actors in production, distribution and consumption of information throughout the system was varied. The organisation itself exercised strong agency, even in relation to the experts providing the majority of the technical knowledge, by editing and reframing the recommendations on the basis of their aims and goals. This ability may partially be understood from the long-term work of the organisation in their field, providing them with a sense of understanding and expertise about the farmers’ situation and cropping practices - even though they admitted to

lacking detailed knowledge of specific practices that could respond to specific weather conditions. However, the organisation was also affected by the priorities of the funder in framing climate change and weather as the most critical issues to address.

In the target region for implementation, the role intended for local actors involved was focused on dissemination and consumption of forecasts and agricultural advisory. However, as most of the field staff - as well as all village volunteers - were recruited from the local area and were provided with relative freedom by the organisation, allowed them to exercise considerable agency in the way that dissemination and consumption was practiced. This was especially important for actors who were not fully included in the planning for the system. The advice provided through the system primarily benefited male farmers - who were responsible for the major crops (rice and limited vegetables) - and specifically those who had for a long time been involved with the organisation. Other farmers - who to a greater degree practiced conventional agriculture - and women in the villages - whose responsibilities centered on smaller crops, livestock and housing - were comparatively neglected. Equally, those who did not own land and managed their livelihoods as day labourers or in employment in smaller industries such as brick kilns were not able to equally participate in the system.

Village volunteers who participated in collecting local weather data and disseminating forecasts were in several cases young students or recent class 12 graduates. They were recruited as they could read and write, and were thus better educated than most others in their villages. However, that they were recruited from local villages and often related to or at least known to others in the village enabled their active participation in disseminating the data.

### **5.3 How Is This Agency Realized Through Everyday Practices?**

We now return to the everyday practices of production, dissemination and consumption discussed above. Firstly, when it come to the production of the data, the main actors both in plan and in practice were the two experts as well as the staff from the head office of the organisation. Not only did they produce the data underpinning much of the system, they also served as the primary translators and gatekeepers deciding what data and in which format it would be provided to the farmers. However, the participation of village volunteers in the production process served important purposes. Not only did it allow the village volunteers to be recognised and act as experts in their villages, but it also provided them with greater understanding of the weather forecasts themselves. This allowed several volunteers and field workers to strengthen their own social position through their participation in the production process.

When it comes to dissemination and consumption, the fact that most of the dissemination activities were managed within the village with the active participation of volunteers was important for several reasons. It strengthened the social position of the volunteers, by making their role highly visible. It also created a sense of ownership among other villagers, as they knew that there was a village member who received this data and should disseminate it. Furthermore, villagers were able to reinterpret and reframe the data provided specifically towards their own needs. This was enabled by the organisation opting to provide weather data in addition to agricultural advice, thus allowing different groups of participants to use the information provided. For example,

female farmers could use the temperature data as an indicator whether they should allow their livestock to graze or children to go to school. Likewise, day labourers could use the system to decide whether there would be work available on a given day or not.

#### **5.4 For Whom and in What Do We Address Participation or Lack Thereof ?**

We used the analytical approach drawn from this toolkit of questions to understand the second phase design of the project. During this phase we undertook the implementation of the same innovation in a new geographic area. Here we relate two of the changes to the programme we identified on the basis of our analysis of participation.

Seeing the impact of village volunteers participating in data production and dissemination, we began by recruiting and training a volunteer in each village. Rather than aligning ourselves with power structures already in place - which had been the approach in the previous district - we recruited students, as they had opportunity for meaningful participation and could draw direct benefit from participating. We ensured that funding was available to place a manual weather station in each village. If viewed from the information needs of the meteorologist, this was a lot more than what was required, however when drawing on our understanding of participation we saw this as a means by which to support participation. We specifically adopted a gender perspective in identifying locations where to place notice boards with weather information. The list of locations drawn up by field staff included places around the tea shop, on the main road, etc. and tended to ignore the sites where women congregated. While traveling through the villages a new set of public locations were therefore identified through discussions with village women - for example near the temple, where the water pump was, around the ration shop. The two examples given above are a few ways in which we have tried to use this toolkit, as part of the ongoing development of the information system. With the help of our framework we were able to reconfigure the relationships between artefacts, actors and practices while expanding the system in new contexts. This ultimately allowed us to approach participation neither as a property nor outcome of a development intervention, but rather as a dynamic process.

## **6 Conclusion**

Through our case study, instead of looking at varied degrees of participation, we sought to highlight for whom and how it is participatory. As has now been well established patterns of inclusion and exclusion plays an important part in the development impact of interventions. We have employed a simple toolkit consisting of four questions in looking at our case and, together with the implementing organisation, used the insights thus generated to develop their programme further. We identified that the establishment of participatory practices related to production, dissemination and consumption of information within the system was of central importance. We conclude that the toolkit, consisting of four simple questions, drawing on an initial analysis of artefacts, actors and everyday practices, is a useful tool by which practitioners and academics can develop shared understandings of the encumbrances of participatory initiatives.

## References

1. Benkler, Y.: *Open Development: Networked Innovations in International Development*. MIT Press, Cambridge (2014)
2. Brown, J.S., Duguid, P.: Knowledge and organization: a social-practice perspective. *Organ. Sci.* **12**(2), 198–213 (2001)
3. Brown, J., Duguid, P.: Organizational learning and communities of practice: toward a unified view of working, learning, and innovation. In: *Knowledge and Communities*, pp. 99–121. Elsevier (2000)
4. Castells, M., et al.: *Information technology, globalization and social development*, vol. 114. United Nations Research Institute for Social Development, Geneva (1999)
5. Chambers, R.: Poverty and livelihoods: whose reality counts? *Environ. Urban.* **7**(1), 173–204 (1995)
6. Cleaver, F.: Paradoxes of participation: questioning participatory approaches to development. *J. Int. Dev.* **11**(4), 597–612 (1999)
7. Cooke, B., Kothari, U.: *Participation: The New Tyranny?* Zed Books, London (2001)
8. Corbridge, S., Williams, G., Srivastava, M., Veron, R., et al.: *Seeing the State: Governance and Governmentality in India*, vol. 10. University Press Cambridge, Cambridge (2005)
9. Cornwall, A.: Making spaces, changing places: situating participation in development. IDS Working Papers (2002)
10. Escobar, A.: Imagining a post-development era. In: *Power of Development*, pp. 211–227 (1995)
11. Ferguson, J.: The anti-politics machine. In: *The Anthropology of the State: A Reader*, pp. 270–86 (1990)
12. Ferguson, J., Soekijad, M.: Multiple interests or unified voice? Online communities as intermediary spaces for development. *J. Inf. Technol.* **31**(4), 358–381 (2016)
13. Gitelman, L.: *Raw Data is An Oxymoron*. MIT Press, Cambridge (2013)
14. Heeks, R.: *Information and communication technologies, poverty and development*. Institute for Development Policy and Management, University of Manchester, Manchester (1999)
15. Helsper, E.: *Digital inclusion: an analysis of social disadvantage and the information society*. Department for Communities and Local Government (2008)
16. Hickey, S., Mohan, G.: *Participation—From Tyranny to Transformation? Exploring New Approaches to Participation in Development*. Zed Books, London (2004)
17. Monk, A., Howard, S.: Methods & tools: the rich picture: a tool for reasoning about work context. *Interact.* **5**(2), 21–30 (1998)
18. Mosse, D.: Power relations and poverty reduction. In: *Power, Rights, and Poverty: Concepts and Connections*, p. 51 (2004)
19. Mulder, F., Ferguson, J., Groenewegen, P., Boersma, K., Wolbers, J.: Questioning big data: crowdsourcing crisis data towards an inclusive humanitarian response. *Big Data Soc.* **3**(2) (2016). <https://doi.org/10.1177/2053951716662054>
20. Norris, P., et al.: *Digital Divide: Civic Engagement, Information Poverty, and the Internet Worldwide*. Cambridge University Press, Cambridge (2001)
21. Sen, A.K.: *Development as Freedom*. Oxford University Press, Oxford (2001)
22. Singh, P.J., Gurusurthy, A.: Establishing public-ness in the network: new moorings for development—a critique of the concepts of openness and open development. Chapter 7 (2013)
23. Slater, D.: *New Media, Development and Globalization: Making Connections in the Global South*. Wiley, Hoboken (2014)

24. Smith, M.: Being open in ICT4D. SSRN 2526515 (2014). <https://doi.org/10.2139/ssrn.2526515>
25. Smith, M.L., Seward, R.: Openness as social praxis. *First Monday* **22**(4) (2017)
26. Warschauer, M.: Reconceptualizing the digital divide. *First Monday* **7**(7) (2002)
27. Warschauer, M.: *Technology and Social Inclusion: Rethinking the Digital Divide*. MIT Press, Cambridge (2004)
28. Williams, G.: Evaluating participatory development: tyranny, power and (re)politicisation. *Third World Q.* **25**(3), 557–578 (2004)
29. Yin, R.K.: *Case Study Research and Applications: Design and Methods*. Sage Publications, Thousand Oaks (2017)





# eHealth in Zimbabwe, a Case of Techno-Social Development

Trymore Chawurura<sup>1</sup>, Ronald Manhibi<sup>2</sup>, Janneke van Dijk<sup>2</sup>,  
and Gertjan van Stam<sup>2</sup>(✉)

<sup>1</sup> Ministry of Health and Child Care, Harare, Zimbabwe

<sup>2</sup> SolidarMed, Masvingo, Zimbabwe  
gertjan@vanstam.net

**Abstract.** This paper presents a transdisciplinary eHealth narrative as it appears to health professionals, information and communication technology experts, and health practitioners in Zimbabwe. Harvesting from rich experiences and focus group discussions, the embedded authors present how various traditions position eHealth. Reflecting upon the genesis of the multiple perspectives – anthropological, computer science, medical, among others – this paper presents a practice of eHealth in Zimbabwe. The paper serves as a rationale for aligning eHealth with people, processes, systems and categorisations that consider the local cultures, the local way of meaning-making, and value local systems.

**Keywords:** eHealth · Development · Africa

## 1 eHealth

The World Health Organisation [1] defines eHealth as “the cost-effective and secure use of ICT in support of health and health-related fields, including health-care services, health surveillance, health literature, and health education, knowledge and research.” eHealth is seen as crucial in achieving universal health coverage by 2030 as outlined in Sustainable Development Goal #3. In contemporary practices, eHealth comprises of rapidly developing and decentralised client-provider forms of health care provisioning based on facilities emerging from ubiquitous information and communication technologies (ICT) and the increasing mobility of people and resources. Further, eHealth enhances the accessibility of clinical data for decision making by health professionals at all levels and facilitates the visibility of information as feedback for continuous health improvement in communities, by individuals, and in the health systems.

The growth of connectivity, devices, and platforms has a direct effect on the available channels of communication and information. The pervasiveness of ICT impacts all aspects of life, including healthcare and the prevention of disease, through new opportunities for information exchange between health clients and health providers. The richness of information flows is enhanced by graphical tagging through Geographical Information Systems (GIS) and by crowdsourcing [2]. eHealth, therefore, represents a field that is to be conceptualised not as subservient to current forms of health care, but as an integral part of such a care. eHealth does not necessarily replace the ‘older systems’ of health care provisioning. Instead, it gives scalability and ability

to additional forms of health care and, thus, overlays and coexists with it. Advanced information technology and the integration of information systems through telecommunication networks and services, including Internet applications, are used to increase operational efficiency, efficiencies in decision-making processes, and management effectiveness [3]. Therefore, eHealth is a horizontal contemporary to the current means of health management and supports health and health care provisioning, operating in the same space. eHealth, however, changes the space as it questions of the spatiality (the reach) of local practices in health. Therefore, eHealth thrives on inputs from social, cultural, health, and information systems. It opens up both exciting opportunities and real threats to the central features of contemporary health management in Africa. eHealth challenges the spatialisation of the (local) health institute and the encompassing role of national health governance. ICTs, through their global nature, alter or bridge spatial imaginaries [4]. Due to new communication possibilities, improved information flows breach long-established spatial and scalar ways of health management and healthcare provisioning. Therefore, eHealth represents opportunities and challenges for the established practices in both public and private health management and healthcare systems.

New manifestations of health provisioning, ‘the trans-nationalisation of the local’ through the employing ICTs, raise political and epistemically issues as to their cultural and moral fit. Also, services emerge that compete with those provided for at the local health institute. In many parts of Africa, these kinds of developments are in their early conceptualisations and review. As in Africa less than a quarter of the population is using facilities provided for through Internet, eHealth is still to go beyond the stage of sensitisation, testing, amending and small-scale implementation, into ubiquitous availability and operation. Evidence as to how eHealth can enhance the wellbeing of the disenfranchised, or potentially brings harm by changing the health management and care landscape, is still meagre in most parts of Africa. However, the growing precariousness of the position of current actors in the contemporary manifestation of changes in health care systems within institutions, in social systems, and in societies need academic scrutiny, regulatory oversight, professionally executed programmes, case-building and the development of African models. Unfortunately, scientific models sensitive to the African contexts and cultures are scarce. Therefore, with this paper, we seek to introduce eHealth from an African context.

## 2 Methodology

The object of this paper is an introduction to perceptions of eHealth in Zimbabwe, setting the context for the development of African models and theories to be wrestled from a non-African hegemony. Our research utilised living research [5]. We reflected upon our experiences of implementing and reviewing eHealth and related activities in Zimbabwe and Zambia over the last 15 years. Our experience encompasses research in development studies, computer science, medicine, and culture studies respectively. During 2017 and 2018, the co-authors presented the outcomes of their experiences and reflections during focus group discussions at Technical Working Group meetings at Zimbabwe’s Ministry of Health and Child Care (MoHCC) and at national and

international meetings, upon their requests. The intersection of the lived experiences, and a quest with, in, and for theory allows participation while observing [6].

### **3 eHealth as a Multi-episteme in Africa**

eHealth is multi-faceted and can be approached from various methodological and conceptual angles. Trans-disciplinarity gives a pertinent voice to practitioners involved in the actual field of implementation and use of eHealth. Our area of review is the whole of Zimbabwe, while we review cases in Masvingo Province.

Geopolitically, eHealth seems to be firmly established in a foreign narrative of the 4<sup>th</sup> industrial revolution, where anticipated internet of services and internet of things are expected to fuel further industrialisation and economic growth, as well as human capacity development [7]. The data revolution that is instrumental for eHealth, ushers forth predictive healthcare, where international – often North-America based – platforms and institutions aim to predict health challenges upon aggregated data [8]. Such development, potentially, reduces Africans (again) as hunters and gatherers of raw data, as native informants who collect and provide empirical data from their areas for external processing in West [9].

In general, the realisation of the promises of eHealth appears to be a distant reality in Africa in 2019, both in temporal and spatial practices. Some islands of activities do exist, mainly in urban conglomerates and countries with relatively high penetration of mobile networks and tools, like Kenya, South Africa, Ghana and Rwanda. However, in other countries, like Zimbabwe, eHealth remains disunited, with fragmented and distant pockets of activities in society and socio-technical systems.

eHealth came as an autonomic arousal process in the wake of international non-governmental organisations (INGO) operating in the African space. Oxfam's report on digital development [10] shows that a significant majority of development specialists see the development sector (including health) 'going digital'. However, they regard INGOs being unengaged with the advances in ICT. This verdict is troubling as, in the health sectors in Africa, INGOs are crucial resource partners in national health programs. Therefore, there appears a unhingedness of contemporary approaches and the resource challenges that affect the use of ICT in many African government ministries. As a result, the most disenfranchised populace in African places, like those in rural areas, risk being left out of eHealth opportunities.

### **4 The Emerging Materialisation of eHealth in Zimbabwe**

The Zimbabwe ICT Policy Framework for MoHCC, states that "ICT has the potential to impact upon almost every aspect of the health sector. In public health, health information management and communication processes are pivotal and are facilitated or limited by the available information and communication technology". The National Health Strategy (2016–2020) states that "The hospital information systems need to be harmonised and fully computerised with all departments, equipment and patient flow properly linked electronically" [11]. An eHealth strategy has been in the making for

several years, guided through technical support by the WHO eHealth strategy development toolkit supported by the International Telecommunications Union (ITU).

In the MoHCC, a variety of initiatives could be gathered under the denominator ‘eHealth’ or ‘digital health’. As these are nationwide initiatives, most of them are at the platform level. In Zimbabwe, like many other African countries, the MoHCC is heavily reliant on funding from external partners, mostly sourcing from outside the country. As a result, the architecture and functionalities of eHealth platforms are influenced by organisations from the outside, often through the method of technical assistance.

The MoHCC operates three nation-wide main electronic health information platforms and some specific care related platforms. The main ones are the electronic Patient Management System (ePMS) for HIV related patient-level care and the Zimbabwe health information system (a national rendering of the District Health Information System (DHIS2)) reporting aggregated information. The third one is an eGovernment initiative, connecting all government ministries to the Ministry of Finance and Economic Development, called the Public Finance Management System (PFMS). Example of a specific care related platform is the Laboratory Information Management System (LIMS/LIS) for viral load testing. All platforms reside upon computer systems located within the premises of the government of Zimbabwe. They feature stringent data security and access measures to secure the integrity of the data.

Additionally, the MoHCC is involved in various experiments and projects, like the development and piloting of an Electronic Health Record (EHR) system. Further developments include an application for e-partograph, the piloting of telehealth in Manicaland province, the notification of maternal deaths, the implementation of blended learning and the monitoring of clinical mentoring, among others. Each of these developments is undertaken with a variety of partners (e.g. Global Fund, CDC, SolidarMed, and the World Bank). INGOs in health in Zimbabwe mostly focus on HIV/AIDS and maternal, neonatal and child-health plus the adolescents (MNCH+A). These organisations run a variety of national and international platforms, using different setups. A few organisations use dedicated computers and software located in Zimbabwe. Many organisations, however, appear to utilise platforms residing in other countries, outside of the control of the Government of Zimbabwe. In general, most ICT activities take place without the active involvement of eHealth experts from government ministries, and, therefore, without local capacity building or transfer of data, knowledge, and skills.

Due to the many possible angles with which eHealth can be approached, in practice, multiple players and local, regional and international powers strive to take control of tools, platforms, and, most importantly, the data that these platforms contain. Struggles on ‘where to manage eHealth’ are particularly rampant in spheres where colonial and ‘old era’ organisational structures have remained. From these long-term embedded structures, the multiverse of eHealth varies from different angles, as will be shown below.

#### **4.1 eHealth as the Backbone of Health Systems**

eHealth as the (future) backbone of the health system sees technology as a tool for prevention and management of disease with the aim of epidemiological control [12, 13].

The National Health Strategy (NHS) of Zimbabwe gives ample evidence for the adoption of this view when it states “Significant investments in health system strengthening are necessary for the health facilities and other service delivery and coordination platforms to function optimally” [11]. Further, the NHS states an objective to drive the production of key health indicators by using ICT platforms.

#### **4.2 eHealth as a Measurement and Evaluation of Health Service Delivery**

In this perspective, eHealth is seen as a necessary and instrumental part of the statistical and administrative enterprise, for the respective, real-time and prospective monitoring and evaluation of health developments, to inform health programs and their (potential) outcomes [14].

#### **4.3 eHealth as a Network of Tools, Platforms, and Applications**

In this view, eHealth is regarded as a network of technologies, requiring attention from technology inclined departments, or from technologically dedicated ministries (e.g., the Ministry of ICT). In a narrative leaning towards technology determination, eLearning and the dissemination of guidelines using Information and Communication Technologies is positioned as to take the health industry by storm.

#### **4.4 eHealth in the Private Sector**

In Zimbabwe, the most prominent component of health care is provided through the MoHCC. Private business and clinics serve the remaining populace, focusing mainly on the well-to-do and urban people. Private health providers do have obligations to report to the government. In practice, they rely on information systems sourced from private industries that do not necessarily interface with the information systems in the MoHCC. A variety of commercial initiatives are available, with mobile operators, hardware (like IBM), and software (like SAP) providers yielding significant influence. For instance, mobile operators provide health messages and operate systems for mobile money transfer and the facilitation of remittances from the diaspora [15].

## **5 eHealth and ICT in Zimbabwe**

When exploring the role of information and communication technologies (ICTs) in eHealth and considering the definition of eHealth by the WHO as cited at the start of this paper, we have tried to narrow the field down by categorising ICTs in *tools* and *platforms*. In this view, mobile phones and other devices are seen as *tools* like a multipurpose equivalent to a Swiss knife, being separated from the transfer, storage and processing of the data in third-party service *platforms*.

We analysed the documents and presentations offered during continuous education meetings and conferences organised by medical associations, monthly UNICEF’s brown bag meetings, and presentations on eHealth at the Computer Society of Zimbabwe, over the last two years. From these, we deduced the main subjects discussed

under the banner eHealth. These are: applications in eLearning (focussing on health professionals), electronic health records, big data analysis, and telemedicine. To a lesser extent, aspirational narratives feature the potential of artificial intelligence, the internet of things, and robotics with little to show in daily Zimbabwean practice yet.

### 5.1 An Anthropological Perspective

eHealth can be approached as to how underserved individuals and communities engage with its existence in the form of tools and platforms. From practices in eHealth within Masvingo Province, Zimbabwe [16], sensitised by the work of Haikin and Flatters [10], we deduce the following prerequisites for ICT employment for eHealth in Zimbabwe.

- *Enable Connectivity and Access*: Network constraints and access barriers suppress the local voices, knowledge and inclusion.
- *Involve Transdisciplinarity*: Multiple, complementary approaches towards society and technologies are necessary to reconcile an abstract international discourse – regimes of non-locally derived ‘truth’ – with the African experience.
- *Value Local*: Many avenues are reported, but most appear not to consider local context, vocabulary, access realities, sensitivities and taboos, and for local inclusion and agency considering the sociology of ubuntu/unhu.
- *Think Local*: Activating local meaning, content, relevance and production of systems is critical for enmeshed end-users and stakeholders and gaining a shared, embodied knowledge base.
- *Put the lead local*: Iterative programmes led by and involving actual end-users and guided by ‘local talents’ produce embedded solutions and applications.
- *Scaling is hard*: Depends on socialites, geopolitics, usability, affordability and common understanding and necessitate diversity.
- *Embed development in ambient culture*: Holistic and efficient development involves sharing of resources and opportunities as well as giving equal opportunities to both women and men.

These non-exhaustive prerequisites are a focus in the private sector, which, naturally, is inclined to align with local realities. However, possibly due to the dominant guidance from players from outside Zimbabwe, these prerequisites seem less guiding in the daily practice within the MoHCC.

### 5.2 A Computer Science Perspective

In the natural sciences, technological development is related to the creation of a ‘modern society’, aligned with ideological constructs from outside Africa [17]. Computer scientists and engineers are the builders of infrastructure, industrial and mechanised production, modern transportation systems, and technological innovations such as mass media, computers and communication systems. Often, in a one-dimensional view, technological interventions are positioned as determining essential outcomes [18, 19]. Gomez and Pather [20] show how such a view of technology determination are in need of a critique of its paradigmatic foundation. This view coincides with Dourish and Mainwaring [21] observation of the colonial bias in ubiquitous computing.

In Zimbabwe, testing of blended learning solutions includes social interactions and computer-aided provisioning of study materials. These are signs of the possibility of contextualised bridging of socio-technical divides [22].

### 5.3 A Medical Science Perspective

In this perspective, ‘quality of care’ involves issues of workload and contextual practicalities in the contact between the health client and the health practitioner [23]. In its assessment of the diffusion of eHealth at a global scale, the WHO [24] states that universal health coverage cannot be achieved without the support of eHealth. Further, the WHO research indicates that eHealth supports interoperability of people-centred health services, moving practices from disease-silos to resilient health systems.

### 5.4 A Data Science Perspective

eHealth is the rendering of data from mission-critical medical operations to garner evidence that focuses attention and resources in a particular direction. This perspective is primarily concerned with harvesting and processing of data, regarding it a resource comparable to other precious resources like oil. Data Science propels eHealth into the non-African concept of the 4<sup>th</sup> industrial revolution where everything hinges around harvesting and processing of data from a universal interconnectedness. An important and contentious area of development is the generation and use of big data to provide health predictions [8]. The onslaught of data leakage and political influencing, enabled by the borderless exchange of information, is putting African governments in difficulties. The scientific basis set in a negotiation of subalternised local and dominant international experiences and epistemes is not yet balanced. Countries are scrambling to react, doing so differently. For instance, Tanzania has put severe restrictions on the transfer of information from its state [25], Zambia has adopted its own home-grown EHR (SmartCare), and Zimbabwe implemented a Ministry of Cyber Security.

### 5.5 A Political Science Perspective

Zimbabwe’s government implements its projects in the geopolitical realities of INGOs and international policies. An example is the blueprint for Zimbabwe’s economy, Zimasset [26], in which the government painted a moral imperative: the focus of the development of the country according to its terms. However, the direction of (monetary) benefits of the global information society remains one-sided as the architecture of the internet maps disturbingly well with the global information society that was created (by shipping) in the 16<sup>th</sup> and 17<sup>th</sup> century [27]. The big question is how African governments and health institutions can benefit from its national data resources. Beneficiation of resources (among which is the healthcare data), is needed to be done ‘in country’ to ensure the creation of embodied knowledge in all aspects of eHealth [28]. Through the central management of its data platforms, the MoHCC controls which data can be accessed by whom. In political manoeuvring, stringent access rules are being used as an excuse by some INGOs to launch their parallel eHealth setups

which collect data in parallel to the government systems, directly from health facilities in acts of defiance.

### 5.6 An Economic Perspective

eHealth helps to lessen the workload in health care through the elimination of costly paper registers that are difficult to procure and maintain. Although there are apparent benefits of using paper registers in resource-limited settings – and their phase-out is not yet eminent – they do not allow for easy linkage of data [29]. Through eHealth, hybrid formats of national data can be managed and be readily available and accessed by authorised (partner) organisations. However, local communities do not have the resource to purchase nor maintain capital-intensive equipment and, therefore, are subject to the whims of the (foreign) financiers and their perspectives. Thus, the implementation of eHealth can result in local exposure to geopolitical meddling of, for instance, the aid-industry. Foreign notions of eHealth are not embedded aligned with Africa’s relatio-economy, with its precepts of sharing and giving. The beneficiation of local data gives rise to regional markets of constructive engagement, for instance by coupling healthcare processes with remittances [15].

### 5.7 A Practitioners Perspectives

Trans-disciplinarity includes the various practitioners involved in the actual implementation and use of eHealth. These practitioners include health experts, computer scientists, ICT engineers and others. Johnson *et al.* [30] have argued that ICT practitioners are facing environmental, skills and cultural challenges. They often handle technologies that are unaligned with local contexts [31]. Due to the geography of African countries like Zimbabwe and the challenges of travelling, the focus of developmental attention is often limited to urban areas. Therefore, deep-rural areas lack attention. Rural realities remain less understood, with interventions being managed ‘from the centre’ creating barriers for local capacity building. In the meantime, computer literacy remains a challenge, with health staff having little exposure to, and experience with, ICTs [32]. Lastly, the discordance of local means of gaining embodied knowledge and the top-down manner of introduction of eHealth interventions disempower practitioners in fully engaging the community.

## 6 Discussion

Literature and narratives on eHealth appear to be originating from a well-resourced, western, individualistic epistemology [18, 33]. To ensure *access* to eHealth, to both contextually sound platforms and tools, the MoHCC recognised the continuous processes of community engagement (focused on reaching collective potential), workforce development (to inspire local talent), and thought leadership (to ensure respectful representation). In the development of eHealth in rural areas, the Masvingo based INGO SolidarMed operates an iterative, inclusive eHealth development process through a monthly Hackathon and daily eHealth lab activities [16, 34]. In a hackathon



process, every month ICT professionals and health experts mingle in a transdisciplinary and voluntary design event. During the events, computer programmers and vocational experts involved in software development, together with health subject-matter-experts, collaborate voluntarily and intensively on projects. Their collective goal is to create usable technologies, applications and services. This engagement aligns with the renderings of the communal values of ubuntu (providing moral grounds in communal love), oratio (communicating embodied knowledge), relatio (relational resource allocation), animatio (continuous present moment), and dominio (striving for maturity) [35].

eHealth developments are context sensitive and must take into account the practices of paradigm switching (between the I, we, and it-paradigms), and the presence and subconscious agency of the Terrible Three, being orientalism, imperialism, and colonialism [35]. Further, eHealth in African settings should be sensitive to the technical realities that influence technical performances due to latency, congestion, and the vast variety of technologies, tools, platforms, and applications. Although ICTs appear enthralling, they harbour real difficulties and fuel inequalities [36]. Among them is the capabilities and disempowerment of 'the haves and the haves not'. Those with equipment 'have', those without 'not'. Those with electricity 'have', those without 'not', and those with 'good' connectivity 'have', those without 'not'. Connectivity and ICTs, and thus eHealth, are unequally distributed. The issues hampering access to communication networks are highly complex while mobile networks are not necessarily reliable in rural areas. Geopolitics and platforms from the West are playing a predominant role [37]. In this hegemony, the development and maintaining of national, African data platforms are being crowded out. In the meantime, equipment is varied and might not be patched in time and thus have security issues [38].

New technologies can lead to new dependencies. These dependencies include having to align with people, processes, systems and categorisations that not necessarily respectful or considerate to local cultures and the local way of meaning-making [18]. Further, foreign involvement involves foreign payments depleting foreign currency reserves. In settings with imported technologies, training is mostly done off location, involving disproportional travel and logistical expenses. Of course, development partners are bound to pursue their agenda, for their organisations and themselves, rather than for the people that they claim to serve [17, 39]. Therefore, the support of technical assistants in eHealth is not necessarily aligned with the needs of the country. This misalignment, again, can lead to dependencies on foreign organisations and persons. In the meantime, national research and development remain underfunded and uninvolved. As shown, the attention for data security is mounting, however, through data breaches that circumvent sovereignties, foreign researchers can assess information and deduce knowledge out of context [33].

Instantiations of eHealth seem connected to coloniality that places peoples and knowledge in systems of thought that strengthen Eurocentric meaning making [5]. However, there is a need for epistemic diversity to envision social life, knowledge and technology in Africa, providing for cognitive justice of African experience [40]. From our experience, there is much room for the deconstructing of to which knowledge and power structures eHealth are linked and a reconstruction of knowledge that acknowledges the agency of African people and groups. Therefore, there might well be

contrapuntal developments in eHealth, with different paths in a globalised society that show differentiated pathways to the aim of quality health provisioning.

## 7 Conclusion

In this paper, we show that eHealth is part of a digital infrastructure that is increasingly becoming all-pervasive in the global society and human life. Though our work on eHealth is situated in Zimbabwe, the deductions offered could resonate with other African settings where eHealth projects are being deployed, providing a platform that can be further built upon by more vertical research. We argue for the primacy of the local episteme in eHealth.

eHealth is connected to a dramatic expansion in the production and use of large amounts of data with a potential of bypassing local and even national policies. eHealth development, therefore, needs careful, contextual guidance as for how to ensure data integrity and that information management and knowledge generate local benefits and empower local communities of practice.

## References

1. World Health Organisation: WHA58.28 eHealth. In: eHealth Resolutions to the 58th Meeting of the World Health Assembly, pp. 121–123 (2004)
2. Watson, R.: Africa's contributions to information systems. *Afr. J. Inf. Syst.* **5**, 126–130 (2013)
3. Southard, P., Hong, S., Siau, K.: Information technology in the health care industry: a primer. In: Proceedings of the 33rd Hawaii International Conference on System Sciences (2000)
4. Smart, C., Donner, J., Graham, M.: "Connecting the world from the sky": spatial discourses around Internet access in the developing world. In: Proceedings of the Eighth International Conference on Information and Communication Technologies and Development (2016)
5. van Stam, G.: Method of research in a we-paradigm, lessons on living research in Africa. In: Nielsen, P., Kimaro, H.C. (eds.) *ICT4D 2019*. IFIP AICT, vol. 552, pp. 72–82. Springer, Cham (2019)
6. Burawoy, M.: *The Extended Case Method*. University of California Press, Berkeley and Los Angeles (2009)
7. Hermann, M., Pentek, T., Otto, B.: Design principles for industrie 4.0 scenarios. In: Proceedings of the Annual Hawaii International Conference on System Sciences, pp. 3928–3937 (2016)
8. Boerma, T., Victora, C., Abouzahr, C.: Monitoring country progress and achievements by making global predictions: is the tail wagging the dog? *Lancet* **6736** (2018)
9. Mamdani, M.: The importance of research in a university. *Pambazuka News* (2011)
10. Haikin, M., Flatters, G.: *Digital Development: What Is the Role for International NGOs?* Oxfam (2017)
11. MoHCC: *The National Health Strategy for Zimbabwe, 2016–2020. Equity and Quality in Health: Leaving No One Behind*. Ministry of Health and Child Care, Government of Republic of Zimbabwe, Harare (2016)

12. WHO/ITU: National eHealth Strategy Toolkit. World Health Organization and International Telecommunications Union, Geneva (2012)
13. Shields, M.: SmartCare. Electronic Health Record System. Continuity of Care... the long view.... In: Erasmus Medical College Symposium, 2 September 2013, Rotterdam (2013)
14. Rajkumar, A., et al.: Scalable and accurate deep learning for electronic health records. *NPJ Digit. Med.* **1**, 18 (2018)
15. Fulgencio, H., Ong'ayo, A., van Reisen, M., van Dijk, J., van Stam, G.: mMoney remittances: contributing to the quality of rural health care. In: Proceedings of AFRICOMM 2016, 6–7 December 2016, Ouagadougou (2016)
16. Bishi, J., Shamu, A., van Dijk, J., van Stam, G.: Community engagement for eHealth in Masvingo, Zimbabwe. In: Proceedings of 1st International Multi Disciplinary Conference, 23–25 August 2017, Lusaka (2017)
17. Ndlovu-Gatsheni, S.: The entrapment of Africa within the global colonial matrices of power. *J. Dev. Soc.* **29**, 331–353 (2013)
18. van Stam, G.: Unveiling orientalism in foreign narratives for engineering for development that target Africa. In: Mawere, M. (ed.) *Development Perspectives from the SOUTH. Troubling the Metrics of [Under-]development in Africa*, Langaa RPCIG, Bamenda, pp. 197–220 (2016)
19. Toyama, K.: *Geek Heresy: Rescuing Social Change from the Cult of Technology*. Public Affairs, New York (2015)
20. Gomez, R., Pather, S.: ICT evaluation: are we asking the right questions? *EJISDC* **50**, 1–14 (2012)
21. Dourish, P., Mainwaring, S.: UbiComp's colonial impulse. In: *UbiComp 2012*, 5–8 September 2012, Pittsburgh (2012)
22. Apollo, T., et al.: eHealth approaches for training of Zimbabwe's health workforce in the national response to HIV/AIDS and TB – introducing Blended Learning in Integrated HIV Prevention, Treatment, Care and Support. In: *ZiMA Annual Scientific Congress*, 15–19 August 2018, Harare (2018)
23. Eysenbach, G.: What is E-health? *J. Med. Internet Res.* **3**, 1–5 (2001)
24. World Health Organization: Global diffusion of eHealth: making universal health coverage achievable. Report of the third global survey on eHealth. World Health Organization, Geneva (2016)
25. Dahir, A.: Tanzania's government is casting itself as the nation's sole custodian of data. *Quartz Africa* (2018)
26. Government of Republic of Zimbabwe: Zimbabwe Agenda for Sustainable Socio-Economic Transformation (ZimAsset) "Towards an Empowered Society and a Growing Economy". Government of Zimbabwe, Harare (2013)
27. Williams, C.: Digital imperialism. In: *Meeting Research Network Globalisation, Accessibility, Innovation and Care*, 15 September 2017, Tilburg (2017)
28. Lindström, N.: *Getting Past the Hype & Practical with New Technologies* (2018)
29. Sahay, S., Nielsen, P., Latifov, M.: Grand challenges of public health: how can health information systems support facing them? *Health Policy Technol.* **7**, 81–87 (2018)
30. van Stam, G., Johnson, D., Pejovic, V., Mudenda, C., Sinzala, A., van Greunen, D.: Constraints for information and communications technologies implementation in rural Zambia. In: Jonas, K., Rai, Idris A., Tchuente, M. (eds.) *AFRICOMM 2012. LNICST*, vol. 119, pp. 221–227. Springer, Heidelberg (2013). [https://doi.org/10.1007/978-3-642-41178-6\\_23](https://doi.org/10.1007/978-3-642-41178-6_23)
31. Johnson, D.L., van Stam, G.: The shortcomings of globalised internet technology in Southern Africa. In: Bissyande, Tegawendé F., Sie, O. (eds.) *AFRICOMM 2016. LNICST*, vol. 208, pp. 325–338. Springer, Cham (2018). [https://doi.org/10.1007/978-3-319-66742-3\\_31](https://doi.org/10.1007/978-3-319-66742-3_31)

32. Braat, F., Sithole, T., Chikwati, B.J., van Dijk, J.: Evaluation of the utilization of an online perinatal training program. In: ZiMA Annual Scientific Congress, Harare, Zimbabwe, 15–19 August 2018 (2018)
33. Mawere, M., van Stam, G.: Research in Africa for Africa? Probing the effect and credibility of research done by foreigners for Africa. In: Nielsen, P., Kimaro, H.C. (eds.) ICT4D 2019. IFIP AICT, vol. 552, pp. 168–179. Springer, Cham (2019)
34. Hobbins, M., Kavenga, M., Manhibi, R., van Dijk, J., van Stam, G.: eHealth: connecting communities for health, selected cases in Zimbabwe. *Medicus Mundi Bulletin* **148** (2018)
35. van Stam, G.: Reflections: a narrative on displacement of technology and meaning in an African place. Gertjan van Stam, Harare, Masvingo, Macha, Tilburg (2017)
36. Graham, M. (ed.): *Digital Economies at Global Margins*. The MIT Press and IDRC, Cambridge, London (2019)
37. UNCTAD: *Trade and Development Report 2018. Power, Platforms and the Free Trade Delusion*. United Nations (2018)
38. Furnell, S., van Niekerk, J., Clarke, N.: The price of patching. *Comput. Fraud Secur. Bull.* 8–13 (2014)
39. Alesina, A., Dollar, D.: Who gives foreign aid to whom and why? *J. Econ. Growth* **63**, 33–63 (2000)
40. Mawere, M., van Stam, G.: African engineering and the quest for sustainable development: levelling the ground for all players. In: Munyaradzi, M., Nhemachena, A. (eds.) *Theory, Knowledge, Development and Politics: What Role for the Academy in the Sustainability of Africa?*, pp. 189–206. Langaa RPCIG, Bamenda (2016)



# ICT Use in the Context of Electricity Access in a Developing Country: A Choice Framework Analysis

Arlene Bailey<sup>1</sup> (✉), Aldrie Henry-Lee<sup>1</sup>, Yhanore Johnson-Coke<sup>1</sup>,  
Richard Leach<sup>1</sup>, Anthony Clayton<sup>1</sup>, Matt Gee<sup>2</sup>, and Oliver Browne<sup>2</sup>

<sup>1</sup> Sir Arthur Lewis Institute of Social and Economic Studies,  
The University of the West Indies, Mona, Jamaica  
{arlene.bailey, aldrie.henrylee, yhanore.johnson02,  
richard.leach, anthony.clayton}@uwimona.edu.jm

<sup>2</sup> Centre for Data Science and Public Policy,  
University of Chicago, Chicago, USA  
mattgee@gmail.com, oliver.r.browne@gmail.com

**Abstract.** With increasing focus on achieving energy access for all by 2030, and working towards the Sustainable Development Goals, in particular SDG 7, there is further interest in the role of Information and Communication Technologies (ICTs). This paper explores the ways in which ICTs are used in the context of initiatives to support electricity access in urban and peri-urban communities in a developing country, Jamaica. A survey of 2,082 households and focus group discussions in 10 communities, along with interviews with key stakeholders, support the data collection for the study. Kleine's Choice Framework, which operationalises Sen's capability approach, is used to analyse individual and collective choices related to ICTs and electricity access, and the associated development outcomes. Implications for research, policy and practice are discussed.

**Keywords:** ICTs · Electricity · Energy access · Choice Framework · Sustainable development · SDGs

## 1 Introduction

Access and use of energy have been key components of both the Sustainable Development Goals (SDGs), and the earlier Millennium Development Goals (MDGs). In September 2015, the members of the United Nations adopted the SDGs with targets to be fulfilled by 2030. SDG Goal 7 advocates that all members put in place strategies that ensure access to affordable, reliable, sustainable and modern energy for all. A key target for SDG 7 is highlighted by Indicator 7.1.1 which looks at the proportion of a country's population with access to electricity [1].

Universal access to modern energy services by 2030 is also one of the primary goals of the Sustainable Energy for All (SE4ALL) initiative which aims to fulfil objectives of ending poverty and increasing shared prosperity. The Energy Sector Management Assistance Program (ESMAP) sponsored by the World Bank helps

countries make informed choices and develop energy sectors that will be sustainable into the future. As part of its support for the SE4ALL initiative, ESMAP supported the development of a multitier methodology for measuring energy access. The new framework defines access as “the ability to obtain energy that is adequate, available when needed, reliable, of good quality, affordable, legal, convenient, healthy, and safe for all required energy applications across households, productive enterprises, and community institutions” [2, p. 4].

Through collaboration with ESMAP, a research project was undertaken with the aim of measuring energy access for urban low-income communities in Jamaica. The main provider of electricity in Jamaica continues to seek to improve distribution and transmission, and support national development [3], while seeking to reduce losses, particularly for non-technical reasons [4]. While reports indicate that approximately 95% of Jamaicans have access to electricity [3], the utility company indicates that about 25% of connections are unauthorized [4]. As the country works towards achieving the SDGs, it is noted that those at risk of being left behind for SDG 7 include households without access to safe electricity supply. The utility company and social investment fund continue to collaborate on initiatives to provide safe and reliable electricity services for all [5].

There is recognition of the role of ICTs in supporting access to electricity services, as well as the impact of electricity access on ICT usage in developing countries [6, 7]. Further, the importance of electricity in supporting ICT4D initiatives, and the need for further research in this area is highlighted [6].

With increasing focus on achieving energy access for all by 2030, and working towards the Sustainable Development Goals, in particular SDG 7, there is further interest in the role of Information and Communication Technologies (ICTs). This paper explores the ways in which ICTs are used in the context of initiatives to support electricity access in urban and peri-urban communities in Jamaica.

The paper proceeds as follows: in the next section we explore the literature related to the role of ICTs in supporting electricity access, and also the connection between electricity service provision and the use of ICTs. Development is discussed in relation to the freedom to choose and the capability to choose from alternative functionings and outcomes [8, p. 17]. The methodology for this study is then discussed, followed by a presentation of the findings and analysis using Kleine’s [9] Choice Framework. The paper concludes with implications for research, policy and practice.

## 2 Related Literature

The ICT for development space continues to explore the ways in which ICTs have contributed and can contribute to achieving sustainable development outcomes. A key component of sustainable development relates to energy access, and the availability of electricity in developing countries. The prioritization of electricity and ICTs as basic needs have been part of the development discourse [10, 11]. Studies have explored areas such as the need for stable electricity supply to support ICT for development initiatives, panel data analyses on ICT growth and electricity consumption, and ICTs to support electricity management systems and reduce theft [12]. It has been highlighted

that increasing energy access centres around the physical infrastructure and critical social actors and norms [13]. In addition, measures of energy sufficiency and energy poverty (lack of access to energy services) have included access to ICTs [14, 15]. There are calls for further examination of the nexus between ICTs and electricity access [6, 16, 17], and the related capabilities in this space [18]. It is also noted that there is limited research on the usage of ICTs in low-income communities which may have challenges related to unauthorized connections to the electricity grid.

Sen's [19] Capability Approach provides a platform by which inputs and resources can be examined to identify the resulting capabilities. Kleine [9], in developing the Choice Framework to operationalize Sen's approach, provides an analytical frame which is useful in exploring community-based initiatives which include ICTs. Kleine [9, p. 110] calls for further analysis using the framework in individual and collective contexts. The framework includes the following elements: assessing the primary and secondary development outcomes and choices, examining the agency-related resources which influence the choices, including social and cultural resources, material and financial resources, natural and geographical resources, information and educational resources, and psychological and health resources.

A further component discusses the structural-related inputs including the related institutions and organizations, policies, laws and norms, and access, availability and support for the use of ICTs. These in turn influence the dimensions of choice, where existence is identified, and there is awareness, the use and achievement of choice. We have selected this framework to guide the analysis, given the elements it articulates which relate to the assessment of the various choices that stakeholders make in the area of electricity access and the associated usage of ICTs.

### 3 Methodology

The survey approach and methodology have been guided by the objectives of the study, and in discussions with project partners – the utility company, the social investment fund, University of Chicago and the World Bank. The research team utilized quantitative and qualitative research approaches, with the following methods of data collection being adopted. The quantitative approach included a face-to-face survey with a representative sample of households in ten communities; including households within the utility company's project area and outside of the project area, and households that had been recently regularized (formally added as a customer) or are not yet regularized. The qualitative approach involved focus group discussions with community members and key informant interviews with other stakeholders, along with community walkthroughs and observation, and a stakeholder workshop.

#### 3.1 Quantitative Survey

The quantitative approach entailed a face-to-face survey with a representative sample of households in ten communities. The utility company had on-going project interventions in seven of the communities, while interventions had just started or were about to begin in the remaining three communities. The sample selection in each community

was guided by the number of households within the community, and the number of households within the specified project areas. The questionnaire focused on a number of areas including community life, household demographic information, household energy sources, usage of ICTs, perceptions of electricity access and regularization, social support initiatives. Questionnaires were pre-tested in 2 communities with similar characteristics to the 10 communities participating in the survey.

The questionnaires were administered by interviewers using mainly tablets, and paper-based questionnaires in a few instances. Consent was sought from the respondents. Confidentiality was assured to all respondents by informing them that all data analysis would be presented in an aggregated and anonymous form so that individual responses would not be identified.

The sample design sought to identify a representative sample through a combination of sampling techniques. A census of the recently regularized households in the project areas of seven communities that have been involved with interventions was conducted, as this was a smaller group of households. A systematic sampling approach was taken in the project area, as well as in areas within the intervention communities that were outside the designated project area. Table 1 below provides a summary of the communities and number of respondents for the questionnaire.

**Table 1.** Percentage distribution of respondents in the survey and number of focus groups held in each community

Community	Actual number of respondents	Percentage of sample	Number of focus groups held
Community 1	195	9.4	1
Community 2	153	7.3	1
Community 3	227	11.0	1
Community 4	335	16.2	2
Community 5	134	6.5	1
Community 6	229	11.0	2
Community 7	142	6.8	1
Community 8	205	9.8	1
Community 9	188	9.1	2
Community 10	274	13.2	2
<b>Total</b>	<b>2,082</b>	<b>100.0</b>	<b>14</b>

### 3.2 Qualitative Data

Key informant interviews and focus group discussions were also conducted. Stakeholder interviews were held with a number of persons from key organizations: Community Renewal and Customer Relations teams from the utility company, Social agencies, Community representatives and Government representatives.

Focus group discussions were arranged with community members within the ten communities participating in the study. The focus group protocol included key discussion areas related to the ongoing and planned interventions in the communities, and



perceptions of energy access, use and support from the utility company. Individual and collective choices and decision-making processes were also discussed in the focus groups and interviews. The findings from the quantitative survey, and current events in the communities related to energy access, also guided areas to be discussed in the focus group sessions. Focus group respondents were invited based on a quota sampling methodology so that key characteristics were represented within the groups. There were 14 focus groups within the 10 communities. Table 1 above shows the number of focus groups held in each community, where each community had at least one focus group session. Two focus group sessions were conducted in four communities to further explore specific characteristics and interventions identified. The focus group sessions were planned for a duration of about 1 h, with 8 to 12 community members in each focus group. The second focus group in selected communities comprised persons experiencing challenges or barriers to regularization. Emphasis was placed on key demographic characteristics for the second focus group in each community – for example, in Community 9, the second focus group included only women given the profile of households indicating unauthorized connections had female heads. In Community 10, there was an older age profile, and the second focus group invited primarily elderly persons to participate. The composition of focus groups looked at characteristics such as gender, age, specific interventions, and stage in the regularization process.

In the next section, following a profile of the ICT access and usage environment of community members, we discuss the analysis facilitated by the Choice Framework.

## 4 Analysis and Discussion

### 4.1 Survey Profile of ICT Access and Use by Community Residents

Community members who responded to the survey indicated that approximately 96% of households had at least one mobile phone, while 34% reported having access to at least one computer or laptop in the household. Approximately 40% of households reported having access to the Internet, with 32.6% reporting Internet access via a home computer, and 83.3% indicating access via a mobile phone. Households with authorized connections to the grid were more likely to have Internet access, than households with unauthorized or shared connections.

In analysing the responses by type of household electricity connection, it is observed that households with authorized, independent connections are more likely to have one or more desktop computers or laptops than households with shared or unauthorized connections. As seen in Table 2 below, 49% of respondents reporting authorized, independent electricity connections indicated that there were one or more computers/laptops in their households. This relationship was moderately significant ( $\chi^2 = 99.448$ ,  $p = .000$ ,  $c.c. = .304$ ).

**Table 2.** Percentage of respondents with computers/laptops in household by type of electricity connection

Number of computers /laptops in household	Authorized, independent connection	Shared connection	Unauthorized connection	Total
None	51.0	60.5	81.9	64.7
One	39.6	34.9	16.4	29.5
Two or more	9.4	4.7	1.7	5.8
Total	100.0	100.0	100.0	100.0

A similar analysis was explored for responses related to mobile phones, as shown in Table 3. It was also observed that households with authorized connections were more likely to have a higher number of cell phones and chargers than households that had unauthorized or shared electricity connections. This relationship was significant ( $\chi^2 = 66.943$ ,  $p = .000$ ,  $c.c. = .206$ ), but weaker than the relationship for computers and laptops.

**Table 3.** Percentage of respondents with mobile phones/chargers by type of electricity connection

Number of mobile phone chargers in household	Authorized, independent connection	Shared connection	Unauthorized connection	Total
None	2.1	3.2	4.6	3.2
One	35.6	54.1	51.3	44.1
Two	28.0	26.8	24.9	26.6
Three or more	34.3	15.9	19.2	26.1
Total	100.0	100.0	100.0	100.0

It was interesting to note that while households with authorized connections were likely to have more ICT devices available, households with unauthorized connections were likely to report usage of the devices for a greater number of hours per day.

Approximately 5% of respondents indicated that they receive an e-bill for the electricity service provided, and similarly 5% of respondents reported that they pay their bills online. Corresponding to the high prevalence of mobile phones, 52% of respondents indicated that they received their bills via text messages.

Households that received bills via text messages were more likely to be aware of the utility company's social interventions and meetings within the community, however no significant difference was found in relation to their views on pre-payment for electricity.

## 4.2 Choice Framework Analysis

Community members had both individual and collective choices to consider in relation to electricity access and their interaction with ICTs in relation to these choices. Based on the data collected through the survey, focus groups, interviews and observation, we assess this case using the components of Kleine's [9] Choice Framework.

**Development Outcomes.** The primary development outcome was the capability of individual community members, and the community as a group to choose between authorized, stable electricity connections, or unauthorized connections with the associated risks. "Having electricity" was seen as a desired functioning. In general, most community members saw the authorized electricity connection as a good option, once it was affordable. Key stakeholders also highlighted the related development outcomes. A summary of the outcomes includes first level: choice, second level: to have electricity, third level: type of electricity access. The second level also included: freedom from fear, sense of empowerment, increased knowledge, easier communication and time savings.

There are several secondary development outcomes that emerge at various levels. For community members who made the choice to regularize and maintain authorized, independent electricity connections, they indicated a sense of empowerment. For example, a focus group participant indicated "*We can take the printed bill to the bank or when making a purchase*", signifying the importance of the document. Others in the focus group agreed. There was also the removal of fear associated with unauthorized connections as they no longer had to be continuously looking out for the utility company's teams or security forces who would visit the communities to remove connections and potentially charge persons for theft. A focus group participant noted that "*we no longer hav to be runnin to tek down light wen police comin*" [We no longer have to run to remove the illegal connections when the police are coming].

Secondary development outcomes also included increased knowledge based on information shared by the stakeholders, through text messages and online social media options such as Facebook and Instagram. Easier communication, based on the choices available to interact with the utility company, was another secondary development outcome. These outcomes also supported savings in time, due to knowledge of communication options, and savings in energy consumption due to the information shared. Communities that maintain regularized connections also benefitted from special social, economic and technical interventions and initiatives to support individuals and the community, including health, education and employment opportunities, and energy usage assessments.

**Agency.** The Choice Framework utilizes Sen's [20] concept of resources, which are capability inputs that are agency-based. In this section, we explore the type and availability of resources that community members and stakeholders that may support or influence the choices made.

Given the nature and history of electricity access initiatives within low-income urban and peri-urban communities, social and cultural resources play important roles in choices made by community members and other stakeholders. A culture of 'sharing' or 'borrowing' electricity may be prevalent and passed down through generations within

the communities, while a cultural shift was also observed by some residents. One focus group participant indicated that *“Is long time we get free light, so we understand it’s time for us to pay now”*. Social resources included family, friends and neighbours within the community, who would share information to support the decisions on the available options for electricity access. This was noticed also in relation to community members lobbying for support for the elderly, as noted by one focus group participant who indicated *“The elderly really need help with the bills”*. Some elderly community members indicated that they received updates via text messages, but others only used mobile phones to make calls, and this depended on whether they had phone credit available, sometimes purchased by family and friends locally and overseas. Further, elderly persons relied on the younger generation to share information circulated by the utility company through social media. This also reflected age-related agency inputs. Gender was also observed as a decision influencer in the choices related to the development outcomes.

While natural resources provide an option in for energy access in the form of solar energy, the material resources of community members did not facilitate the immediate uptake of this option. Material and financial resources also played a role in the choice related to development outcomes. A focus group participant from Community 9 indicated *“A lot of people want to pay but the bills are too high”*. Mobile phones were also material resources which could facilitate information and payment activities.

Geographical resources also influenced the choices available and decisions made in relation to electricity access. The proximity of an individual’s home to a power line would assist in whether they would be able to afford the process of regularization. Community members who have to pay to run lines to their homes may opt to acquire the connection and service through unauthorized means. Geographical resources also were key in supporting information sharing and communication. Physical proximity to a community centre with Internet access and a representative from the utility company was seen as useful, which also reflected the usage of time as a resource. Similarly, being close to a Wi-Fi hotspot within the community, would facilitate the use of social media and updates from the utility company.

Psychological resources were observed in responses from participants in the study, with one focus group participant from Community 7 indicating that *“we can show our bill when we go to get loans, we feel a part of society now”*. This reflected the development outcomes of empowerment, social and cultural capital. The psychological influence in choice of approach was also observed in the preference for printed bills, in comparison to the electronic options of text messages and e-bills. While the advantages of the paperless choices are highlighted, a focus group participant from Community 9 noted that *“We want paper bills just like the ‘uptown’ customers get delivered to their house”*.

**Structure.** The institutions and organizations which are involved in the efforts to facilitate affordable and safe electricity access, can provide some of the inputs to enable individual and collective choices. The utility company’s partnership with the national social investment agency provided the opportunity for the development of a Community Renewal Programme to assist with development projects, including ICT for development initiatives in participating communities. Policies and programmes sought

to regularize authorized electricity connections, however there were instances where informal laws within communities were not supportive.

Access to ICTs in the areas of availability, affordability and necessary skills were important components. Mobile phones are the most readily available ICT devices. The affordability of the different types of devices to support enhanced communication, knowledge sharing, bill payment and financial inclusion are areas that need to be considered. Similarly, additional training and demos may be needed to develop the skills required to utilize the devices to support the development initiatives. These elements reflect some of the inter-relationships between agency and structure.

**Dimensions of Choice.** Given the structure and resource-based agency, community members and the communities were able to identify the possible choices, and drawing on supporting resources use the available choices to make a decision. Based on the choices made, these would lead to particular development outcomes.

In the next section, we discuss implications of the findings of this study.

## 5 Conclusion

Based on the discussion and analysis related to the usage of ICTs in communities exploring improved electricity access, and the role of ICTs in influencing and supporting this access, we discuss implications for research, policy and practice. If increased usage of ICTs can support the process of accessing and maintaining affordable, safe electricity supply, and if the presence of such a supply increases the use of ICTs, then investments in facilitating choices which lead to these development outcomes would be useful.

Further research would be useful in exploring the adjustments and transitions in ICT usage as access to affordable and safe electricity increases. The analysis of the case using the Choice Framework also contributes to the literature in this area. Practitioners may also be guided by the development outcomes, agency, structure and dimensions of choice involved in community members and other stakeholders making decisions in relation to energy and electricity access and SDG 7. Some implications for policy are also discussed.

Analysis of the data highlights several broad societal and community issues. Participants in the focus groups, the key informant interviews, and stakeholder workshop were asked to discuss their policy recommendations. In conjunction with the policy recommendations of the research team, the suggestions of other stakeholders are synthesised and discussed in this section. The policy recommendations are related to the development outcomes, desired functioning and related choices and resources.

**Macro.** At the macro level, poverty issues and access to energy are linked to the country's own economic situation. There is the expectation that governments in developing countries should provide a package of minimum basic social services. For example, residents in Community 8 wanted increased access to land titles, birth certificates, taxpayer registration numbers, water, electricity, community centre/Internet access point and early childhood education facility, as part of a holistic intervention. Respondents from Community 10 also lamented the lack of street lights in the

community; while recognizing that this is not directly the utility company's responsibility, they felt an integrated approach would provide better results.

Community renewal and empowerment were recurring issues throughout the study communities suggested that the utility company implement or continue to implement social interventions that aim to reduce unemployment among the youth; educate and feed community members and also provide access to social goods. Communities where these interventions were underway expressed high levels of satisfaction with the interventions. Implementation of these mechanisms requires partnerships among key stakeholders: Government, private sectors, development partners, NGOs, CBOs and the residents themselves.

**Meso (Institutional).** Two main types of communities were identified for this study: - high need and high loss. The former includes those in areas where improved access to energy would necessitate major infrastructural adjustments. Respondents were of the view that a combination of interventions (social/good and enforcement) is needed to improve access to energy. These include community-based social interventions along with affordable payment plans, reliable service, better communication with representatives of the utility company and more stringent measures such as the removal of the illegal connections and take legal actions.

Community empowerment has been effective, as evident in Community 4 and Community 7 where there was great communication, via ICTs and face-to-face, along with community spirit. Having an active Representative on the ground and allowing that representative more ability to resolve some the more routine problems, was also recommended by increasing autonomy with facilitating resources such as internet access.

There was a general consensus that prepaid metering was the best payment option for electricity but there was a general yearning for their own meters or ability to read their own units (without the perceived additional expense of plugging in the Customer Display Units (CDUs)) to be like "up-town folks." More payment locations, closer to the community would also increase timely payment. Respondents also suggested special rates for the elderly; those on conditional cash transfer programmes; persons with disabilities and the chronically ill. It was felt that ICTs could also facilitate ease of payments and sharing of information for these vulnerable groups.

In general, residents sought more interactions, and across communities, residents wanted more information on the pre-paid system. Information on estimated usage and the amount for first payment would be useful prior to sign up.

There were high levels of conservation resultant from the utility company's own educational campaign strategies via electronic and face-to-face interactions. Public education on the conservation of electricity should continue and be more targeted towards those communities which are still unaware of the conservation messages. Respondents expressed that their preferred methods of communication included text messages on phones, television and radio broadcasts.

**Micro.** Residents expressed a willingness to pay regularly once the service was affordable and reliable and the customer service was "respectful." As evident in Community 7, consumers and the utility company can enjoy a mutually beneficial relationship when the interaction between provider and client is one of mutual respect.

When the process of increasing access to energy is participatory and consultative, including the facilitation of the use of ICTs, the community members become guardians of the service and will even be agreeable to the disconnection of service for those community members who violate the parameters of an established good relationship and continue to steal electricity.

**Acknowledgements.** We thank all participants and stakeholders in the study. This paper is part of a larger research project, and the financial and technical support by the Energy Sector Management Assistance Program (ESMAP) is gratefully acknowledged. ESMAP—a global knowledge and technical assistance programme administered by the World Bank—assists low- and middle-income countries to increase their know-how and institutional capacity to achieve environmentally sustainable energy solutions for poverty reduction and economic growth.

## References

1. United Nations: Sustainable Development Knowledge Platform (2015). <https://sustainabledevelopment.un.org/sdg7>
2. EnDev: Energising Development (2015). [https://endev.info/images/d/dc/EnDev\\_Annual\\_Planning\\_2015\\_short\\_version.pdf](https://endev.info/images/d/dc/EnDev_Annual_Planning_2015_short_version.pdf)
3. Planning Institute of Jamaica: Jamaica Voluntary National Review on the Implementation of the 2030 Agenda for Sustainable Development, PIOJ (2018). [https://sustainabledevelopment.un.org/content/documents/19499JamaicaMain\\_VNR\\_Report.pdf](https://sustainabledevelopment.un.org/content/documents/19499JamaicaMain_VNR_Report.pdf)
4. ESMAP: Machine Learning Helps Power Down Electricity Theft in Jamaica, Energy Sector Management Assistance Programme, World Bank (2015). <https://www.esmap.org/multimedia/machine-learning-helps-power-down-electricity-theft-jamaica>
5. Sweeney, O., Mitchell, K.A.: The Jamaica Social Investment Fund and the Jamaica Public Service Company: partnering for electricity regularization through community renewal. *Int. J. Res. Eng. Soc. Sci.* **6**(9), 21–30 (2016). [http://www.indusedu.org/pdfs/IJRESS/IJRESS\\_941\\_16959.pdf](http://www.indusedu.org/pdfs/IJRESS/IJRESS_941_16959.pdf)
6. Arney, L.E., Hosman, L.: The centrality of electricity to ICT use in low-income countries. *Telcom. Pol.* **40**(7), 617–627 (2016)
7. Sengupta, R., Heeks, R., Chattapadhyay, S., Foster, C.: Exploring big data for development: an electricity sector case study from India. In: Association of Information Systems pre-ICIS SIG GlobDev Workshop, Seoul, South Korea (2017)
8. Sen, A.: The concept of development. In: *Handbook of Development Economics*, vol. 1, pp. 9–26 (1988)
9. Kleine, D.: ICT4WHAT?—Using the choice framework to operationalise the capability approach to development. *J. Int. Dev.* **22**(5), 674–692 (2010)
10. Heeks, R.: ICT4D 2.0: the next phase of applying ICT for international development. *Computer* **41**(6), 26–33 (2008)
11. Kleine, D., Unwin, T.: Technological revolution, evolution and new dependencies: what’s new about ICT4D? *Third World Q.* **30**(5), 1045–1067 (2009)
12. Mutebi, R.M., Otim, J.S., Okou, R., Sebitosi, B.: Electricity theft in Kampala and potential ICT solutions. In: Nungu, A., Pehrson, B., Sansa-Otim, J. (eds.) *AFRICOMM 2014*. LNICST, vol. 147, pp. 198–206. Springer, Cham (2015). [https://doi.org/10.1007/978-3-319-16886-9\\_21](https://doi.org/10.1007/978-3-319-16886-9_21)
13. Goldthau, A.: Rethinking the governance of energy infrastructure: scale, decentralization and polycentrism. *Energy Res. Soc. Sci.* **1**, 134–140 (2014)

14. Day, R., Walker, G., Simcock, N.: Conceptualising energy use and energy poverty using a capabilities framework. *Energy Policy* **93**, 255–264 (2016)
15. Nussbaumer, P., Bazilian, M., Modi, V.: Measuring energy poverty: focusing on what matters. *Renew. Sustain. Energy Rev.* **16**(1), 231–243 (2012)
16. Saidi, K., Toumi, H., Zaidi, S.: Impact of information communication technology and economic growth on the electricity consumption: empirical evidence from 67 countries. *J. Knowl. Econ.* **8**(3), 789–803 (2017)
17. Unwin, T.: *ICT4D: Information and Communication Technology for Development*. Cambridge University Press, Cambridge (2009)
18. Ibrahim-Dasuki, S., Abbott, P.: A socio-technical analysis of ICT investments in developing countries: a capability perspective. *Electron. J. Inf. Syst. Developing Countries* **67**(1), 1–29 (2015)
19. Sen, A.: *Development as Freedom*. Oxford University Press, Oxford (1999)
20. Sen, A.: *Resources, Values and Development*. Harvard University Press, Cambridge (1984)





# An Inquiry into IT Governance in Healthcare Organizations in Uganda

Michael Kizito<sup>1,2</sup> 

<sup>1</sup> University of Gothenburg, Gothenburg, Sweden  
michael.kizito@ait.gu.se

<sup>2</sup> Makerere University, Kampala, Uganda

**Abstract.** Looking at the world today, various organizations have taken up IT to support most of their work processes. IT can no longer be considered only a support component but has become strategic. Given that IT is ubiquitous, it requires proper governance in order for organizations to derive value and achieve organizational objectives from its use. IT governance is therefore advocated as a necessary means for ensuring the effective and efficient use of IT. Previous literature does not say much about IT governance adoption and enactment in healthcare organizations. In this study, resource orchestration is used as a framework for understanding management strategies for IT governance adoption in healthcare organizations. The study answers the research question, “How are managerial strategies impacting the adoption of IT governance in healthcare organizations?”. This was done through an interview study of managers, IT workers and policy makers in select Ugandan organizations. The participants in the study were from the private and public healthcare organizations, IT authority and the capital city authority. Findings show that there are informally agreed upon and approved strategies in place for the adoption of IT governance. The contribution is in terms of suggestions of how senior management can enact the strategies and make use of the organization’s knowledge based and financial resources to inform adoption of IT governance.

**Keywords:** IT governance · Resource orchestration · Healthcare

## 1 Introduction

Information Technology (IT) is now ubiquitous in many organizations and is increasingly considered a strategic resource. IT has played a key role in transforming various industries leading to new business models [1, 2]. IT initiatives rely on funding approved by senior management but at the same time suffer from the limited knowledge of IT investment processes by senior management [3]. IT is seen as an enabler in the effort to attain improved efficiency in the services offered in healthcare [4].

Over the years there has been a growing need to provide high quality health services at affordable cost as well as easier access to medical information for the patients. As a result, hospitals have turned to or are turning to IT to find solutions to these requirements [5, 6]. Most of the hospitals that have embraced IT have implemented integrated IT applications that cut across many functions [7]. The growing

trend of moving from the traditional healthcare to what is referred to as ehealth has stimulated some debates leading to research focusing on the role IT plays in improving efficiency in healthcare [8].

There has been a notable increase of IT complexity in healthcare organizations [9] which adds to the need for IT governance in these organizations. The increasing level of IT investment and the expected impact on the performance of healthcare organizations demands an active governance stance [10]. There is not much in the previous literature specifically giving information about the state of IT governance in healthcare organizations in developing countries. The definition of control enactment by Wiener [25], gives the motivation for this study in order to understand the interaction between the senior management and those they lead. The aim of this study is to explore the state of IT governance in healthcare organizations in Uganda.

In order to get value from IT governance, board members in organizations should ensure management and organizational structures and processes that sustain the organization's IT in order to extend the organization's strategy and objective [11]. The enactment of control [25] by the board members can potentially realize the desired goals by influencing senior management. In the same vein, the resource orchestration perspective was used to study IT governance in healthcare organizations.

This empirical study was done in select public and private healthcare organizations in order to answer the following research question: *“How are the managerial strategies impacting the adoption of IT governance in healthcare organizations?”*

The contribution of this study offers an understanding of the strategies in healthcare organizations to support IT governance. The rest of the paper is organized as follows; Sect. 2 discusses the relevance of IT governance and describes the theoretical lens. Section 3 describes the method, empirical description of case, data collection and analysis. Section 4 presents the findings and Sect. 5 has the discussion. Section 6 has the implications for research and practices, and Sect. 7 presents the conclusion.

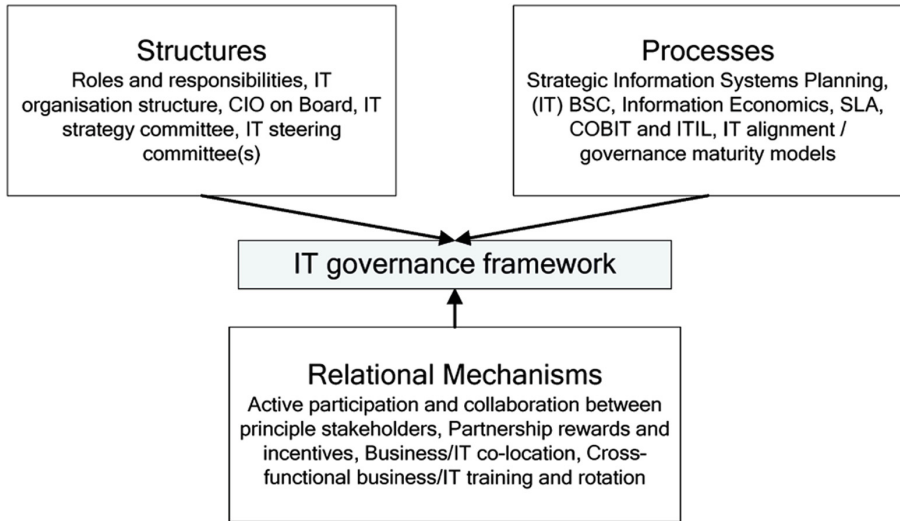
## 2 The Relevance of IT Governance in Healthcare

Healthcare is paramount to a population's wellbeing and as such becomes a complex industry. There are many ways in which IT can be used to improve the efficiency in healthcare like in the areas of electronic health records (EHR), sharing of patient records and so on. In order to realize efficiency in healthcare using IT as an enabler of the business, requires acquiring new infrastructure among other things. This then points to IT investment and the realization of IT business value.

There is need for emphasis on the transparency and effective governance of IT. What is necessary to achieve this is not getting IT right but rather managing the process.

There are various definitions for IT governance [12, 15, 16] and for this study, the definitions by [13] and [14] are adopted, since they give a precise meaning of IT governance. Van Grembergen [13] defines IT governance as “the organizational capacity exercised by the board, executive management and IT management to control the formulation and implementation of IT strategy and in this way ensure the fusion of business and IT”. Peterson [14] defines IT governance as “the distribution of IT

decision making rights and responsibilities among enterprise stakeholders, and the procedures and mechanisms for making and monitoring strategic decisions regarding IT". The IT governance framework is made up of structures, processes and relational mechanisms as depicted in Fig. 1 adapted from De Haes and Van Grembergen [15].



**Fig. 1.** Element of IT governance framework adapted from De Haes and Van Grembergen (2006)

## 2.1 Structures: Roles and Responsibilities and IT Department

IT governance has been prevalent in three modes over the years, namely; the centralized IT governance modes, the decentralized IT governance mode and the organizational IT governance mode.

The centralized IT governance mode is about the corporate IS taking on responsibility to deal with the infrastructure, its use and project management. The main thing in this mode is the business strategy since there is no IT strategy. It is referred to as a business monarchy [15], where the IT department does not act independently of senior management.

The decentralized IT governance mode is about the divisional IS and line management taking on authority. The authority can be played differently for IT [16]. There is localization of governance rights with each business leader who acts autonomously depending on the needs and with his own budget [15].

The organizational IT governance mode bundles both the corporate IS and the business units and undertakes the responsibility for the IT activities [17–19]. This approach makes use of the multi skilled teams and cross functional liaison with the developed strategy. This makes the formulation, analysis and implementation a more fluid process [20].

There is diversity in the choice of approaches mentioned above since organizations are different. In order to manage the required change, IT governance requires the implementation of structures. The success of these structures lies in the ownership of the stakeholders involved. The new governance structures need to come along with better costs, results, and lower risks.

The purpose of IT governance is to manage and achieve structures that are core to business success and trust by the board in order to realize the strategic goals in a competitive manner. This involves the management team having control over cost and investment alongside accountability as well as maximizing the capability of the IT selected to provide support to the clinicians and administrators in a hospital. When all the stakeholders are working together, there is trust and ownership of the structure and its related process [21].

## **2.2 Processes: Planning and Monitoring**

In the earlier days, as a requirement for IT governance, each business had to identify and establish its own procedures and processes in order to manage the flow of information related to the initial proposals, business plans, documentation and approval processes for IT investments [15]. IT governance has been guided by the gating process over the years while handling projects. Lately, there had been development of various frameworks like COBIT, ITIL among others that are being used in the implementation of IT governance [17]. All these available frameworks today aim at having the projects realize the organization's strategy.

## **2.3 Relational Mechanisms: Role of IT Departments and the Frameworks**

The type of the organizational setting will determine the success of the mechanisms which also depends on the governance approach taken on by the organization. The mechanisms go a long way in facilitating collaboration and cross function business/IT training. This is helpful in that if we have an expert whose powers are seemingly being usurped due to the new structures as pointed out earlier, so that we can have mediation through these relational mechanisms to help avert such scenarios.

The IT department in conjunction with the human resources department is central in the implementation of the strategic IT management across the organization. In order for the IT department to handle this well, it requires frameworks which were discussed earlier in Subject. 2.2. People are key to attaining integrative effort and therefore must be trained to make the lateral dimension their focus [22]. With the relational mechanisms in place, the focus now remains on how to effectively manage IT governance and also sensitizing the stakeholders on the deployment of the methodologies.

The next section describes the theoretical lens to help understand the IT governance practices in healthcare organizations in Uganda.

### 2.4 The Resource Orchestration Framework

The resource orchestration framework (ROF) [22] is used as an analytical lens to explore how healthcare organizations are adopting IT governance. The ROF has three main components that can potentially support control enactment in healthcare organization as they work to adopt IT governance.

The ROF (Fig. 2) addresses issues not previous considered and these include the organizational breadth (scope of the organization), depth (managerial levels within the organization) and the life cycle. The empirical study was done amongst some of the healthcare organizations in Uganda focusing on the managerial levels in the organizations and how they affect resource orchestration actions during the realization of IT governance.

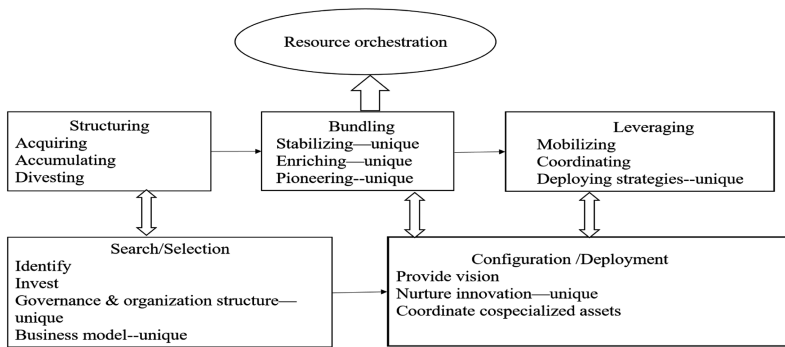


Fig. 2. The resource orchestration framework (Adapted from Sirmon et al. 2011)

## 3 Method

### 3.1 Empirical Selection and Description of Case

The study was conducted mainly in Kampala, the capital city of Uganda, which is in the central region. Uganda is among the developing countries trying to adopt the use of IT in many areas including healthcare. Healthcare organizations have adopted the use of IT in the form of health information systems and mobile apps. This has brought about some disruption which calls for IT governance in order to realize value for the IT Investments. Interviews were also done in the eastern region of Uganda in Mbale at the regional referral hospital and the western region of Uganda in Fortportal at the regional referral hospital. The choice of Kampala hospitals was mainly because they are private hospitals considered to be with the state-of-the-art equipment and therefore use IT in their processes. In other words, the private hospitals are considered to be the pace setters. In order to get an understanding of what goes on in the public sector, the two regional referral hospitals in the east and west of the country were selected.

### 3.2 Data Collection

Data was collected from key stakeholders who mainly included health IT professionals and administrators. In depth interviews were done with 11 informants. 4 out of the 11 informants were administrators who advise senior management on key IT investment decisions while others are policy makers, and the rest of the informants were health IT professionals. The interviews were around issues of governance of IT in healthcare and lasted between 45–60 min. The intention was to explore how administrators and IT professionals enact IT governance in their organizations and whether there is a national IT governance plan for healthcare.

In addition to interviews, secondary data was collected from websites and documentation shared by some of the informants. Those interviewed were requested to suggest other potential interviewees as external interviewers can have difficulty in identifying the right informants (Table 1).

**Table 1.** Informants interviewed showing organizations they work for and their designations

Organisation	Designation of person interviewed
Uganda Catholic Medical Bureau	Head IT
Nsambya Home care	IT Manager
Nsambya Hospital	Systems Administrator
Rubaga Hospital	IT Head
Kampala Capital City Authority	Manager Medical Services
Mbale Regional Referral Hospital	IT Officer
Fortportal Regional Referral Hospital	IT Officer
International Hospital Kampala	IT Head
Ministry of Health	Commissioner
National Information Technology Authority of Uganda	Director e-government services
National Information Technology Authority of Uganda	Health Lead

### 3.3 Method of Analysis

For the analysis, themes were developed using the ROF. Systematic coding across the data set was done and this helped in coming up with the initial codes. Using the ROF, the following categories emerged; coordinating, enriching, pioneering, acquiring, accumulating, nurturing of innovation and divesting of resources. Repeatedly listening to the transcribed interviews and interview notes helped in developing the results as viewed from the resource orchestration lens.

## 4 Results

In this section, the findings are presented using some components of ROF.

## 4.1 Structuring

Most of the healthcare organizations that participated in the study are in the process of acquiring and improving their IT infrastructure. There are minor improvements on existing infrastructure (accumulating). Some have divested both the software and hardware and have new software and hardware that suits the requirements of the organizations.

Many of the healthcare organizations are using the rudimentary method of recording patient records in books and on cards. This has its own issues of privacy of the patients' records and at the same time the patients may lose their books, which means that at each visit they have no records. This makes it hard to do a good assessment of the patient. Subsequently, these and other issues have led to the adoption of IT by implementing Health Information systems (HIS). Table 2 below shows some of the systems in use in both private and public hospitals and whether they are standalone or integrated in the various organizations.

**Table 2.** Showing the IT systems available and whether they are standalone or integrated

Organization	Types of systems	Integrated/Standalone
Alpha	Electronic Patient Record (EHR), radiology, billing, pharmacy	Over 50% integrated
Omega	Hospital Management System (HMIS), lab system, billing	Heterogeneous integrated systems
Beta	Uganda Electronic Medical Record (UgEMR), pharmacy and lab system,	Standalone
Nano	Billing, pharmacy and lab, patient records	30% integrated
Gamma	District Health Information Systems (DHIS2), UgEMR, HMIS	Standalone

<sup>a</sup>Pseudo names are used for the names of the organizations in the table

The table above shows the IT systems available in the hospitals. Most of them are standalone. This probably shows that the IT value from the systems is not yet optimal. There is need for complete integration, which requires support from the board to fund the IT budget as stated by one of the health IT staff: *“The board approved the integration of Clinic Master with the ERP system currently in use. This is one way of aligning the IT with the business to realize value for the IT investment and the strategic objectives of the organization.”*

In order to realize smooth sharing of information among the existing standalone systems, the necessary infrastructure and software have to be procured. Training of both the IT staff and the end users should take place after the implementation. This requires a lot of support from senior management and the board. One of the IT staff stated that: *“There are many challenges as we move towards realization of the integration process and these include, infrastructural changes, bureaucracy in getting new infrastructure, non-IT savvy clinicians and insufficient training for both IT staff and end users.”*

Generally, structuring is happening mainly in the private hospitals where the management at all levels is keen to support the use of IT. As for the public hospitals, they are still tied to DHIS2 which focuses on aggregate data from all districts in the country. This clearly shows the need for an IT infrastructure procurement plan for health information systems in health centres at all levels in the country. Speaking to an IT officer at a regional referral hospital, he stated: *'In the current state, we have no IT team, we rely on services of the outsourced IT company. This is mainly because we literally have no IT network in place. There are just a few standalone computers that are used for various tasks in the hospital.'*

In the private hospitals, the board and senior management have given the necessary support by approving the roll out of the health information system to the entire network of clinics. The customized HMIS is operational at the Nano headquarters and will be rolled out to the clinics network in a year's time.

## 4.2 Bundling

The integration of resources to achieve improvements to existing capabilities as well as extending and creating of new capabilities is evident. In one of the private not for profit (PNFP) hospitals, there is an ongoing effort to improve the existing capabilities of the health information system (HIS). In its current state, it serves only the clinicians and the top management. The IT support staff stated that: *'Streamline was designed by the doctors and they did not involve other stakeholders like patients. In terms of performance, it is good for the doctors but not good for the patients.'*

The IT support staff advised top management that it is imperative that the existing HIS be modified to involve and serve all stakeholders. This was work in progress and should be operational now.

In the case of public hospitals (state owned) the ministry has embarked on enriching the current capabilities by adding the health management information system (HMIS). However, for this to happen there must be an appropriate governance structure and infrastructure in place. In support of this the Commissioner in the ministry of health stated: *'There are different patient information systems that don't 'talk' to each other. For proper system integration, there is need for a national health facility master list that is coded, infrastructure that can facilitate the use of systems at the health centre level and regional referral hospitals. Ultimately, an appropriate governance structure is necessary.'*

At the Nano hospital which is private, efforts are underway to do minor improvements to existing capabilities. This is through the upgrading of their customized HISs after acquiring better hardware and software. The IT manager at Nano hospital stated that: *'Originally the hospital (headquarters) was using Navisionattain ver 3.6 and has now upgraded to MS Dynamics Nav 2016 (ERP) which had been customized to include patient handling. The clinics still use Navisionattain but Nav 2016 will be rolled out in a year's time.'*

At Omega hospital, bundling efforts have met challenges that include bureaucracy in the procurement of IT infrastructure, clinicians that are not IT savvy, insufficient training of staff both clinical and IT in regard to IT systems and the security of patient records. The IT officer at Omega stated: *'As the IT team we advise management on*



*what needs to be in place to improve the efficiency of the systems in place. They have been supportive and approve our requests. The challenge though is that the procurement takes ages and so affects the entire process. After implementation of the new systems, only a few IT and clinical staff are trained to handle the new systems. This affects the systems performance as it will not work at its optimal level.'*

At the Alpha hospital, they have ClinicMaster for the patient records and Navision to handle the accounts and inventory. The hospital director requested that there is seamless flow of information between the two systems. The project to do the integration of the two systems is underway and was midway as stated by the IT officer at Alpha Hospital: *'The hospital management in the bid to realize improved efficiency run to IT in the form of a HIS. The outcome was procurement of ClinicMaster and Navision. After a while management requested for the integration of the two systems. The project was approved and is now close to completion.'*

Overall there is a drive to improve the existing capabilities as well as creating new capabilities in most of the private hospitals as a way to tap into IT.

### **4.3 Leveraging**

There are practical issues and managerial strategies that are in place to realize efficiency from the use of IT. Most of the private hospitals' boards and senior management have projects in place and are willing to support them to succeed. They monitor the progress of the projects as part of their roles. This was evident at the Alpha hospital where the IT officer stated: *'The board and senior management agreed on financing a project to realize the integration of ClinicMaster and Navision. The objective for this was to have seamless flow of information between the two systems. This is expected to improve the efficiency of the hospital as they serve their clients.'*

The IT manager at Nano hospital stated that there are no IT governance structures. However, he added that there was an IT audit report which recommended among other things the deployment of IT governance tools and implementation of IT projects in a timely manner. The IT manager at Nano hospital stated: *'At the moment we don't use any IT governance frameworks but these are planned for after the audit. These are some of the recommendations following the IT audit. The board takes keen interest in the recommendations made and oversees their implementation.'*

Beta home care which is part of Omega hospital is looking to fully use the UgandaEMR system in order to track and monitor patients in any part of the country. The UgandaEMR is a medical records system that is in use in over 340 sites in Uganda and mainly deals with HIV treatment. The Beta home care being an HIV treatment centre is keen to make the most of the UgandaEMR as stated by their IT officer: *'In collaboration with development partners, we are in the process of having UgandaEMR to help us in the monitoring of the following aspects of the patients; demographics, vitals for the patient and viral loads. With UgandaEMR we will be able to track patients in any part of the country.'*

In the current state, there are literally no HISs in the public hospitals. The Ministry of Health (MoH) relies on information from the DHIS2 that is provided by the district health Officers (DHOs). The DHIS2 Tracker is an addition to the DHIS2 platform and is mainly for sharing critical clinical health data across multiple health facilities.

However, if it is to be used at a national level as an HIS for the case of MoH, it has to be combined with more advanced electronic medical records as stated on the DHIS2 website: *'The aim of the DHIS2 tracker is not to become an advanced electronic medical record system to support clinical care, but to be a basic transactional system easy to set up and that it builds on an existing and proven platform with available technical capacity.'*

Typically, there are efforts in hospitals involving a sequence of processes that shall lead to the use of IT to improve service delivery in hospitals.

## 5 Discussion

The research findings show that the various managerial levels are not supporting each other as they seem to have different agendas. Synchronization of the resource orchestration actions is important if value for IT investment is to be realized. According to [23], there is need for senior management to be involved concurrently at all stages of the process of resource management, and at the same time consistently scanning the outside surroundings for relevant prompts about change.

A majority of respondents stated that their organizations did not have a clear IT governance structure in place e.g. IT steering committees, IT strategy committees, COBIT, ITIL, etc. Based on the responses it seemed like some of these things were on paper but not implemented. Furthermore, due to the unclear IT strategy, the IT structures and processes (Fig. 1) are not clear or nonexistent in many of the healthcare organizations. Again, IT outsourcing in the public health care organizations, affected the IT investments decisions. Without IT structures and unclear IT processes in place, it is a barrier to effective IT governance [24].

Healthcare access is still low given the number of health centres and regional referral hospitals in place vis-a-vis the population. Public health facilities are deficient of drugs and basic equipment to do diagnosis and laboratory tests. The use of IT is extremely low and health records are written in books carried by the patients and so they can get destroyed or misplaced easily. Also, a patient can use three books each for a specific health facility in order to acquire as much available free drugs. This then does not give an accurate picture of the number of patients treated since there is a duplication. IT systems could reduce the duplication and also help develop an accurate health record of patients.

## 6 Implications for Research and Practice

The study gives insight for possible research on how value for IT investment can be realized in a setting without well-defined IT governance structures. Then in practice, how to put in place an effective EHR could provide accurate information of patients who move from health facility to facility in terms of diagnosis and prescription. In conjunction with MoH also come up with an IT system that can be used to monitor the distribution of drugs between the national drug authority and the hospitals.

## 7 Conclusion

The state of IT governance (ITG) in healthcare organizations in Uganda has been noted as below par. Many of the healthcare organizations have it on paper and have never gone an extra mile to do the implementation. Having ITG mechanisms in healthcare organizations could support the adoption of IT in healthcare organizations. Managerial teams in healthcare organizations need to support the development of electronic health records (EHR) that can be shared amongst both the private and public healthcare organizations. EHRs could bring into play, storage of accurate information about the patients in terms of diagnosis and prescription. The study showed that in the private hospitals, all the managerial levels (top, middle and operational) are involved in the IT investment decisions which follows the hierarchy until a final decision is taken. Other benefits could be improvements in the areas of IT strategy planning and formation which could in turn lead to improved IT governance structures. Finally, with proper IT governance structures in place, there is likely to be easier IT adoption in healthcare organizations leading to better and improved healthcare service delivery.

**Acknowledgement.** The author would like to thank SIDA. This work was supported by the Sida/BRIGHT project 317 under the Makerere-Sweden bilateral research programme 2015–2020. In addition, I would like to thank the IFIP reviewers for their insightful comments that allowed us to improve the paper.

## References

1. Barrett, M., Davidson, E., Middleton, C., DeGross, J.I. (eds.): *Information Technology in the Service Economy: Challenges and Possibilities for the 21st Century*. ITIFIP, vol. 267. Springer, Boston, MA (2008). <https://doi.org/10.1007/978-0-387-09768-8>
2. Bryson, J.R., Daniels, P.W., Warf, B.: *Service Worlds: People, Organisations and Technologies*. Routledge, London (2004)
3. Argyris, C.: Double-loop learning in organizations: a theory of action perspective. In: Smith, K.G., Hitt, M.A. (eds.) *Great Minds in Management: The Process of Theory Development*, pp. 261–280. Oxford University Press, Oxford (2005)
4. LeRouge, C., Mantzana, V., Wilson, E.V.: Healthcare information systems research, revelations and visions. *Eur. J. Inf. Syst.* **16**(6), 669–671 (2007)
5. Glaser, J., Henley, D.E., Downing, G., Brinner, K.M.: Advancing Personalized Health Care through Health Information Technology: an update from the American health information community' personalized Health Care Workgroup. *J. Am. Med. Inform. Assoc.* **15**(4), 391–396 (2008)
6. Raghupathi, W., Tan, J.K.: Information Systems and Healthcare: charting a strategic path for health information technology. *Commun. Assoc. Inf. Syst.* **23**, 501–522 (2008)
7. Garets, D., Davis, M.: *Electronic Medical Records vs. Electronic Health Records: Yes, There is a Difference*, pp. 1–14. HIMSS Analytics, LLC, Chicago (2006)
8. Haddad, P., Gregory, M., Wickramasinghe, N.: Business value of IT in healthcare. In: Wickramasinghe, N., Al-Hakim, L., Gonzalez, C., Tan, J. (eds.) *Lean Thinking for Healthcare. Healthcare Delivery in the Information Age*, pp. 55–81. Springer, New York (2014). [https://doi.org/10.1007/978-1-4614-8036-5\\_5](https://doi.org/10.1007/978-1-4614-8036-5_5)

9. Bradley, R.V., Byrd, T.A., Pridmore, J.L., Thrasher, E., Pratt, R.M., Mbarika, V.W.: An empirical examination of antecedents and consequences of IT governance in US hospitals. *J. Inf. Technol.* **27**(2), 156–177 (2012)
10. Kaarst-Brown, M.L.: Understanding an Organization's View of the CIO: the role of assumptions about IT. *MIS Q. Exec.* **4**(2), 287–301 (2005)
11. ITIG (IT Governance Institute): Board Briefing on IT Governance, 2nd edn. (2000). [www.itgi.org](http://www.itgi.org)
12. Brown, A.E., Grant, G.G.: Framing the frameworks: a review of IT governance research. *Commun. Assoc. Inf. Syst.* **15**(1), 38 (2005)
13. Van Grembergen, W.: Introduction to the minitrack IT governance and its mechanisms. In: Sprague Jr., R.H. (ed.) *Proceedings of the 35th Hawaii International Conference on System Sciences*, Big Island, Hawaii. IEEE Computer Society, Los Alamitos (2002)
14. Peterson, R.: Information strategies and tactics for information technology governance. In: Van Grembergen, W. (ed.) *Strategies for Information Technology Governance*. Idea Publishing Group, Hershey (2004)
15. De Haes, S., Van Grembergen, W.: Information technology governance best practices in Belgian organisations. In: *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS 2006)*, vol. 8, p. 195b. IEEE, January 2006
16. Sambamurthy, V., Zmud, R.W.: Research commentary: the organizing logic for an enterprise's IT activities in the digital era—a prognosis of practice and a call for research. *Inf. Syst. Res.* **11**(2), 105–114 (2000)
17. Sambamurthy, V., Zmud, R.W.: Arrangement for information technology governance: a theory of multiple contingencies. *MIS Q.* **23**(2), 261–290 (1999)
18. Brown, C.V., Magill, S.L.: Alignment of the IS function with the enterprise: toward a model of antecedents. *MIS Q.* **18**(4), 371–403 (1994)
19. von Simson, W.: The centrally decentralized IS organization. *Harvard Bus. Rev.* **68**(4), 158–162 (1990)
20. Earl, J.M.: Experiences in strategic information systems planning. *MIS Q.* **17**(1), 1–24 (1993)
21. Suomi, R., Tahkapaa, J.: Chapter XIV governance structures for IT in the health care industry. In: Van Grembergen, W. (ed.) *Strategies for Information Technology Governance*. Idea Group, Hershey (2004)
22. Sirmon, D.G., Hitt, M.A., Ireland, R.D., Gilbert, B.A.: Resource orchestration to create competitive advantage: breadth, depth, and life cycle effects. *J. Manag.* **37**(5), 1390–1412 (2011)
23. Sirmon, D.G., Hitt, M.A., Ireland, R.D.: Managing firm resources in dynamic environments to create value: looking inside the black box. *Acad. Manag. Rev.* **32**(1), 273–292 (2007)
24. Peterson, R.: Crafting information technology governance. *Inf. Syst. Manag.* **21**(4), 7–22 (2004)
25. Wiener, M., Mähring, M., Remus, U., Saunders, C.S.: Control configuration and control enactment in information systems projects: review and expanded theoretical framework. *MIS Q.* **40**(3), 741–774 (2016)



# Exploring an Impact Sourcing Initiative for a Community of People with Disabilities: A Capability Analysis

Karsten Eskelund<sup>1</sup>(✉), Richard Heeks<sup>2</sup>, and Brian Nicholson<sup>1</sup>

<sup>1</sup> Alliance Manchester Business School,  
University of Manchester, Manchester, UK  
karsten.eskelund@postgrad.manchester.ac.uk  
<sup>2</sup> Centre for Development Informatics,  
University of Manchester, Manchester, UK

**Abstract.** The purpose of this paper is to bridge the knowledge gap on how new technology, like online platforms can help people with disabilities (PWD's) improve their capabilities.

The paper presents an interpretive qualitative case study of individuals who were all trained to be online freelancers using digital “gig” work platforms (e.g. Upwork) by “Virtualahan”, a social enterprise based in the Philippines. Data is analyzed through the lens of Bjørn Giger’s Alternative Evaluation Framework (AEF). Interview and ethnographic data provide the evidence to analyze the achieved functionings for PWD and the barriers and facilitators of the functionings.

The findings indicate that online technology facilitated employment has wider implications than an improved financial situation. Employment through online technology increased the informants self-confidence and how they are perceived by their families.

This paper contributes to the literature on PWD's, capabilities and online gig work, and how such work can help to build a community for PWD's. Practical contributions of the findings for policymakers, consultants etc. are guidelines for helping PWD's to find online employment, which can contribute to their capabilities.

**Keywords:** Impact sourcing · ICT4D · People with disabilities (PWD) · Society · Capabilities approach

## 1 Introduction

From previous research, it is known that people with disabilities (PWD's) regularly experience challenges in obtaining employment [13, 17]. They might be faced with difficulties in travel due to physical disability or a hearing or sight disability may disqualify from opportunities. They are often being discriminated against and seen as having a lack of knowledge [26].

A gap in knowledge is related to the effect of training and utilizing of new technology gives people with disabilities opportunities “to live a life they value”, [23]. In

this paper we use an evaluation framework developed by Gigler [6] to understand how new technology used in an impact sourcing initiative influences communities of PWD's

The data for a case study is collected through interviews with PWD's who have all undergone training by Virtualahan, a social enterprise located at Mindanao Philippines. Virtualahan consider itself as an impact sourcing organization, providing training to and hiring people from a disadvantaged background [11]. Previous impact sourcing research have focused on rural communities [21]. There is a gap in the research regarding how impact sourcing can contribute to a community of people with disabilities.

This paper responds to a call about how technology can help people with disabilities [28: 28]. According to Walsham, ICT-initiatives which attempt to help disadvantaged people often does not reach the most disadvantaged groups. Such groups include people with disabilities, which is to a huge extent neglected in academia.

With this as a background, we examine the following research questions:

**RQ:** How does new technology influence capabilities of a community with people with disabilities?

We contribute to previous literature in 3 ways: (1) we reduce the knowledge gap regarding how an impact sourcing initiative, in the shape of training and by utilizing new technology, can help people with disabilities can get jobs they otherwise would not have been able to get and how this impact their communities, (2) apply the capabilities approach in a novel domain of an impact sourcing initiative for PWD's, and (3) offer guidance to practitioners and policymakers.

The paper proceeds as follows: In Sect. 2, we review the literature on impact sourcing, disability and work, and outline the capabilities approach that shaped our field-work and data-analysis process. In Sect. 3, we describe the case study. Section 4 outlines the research methodology. In Sect. 5 the findings are presented, and these findings are analysed and discussed in Sect. 6. Finally, in Sect. 7 we conclude.

## 2 Literature Review and Conceptual Framework

Three bodies of literature are presented in this section. First, we review the literature regarding impact sourcing. Secondly, we review the previous literature regarding disability and in particular disability and work. Finally, we present the framework that guides this research and in particular look into how this framework has previously been used in research about disability.

### 2.1 Impact Sourcing

Impact sourcing is a recent development within the wider sourcing of information technology (IT) and business services (BPO) industry. Specific impact sourcing vendors are established not just to maximize its profit, but also to contribute to general development of communities [11]. Traditionally impact sourcing is defined as “the practice of hiring and training marginalized individuals to provide information technology, business process, or other digitally-enabled services who normally would have

few opportunities for good employment” [2: 401]. Previous impact sourcing literature includes studies of communities like women in a social enterprise [8], youth in rural areas both in India and in Pakistan [16, 21], and prisoners [12]. New technology like digital platforms, defined as “a set of digital resources – including services and content – that enable value-creating interactions between external producers and consumers” [3: 381] have created new ways of doing business. In particular, online outsourcing platforms, where clients can contract work from potential workers across the world have changed the dynamics of the out-sourcing industry [9].

What we do not know is how impact sourcing initiatives can have implications for communities, and not just for individuals. As capability development of individuals does not necessarily mean development of the communities that these people belong to, it is important to analyze the implications also for communities.

## 2.2 People with Disabilities and Work

Disability can be defined as “a problematic interaction between an individual who has a specific, functional requirement and an environment that is designed without taking that requirement into consideration” [24: 108]. According to this model, the disability shall not prevent a person with a disability to live the way they would like to live. This is called the social model, as opposed to the medical model, where disability is seen as medical in nature and where disability is the object of medical care [24: 106].

In this paper we rely on the social model. The main reason for this is that we judge that model to best explain the relationship between the individual PWD and the society, and hence to describe their opportunity to increase their capabilities.

There are many reasons why companies do not hire people with disabilities. Some main reasons include fear of additional cost related to the work environment, lack of knowledge about how to handle people with disabilities and fear that the employer will not be able to discipline people with disabilities due to potential lawsuits [10]. Employees with disabilities are assumed to be incompetent, not productive and create undue hardship for an employer; hence, they face limited career advancement opportunities [13].

Most of the literature on disability and work is from developed countries (typically USA). Thus, we have limited understanding of the circumstances of PWD’s in developing countries but they are likely to face more constraints due to institutions such as lack of welfare benefits or State support [1, 5, 15]. Previous research indicates that the employment rate for people with disabilities in developing countries, including the Philippines, is generally lower than the employment rate for people without disabilities [17, 18].

Previous research has also shown how digital technology such as online platforms can help PWD’s to find freelance work [4, 25]. However, there is a gap in this research regarding what further implications impact sourcing can have on communities of people with disabilities.

### 2.3 Capability Approach and Marginalization

The Capabilities Approach, developed by Amartya Sen is the foundation for the analysis in this paper. The capabilities approach consists of three main pillars; functionings, capabilities and freedom. Sen distinguishes between functionings and capabilities by stating: “A functioning is an achievement, whereas a capability is the ability to achieve. Functionings are, in a sense, more directly related to living conditions, since they are different aspects of living conditions. Capabilities, in contrast, are notions of freedom, in the positive sense: what real opportunities you have to live the life you may lead” [22: 36]. Freedom is defined as “the expansion of capabilities of persons to lead the kinds of lives they value – and have reason to value” [23: 18].

Sen has been criticized for not defining specific capabilities [19, 20]. Other authors have used Sen as a starting point for alternative frameworks, where specific capabilities are defined. One such example is the alternative evaluation framework AEF, created by Björn Gigler, which is used in this paper [6, 7].

Gigler put people’s assets and capabilities in the center, and then examine how information technology might help them to improve their information capabilities, and ultimately improve people’s human and social capabilities. A key element of the framework is the role that intermediary organizations, or brokers, as Gigler call it play in the development process [14]. Intermediaries might act as a liaison or a broker between individuals or a group of people in a particular community and a group or source of information outside the community.

Gigler further stresses the concept of power and that “one of the most important assets of poor people is their strength to form groups and organizations at the community level and to collectively pursue goals based on a shared vision” [6: 16]. By this, Gigler focuses on empowerment of not just individuals, but empowerment of communities as a whole. He then distinguishes between indicators for individual empowerment and indicators for community empowerment, while at the same time acknowledging that there is a clear link between these.

## 3 Case Description

All interviewees are PWD’s who have been trained by Virtualahan, a social enterprise based in Davao in Mindanao, the southernmost main island of the Philippines. Virtualahan trainees were selected because they all fit into the profile of people we wanted for this study (people with disabilities in developing countries). Virtualahan was very helpful regarding helping us to get access to the informants. Our unit of analysis is the individual trainees and not Virtualahan as an organization. The reason for this approach is the focus on the impact the capability building of the individuals, not the growth of the organization. Although Virtualahan has its main base at Mindanao, the trainees are from all the three main groups of islands (Luzon, Visayas, and Mindanao). Due to the unstable political situation in Mindanao, interviews were conducted only in Luzon and Visayas. The interviewees live in a mix of urban and more rural areas. The age group is from the early twenties to late forties and of both genders. It is also a mix of people who have had their disability since birth, and others who experienced disability later in



life, typically through accident or illness. This spread of interviewees makes it possible for us to understand how different social settings have an impact on the individual's capabilities.

There are four different ways that Virtualahan helps the trainees to get jobs. The first level is through direct employment. The trainees are employed by Virtualahan and either work with internal activities for the organization and some of the direct customers. Secondly is employment through some of the partners that Virtualahan has. This includes companies like ATRIEV, HSBC, Globe Telecom, Genasthim and GO2 Impact. These partners do not pay Virtualahan directly for helping them to recruit people, but the trainees being hired by them will then be part of the pay later program. The third way is that the trainees manage to find jobs on their own. Such jobs are typically found through online platforms like Facebook, OnlineJobs.ph or UpWork, or through private connections. The fourth way is to help the trainees create their own businesses.

## 4 Methodology

The paper is based on an interpretive case study methodology to explore the issue in its natural setting [27]. Qualitative research methods for data collection and analysis were used. Primary data was collected through semi-structured interviews with individuals during a field-trip to the Philippines from March to May 2018 whom all had undergone training by Virtualahan. A total of 22 individuals were interviewed. Each interview lasted from, 30 to 80 min (Table 1).

**Table 1.** Gender distribution

Gender	Number of informants	Average age
Male	12	36
Female	11	33,7

The interviews were either conducted at the homes of the informants or, if the interviewee did not want the researcher to visit the home, in a nearby coffee shop or other suitable location. Before and after the interviews, questions regarding the content of interviews or to follow up for more detail were conducted using Facebook chat function. Data from these chat sessions was downloaded and used in the analysis.

Also, interviews with policymakers in the Department of Information and Communications Technology (DICT) and National Council on Disability Affairs (NCDA) were undertaken. We also had a number of interviews and informal conversations with the management team of Virtualahan.

There is also extensive information about the company on the Virtualahan website. Virtualahan also has a YouTube page where some of the informants had created videos where they presented themselves. This secondary information was also collected and used in the analysis.

The first author spent a day as an observer with six trainees receiving training and also observed a “well-being” session. Experiences from this session was recorded in a research dictionary.

The purpose of such sessions is to get to know each other better and to get to know how the trainees might help each other. Confidence building was also a key area during the session.

## 5 Findings

Our findings are presented as stories told by the different informants. We present four different vignettes which all are examples on how Virtualahan and new technology have helped different groups of PWD’s to enhance their capabilities. In the next session these findings are all discussed according to Gigler’s framework. All names are changed to protect the anonymity of the informants.

### 5.1 Vignette One – Going from a “No-One” to Becoming a Someone

Rodrigo used to work in the service sector, and had for a number of years worked as a bowling supervisor at a hotel in the Arabian Gulf. In 2011 he met with an accident which meant that he lost mobility in his legs, and he now needed a wheelchair. This also meant drastic changes in his life. Because he was not able to move independently, he lost his job. As he was no longer able to pay the monthly housing costs, he and his family had to move to an area of Manila without regular supply of water and electricity.

In order to obtain some income, he told his story on Facebook, and received some donated money from previous colleagues and classmates. This money was used to invest in a peanut butter making machine. With this machine he managed to earn some money, which was enough to survive.

In 2017 he joined Virtualahan and learned search engine optimization (SEO). Through Onlinejobs.ph, he contacted an American company and eventually was hired. This employment has enabled Rodrigo to pay his monthly bills. He said that:

*“Previously I was a no-one. Now I am a someone. I have gone from being a burden to my family to being a contributor”.*

In addition to work for the American company, Rodrigo is quite active in promoting online work for other Virtualahan trainees. He quite regularly writes Facebook posts on the topic of search engine optimization.

### 5.2 Vignette Two – Being Employed by a Social Enterprise

Ferdinand is a graduate in business management. He used to work in the micro lending business.

He incurred a spinal cord injury after a motorcycle accident eight years ago. This means that he has a limited hand function and no mobility in his fingers. This means that he need help to perform normal everyday tasks such as eating, bathing etc. This means that his mother has to help him with any such daily activities. In 2017 he decided to enroll as a Virtualahan scholar, in order to obtain the skills needed to work

on-line. He is today hired by Virtualahan both to work on internal projects and to work with some of the Virtualahan customers.

After the accident, he studied graphic design and Wordpress design online with Virtualahan and this is the type of work he performs today as a freelancer. Clients are obtained primarily by extracting e-mails from Instagram accounts, and uses the e-mail marketing-tool Mailchimp. One key contribution of Virtualahan was not just to help him increase his technical skills, but also to improve his communication skills, which makes it easier for him to identify and communicate with his clients verbally and in writing.

He is now a graphic designer coach for new Virtualahan students and delivers the training. This is part of what he considers as giving back to the society. His target is to continue to work as a web-developer and to get more clients abroad. He wants to have his own graphic design agency.

*“I really enjoy graphic design. That is my passion. I want to pursue computer programming. After mastering the skill, I am going to reach out to more clients abroad. In 2–3 years I will have my own graphic design agency.”*

### **5.3 Vignette Three – How New Technology Enables Blind People to Work in the Online Outsourcing Industry**

Carmela and Patricia are neighbors in a suburb of Manila and both of them are blind. Both of them work as online transcriptionists. Patricia used to work in the business process outsourcing-industry before. However, because of her blindness, she needed assistance from her aunt to get to the office. Her aunt was also employed and bound by her own work schedules.

Carmela and Patricia are now employed by ATRIEV, which specializes in training and hiring visually impaired PWD. Carmela and Patricia were both trained by ATRIEV in addition to Virtualahan.

This work has made it possible for them to be those who now treat their family members for meals and other social events, like going to restaurants and malls. Without this job, such treatment, which some might find basic, was not possible.

They use a plug-in to Microsoft Word called Express Scribe for the transcription. They also use screen-reader and explains that it:

*“converts the text that comes from the computer into audio so whatever you see in the monitor we can hear it”.*

In Windows 10 there is an in-built app called Narrator. This app makes it easier for blind and visually impaired to use the computer. Another tool in use is Non-visual desktop access also built into Windows. The neighbors demonstrated on an iPhone how this tool help them to hear what is on the screen, enabling them to use platforms such as Facebook, and can identify photographs by hearing the tagged content. Facebook also has an in-built tool for picture recognition. They report the tools are “discriminating”, because it is not always that the screen-reader app works. One example they mention is a situation where they use a VPN to connect to a company system.

Carmela said that she sees this job as a good start, but that her dream job ahead is to work as a teacher, in particular as a teacher for blind children.

*“I will be teaching in public school, because that is my dream. To teach in a school. Specifically, the school for special children, those who are totally blind. But when I have that job I will keep the transcription maybe as a part-time”*

#### **5.4 Vignette Four – Contribute to the Society**

Before she was diagnosed with cancer, Pia, had a leading position in the offshore unit of a leading American law company. She commuted to the leading business district in Manila. After she got diagnosed, she had to undergo treatment for a several years. Initially, she was able to continue in her job, but she felt more and more marginalized, and does not get the promotions she felt deserved, and also that tasks were taken away from her. After a while, she became frustrated with the discrimination and left the organization. She was also diagnosed with a mental disorder.

Pia is very passionate about helping people who are in the same situation as herself, people with a disability that is not visible, and in particular cancer survivors. She made it very clear that whenever her company need more people, she would like to hire cancer survivors. When asked about why she had such a strong desire to help the society, she point to the Filipino phrase “Bayanihan”. Traditionally this describes the situation where, when a family are to move a house, all members of the society will volunteer to join and help. Houses in ancient time was mostly made of bamboo, so it was possible for a group of people to physically move the house to a new location. Today bayanihan has reached internet, and in particular Facebook. Pia, like many other of the Virtualahan trainees uses Facebook regularly to encourage and support people with different types of disability.

## **6 Analysis and Discussion**

In this paper we have seen four examples on how people with different types of disability uses technology to participate in the society in ways they were not previously able to do [7]. In this section, we discuss our findings according to the relevant dimensions in Gigler’s evaluation framework.

### **6.1 Informational**

All of the informants uses new technology to increase their informational capabilities. It is maybe most evident in the case of the blind people. By usage of screen-readers, they are able to understand what is shown on the screen, even if they cannot physically read it. Being able to understand the information they can both do regular tasks like communicating with other people through online platforms like Facebook. But more importantly, they can also work and earn money (discussed below).

Ferdinand and Rodrigo both uses the online platforms to get information about potential jobs, and to actually work. They also use technology like Google and YouTube to enhance their knowledge and to get more information, which again increases their knowledge and make them able to do more challenging jobs.

Pia uses her already existing information capabilities to share knowledge by others. She uses Facebook actively to share the information with other people in her situation.

## **6.2 Organizational**

As mentioned above, in particular Pia utilizes her organizational skills to strengthen her community. Thanks to new technology, she can help people who are in the same situation as herself (cancer survivors), even if they are not located next door. New technology enables her to help the community of cancer survivors all across the archipelago.

## **6.3 Social Development**

We have seen examples on how the new technology have enabled the informants to gain education. All the trainees interviewed are active on social media, where they regularly post about their recent success. By sharing this information, they also encourage others to take up the same type of jobs as they do. This way, they strengthen how the community of PWD's see themselves. Instead of identifying themselves purely as a community of people with disabilities, they no identify themselves as a community of people who are now working.

Another indirect social development identified, is the belonging to the community, as clearly stated by Rodrigo when he said that he "went from a no-one to a someone". A statement like this indicates that he is in a situation where he feels better with himself now than what he might did previously.

## **6.4 Economic Development**

The opportunity to work from home have given all the informants, with the exception of Pia, an opportunity to do jobs that they previously could not do. Restricted movement, either due to blindness or to be in a wheelchair restricted the opportunities to have regular work and then regular income from the other informants. By usage of new technology, they are now able to earn money that they previously could not earn.

The link between individual economic development and economic development for the community is clear. When the trainees get paid jobs, they are able to provide money to their family. Some of them used their earning to send siblings or more distant family members to school. This is an example on how their new status as workers created economic development not just for the individual, but also for the local community where they live.

## **6.5 Enabling Factor, the Influence of Virtualahan**

Virtualahan is, as stated by all of the informants, a key enabler in helping the individuals. Virtualahan is also an organization that highly utilizes technology, and it is an important aspect of how they work that the training shall be accessible for everyone, regardless of where they are and whether they have any mobility issues or not.

## 7 Conclusion

This paper demonstrates that an impact sourcing initiative can help to increase capability building of individual people with disabilities, and through this help wider societies of people with disabilities.

Our findings show that technology help to improve the self-confidence of the PWD's, and through usage of platforms like Facebook, they are able to strengthen the identity of the community of PWD's. Instead of just seeing themselves as a community that is a burden for the society, they are now able to be part of a different community; the community of workers who earn money and contribute to their family.

We contribute to the ICT4D literature by showing how technology can help a particular group of marginalized people, PWD's, and by doing so, responding to the call by [28].

The paper also contributes to practitioners, by providing an example of how one particular impact sourcing vendor can have a huge impact in the society. Findings from this paper can be utilized by policymakers and other impact sourcing vendors in other countries.

We also contribute to the methodology by showing how the AEF framework can be used not only for a physical community, like villages in rural Bolivia, but that it can also be used to analyze a community of people who primarily meet each other online.

Limitations of this paper includes that there is data only from one country. This research should be replicated also in other countries, and more longitudinal research from the same country (Philippines) is very welcome.

## References

1. Arts, W., Gelissen, J.: Three worlds of welfare capitalism or more? A state-of-the-art report. *J. Eur. Soc. Policy* **12**(2), 137–158 (2002). <https://doi.org/10.1177/0952872002012002114>
2. Carmel, E., Lacity, Mary C., Doty, A.: The impact of impact sourcing: framing a research agenda. In: Hirschheim, R., Heinzl, A., Dibbern, J. (eds.) *Information Systems Outsourcing*. PI, pp. 397–429. Springer, Heidelberg (2014). [https://doi.org/10.1007/978-3-662-43820-6\\_16](https://doi.org/10.1007/978-3-662-43820-6_16)
3. Constantinides, P., Henfridsson, O., Parker, G.G.: Introduction—platforms and infrastructures in the digital age. *Inf. Syst. Res.* **29**(2), 381–400 (2018). <https://doi.org/10.1287/isre.2018.0794>
4. Ding, X., Shih, P.C., Gu, N.: Socially embedded work: a study of wheelchair users performing online crowd work in China. In: *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing (CSCW 2017)*, pp. 642–654 (2017). <https://doi.org/10.1145/2998181.2998282>
5. Esping-Andersen, G.: *Welfare States in Transition: National Adaptations in Global Economies*. Sage, Thousand Oaks (1996)
6. Gigler, B.S.: Including the excluded-can ICTs empower poor communities? Towards an alternative evaluation framework based on the capability approach. In: *4th International Conference on the Capability Approach* (2004)
7. Gigler, B.S.: *Development as freedom in a digital age: experiences from the rural poor in Bolivia*. Washington, D.C. (2015)



8. Heeks, R., Arun, S.: Social outsourcing as a development tool: the impact of outsourcing IT services to women's social enterprises in Kerala. *J. Int. Dev.* **22**(4), 441–454 (2010). <https://doi.org/10.1002/jid.1580>
9. Hong, Y., Pavlou, P.A.: On buyer selection of service providers in online outsourcing platforms for IT services. *Inf. Syst. Res.* (2017). <https://doi.org/10.1287/isre.2017.0709>
10. Kaye, H.S., Jans, L.H., Jones, E.C.: Why don't employers hire and retain workers with disabilities? *J. Occup. Rehabil.* **21**(4), 526–536 (2011). <https://doi.org/10.1007/s10926-011-9302-8>
11. Khan, S., Lacity, M., Carmel, E.: Entrepreneurial impact sourcing: a conceptual framework of social and commercial institutional logics. *Inf. Syst. J.* (2017). <https://doi.org/10.1111/isj.12134>
12. Lacity, M.C., Rottman, J., Carmel, E.: Impact sourcing: employing prison inmates to perform digitally-enabled business services. *Commun. Assoc. Inf. Syst.* **34**(1), 913–932 (2014)
13. Lengnick-Hall, M.L., Gaunt, P.M., Kulkarni, M.: Overlooked and underutilized: people with disabilities are an untapped human resource. *Hum. Resour. Manage.* **47**(2), 255–273 (2008). <https://doi.org/10.1002/hrm.20211>
14. Lewis, D., Mosse, D.: *Development Brokers and Translators: The Ethnography of Aid and Agency*. Kumarian Press, Bloomfield (2006)
15. Lewis, J.: Gender and the development of welfare regimes. *J. Eur. Soc. Policy* **2**(3), 159–173 (1992). <https://doi.org/10.1177/095892879200200301>
16. Malik, F., Nicholson, B., Heeks, R.: Understanding the development implications of online outsourcing. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017*. *IAICT*, vol. 504, pp. 425–436. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_35](https://doi.org/10.1007/978-3-319-59111-7_35)
17. Marella, M., Devine, A., Armecin, G.F., Zayas, J., Marco, M.J., Vaughan, C.: Rapid assessment of disability in the Philippines: understanding prevalence, well-being, and access to the community for people with disabilities to inform the W-DARE project. *Popul. Health Metr.* **14**, 26 (2016). <https://doi.org/10.1186/s12963-016-0096-y>
18. Mizunoya, S., Mitra, S.: Is there a disability gap in employment rates in developing countries? *World Dev.* **42**, 28–43 (2013). <https://doi.org/10.1016/j.worlddev.2012.05.037>
19. Nussbaum, M.: *Women and Human Development: The Capabilities Approach*. Cambridge University Press, Cambridge (2000)
20. Robeyns, I.: The capability approach: a theoretical survey. *J. Hum. Dev.* **6**(1), 93–117 (2005). <https://doi.org/10.1080/146498805200034266>
21. Sandeep, M.S., Ravishankar, M.N.: Impact sourcing ventures and local communities: a frame alignment perspective. *Inf. Syst. J.* **26**(2), 127–155 (2016). <https://doi.org/10.1111/isj.12057>
22. Sen, A.: The standard of living. In: Hawthorth, G. (ed.) *The Standard of Living*. Cambridge University Press, Cambridge (1987)
23. Sen, A.: *Development as Freedom*. Oxford University Press, Oxford (1999)
24. Toboso, M.: Rethinking disability in Amartya Sen's approach: ICT and equality of opportunity. *Ethics Inf. Technol.* **13**(2), 107–118 (2011). <https://doi.org/10.1007/s10676-010-9254-2>
25. Vashistha, A., Sethi, P., Anderson, R.: *BSpeak: an accessible crowdsourcing marketplace for low-income blind people* (2018)

26. Villanueva-Flores, M., Valle, R., Bornay-Barrachina, M.: Perceptions of discrimination and distributive injustice among people with physical disabilities: in jobs, compensation and career development. *Pers. Rev.* **46**(3), 680–698 (2017). <https://doi.org/10.1108/PR-04-2015-0098>
27. Walsham, G.: Doing interpretive research. *Eur. J. Inf. Syst.* **15**(3), 320–330 (2006). <https://doi.org/10.1057/palgrave.ejis.3000589>
28. Walsham, G.: ICT4D research: reflections on history and future agenda. *Inf. Technol. Dev.* **23**(1), 18–41 (2017). <https://doi.org/10.1080/02681102.2016.1246406>





# System Use and User Satisfaction in the Adoption of Electronic Medical Records Systems: A Case of DHIS2 Tracker Implementation in Tanzania

Immaculate Ayebazibwe<sup>1</sup>✉, Honest C. Kimaro<sup>1</sup> ,  
and Jens J. Kaasbøll<sup>2</sup> 

<sup>1</sup> University of Dar es Salaam, Dar es Salaam, Tanzania  
ekassy29@gmail.com

<sup>2</sup> University of Oslo, Oslo, Norway

**Abstract.** The adoption of Electronic Medical Records Systems (EMRs) is on the rise in developing countries due to the need to ensure improved quality of healthcare through client continuum and monitoring and information sharing through collecting detailed, good quality and reliable information overtime. In spite of the benefits of EMRs, their success depends on use and satisfaction of users with the system. Recently National Tuberculosis and Leprosy Program of Tanzania adopted an EMRs known as the DHIS2 Tracker to help with case management, improve reporting and reduce lost to follow-up cases.

This study therefore aimed to investigate factors influencing use and user satisfaction of DHIS2 Tracker by adapting both the DeLone & McLean Model with the Technology Acceptance Model. The research model consisted of six factors from which an online questionnaire using Google forms was developed and shared with users of the system. In order to assess the relationship between factors, nine hypotheses were developed and multiple regression analysis was conducted.

The analyzed data supported five out of nine hypotheses and indicates that system quality and attitude have positive significant influence on both system usage and user satisfaction, while use of the system has a positive significant influence on satisfaction. However, user background and information quality do not have significant influence on either use or satisfaction of DHIS2 Tracker. These findings help implementers understand areas of focus during implementation of DHIS2 Tracker.

**Keywords:** Electronic Medical Records Systems · DHIS2 Tracker · System use · User satisfaction

## 1 Introduction

According to Karimi, Poo, and Ming [1], prior research on information systems (IS) shows that users' attitudes and continuance intentions are associated with their satisfaction with information systems. As such, the increasing amount of investments in IS signifies the importance of understanding end users' satisfaction and system usage. Furthermore, it is reported that user satisfaction as a subjective or perceptual measure

has been widely used to measure IS success which is associated to users' attitudes and continuance intentions [1–3]. Similarly, users' satisfaction has also been found to explain intended future use of EMRs. In addition, user satisfaction has been studied in relation to other important IS concepts such as system usability. Most research on EMRs have looked at either satisfaction or use but not both, this research looked at both use and satisfaction of DHIS2 Tracker in Tanzania. The objective of this study is to identify factors that might influence the use and user satisfaction of DHIS2 Tracker in Tanzania and suggest strategies that will foster successful implementations.

## 2 Literature Review

DHIS2 is an open source platform that has been used to collect, collate, store and retrieve aggregate data [4–7]. Since DHIS2, has been so highly adapted and adopted for aggregate data, users and developers thought why not use the same platform to collect detailed information on clients thus the DHIS2 Tracker. Furthermore, the increased demand for details in information also explains the adoption of DHIS2 Tracker. DHIS2 Tracker has been adopted in a number of programs such Maternal Child Health, Drug Resistance Tuberculosis, HIV care and Death registration in a number of developing countries and most recently in Tanzania by Ministry of Health, Community Development, Gender, Elderly and Children (MoHCDGEC).

The measure of IS success has moved away from the use of financial tools like Return on Investment. In order to have a better grip on the tangible and intangible benefits of IS implementation, organizations have used methods such as Kaplan and Norton's balanced scorecard, benchmarking by Seddon et al., and researchers have developed models such as the DeLone and McLean's model (D&M), Doll's model and Technology Acceptance Model (TAM) thus emphasizing the need for better and more consistent success metrics [8].

User satisfaction is one of the most popular ways of determining system effectiveness and hence its success [3, 9, 10]. However user satisfaction alone does not fully measure IS system success [10]. Also, according to Petter et al. [8], the six variables in the D&M are not independent but rather interdependent this is why this research will focus on both system use and user satisfaction. User satisfaction is categorized into three aspects; judgment, affect and a mixture of both affect and judgment. User satisfaction with IS shows the extent to which the user is satisfied with the IS ability to achieve the intended information requirements [3]. User satisfaction helps to show the system from the user perspective. In fact, when a system is deemed poor by its users, then it is indeed poor [1]. Karimi et al. [1] goes on to say that it is hard to deny the success of a system that is liked by its users. A number of evaluation studies have been conducted to determine the user satisfaction of IS using different tools or models. For example Amin, Abdul, Wan, & Isa [11] looked at studies that had used perception of usefulness and ease of use and Responsive IT infrastructure. DeLone and Mclean [10] mention that "Use" can still be a considerable variable in mandatory systems because for systems adopted by organisations, as long as the system performs accordingly it will be mandatorily used by the end users with the blessing of organisation management, and as such "Use" was therefore maintained. It is further argued that researchers

need to consider the extent, nature, quality and appropriateness of system use thus simply measuring the amount of time a system is used is not enough but informed and effective use help to indicate the success of said system [12].

### 3 Research Methodology

This study adopted mixed research method allowing sequential explanation of quantitative findings using qualitative tools. The study explored factors that influence use and user satisfaction of EMRs from literature review based on both D&M and TAM models in order to determine the key factors that influence use and user satisfaction of DHIS2 Tracker in Tanzania. Figure 1 suggests an interdependency between attitude, user background, information and system quality with use and user satisfaction. From literature review, 5 factors were identified that is Attitude (ATT), System Quality (SQ), Information Quality (IQ), User background (UB), System Use (USE) to measure User satisfaction (US) and 4 factors that is ATT, SQ, IQ and UB to measure System Use. The questionnaire items with validated scales were adopted from [13–17] to form a 44 item questionnaire survey. A questionnaire survey was used to quantitatively answer 9 hypotheses created in regard to factors that will influence use and user satisfaction of the ETL register. The questionnaire was administered through Google forms. A link was shared via the Resources App with in the ETL register system. Data was then transferred from Google forms to SPSS for analysis via excel. Observation and interviews were done during training and support supervision. Researcher checked for ease of navigation and ability to recall steps taken to accomplish tasks and ability to troubleshoot in case of issues, how users were using the system in order to provide qualitative understanding of data. The study determined and tested the statistical significance of the causal relationships as hypothesized using multiple regression analysis.

The study was conducted in Tanzania, it involved mostly TB and Leprosy coordinators from both district and region level. The study targeted all the users of the system who had been trained at the regional and district offices.

### 4 Adapted Research Model and Analysis

The study adopted a mixture of DeLone and McLean Model with Technology Acceptance Model. Most research conducted in relation to EMRs had used either one or both models to explain system satisfaction and system use among users.

#### 4.1 Factor Identification

A comprehensive list factors was generated based on past research and the most suitable factors were selected for this research based on importance, relevance and frequency of appearance in the literature review. Overlapping factors were discarded from the selection and only 6 factors were chosen to be used in the study. Overlapping factors like perceived usefulness and perceived ease of use appeared frequently in the literature, they were seen as attributes of system quality in this study and training as an attribute of user background. Figure 1 shows selected factors.

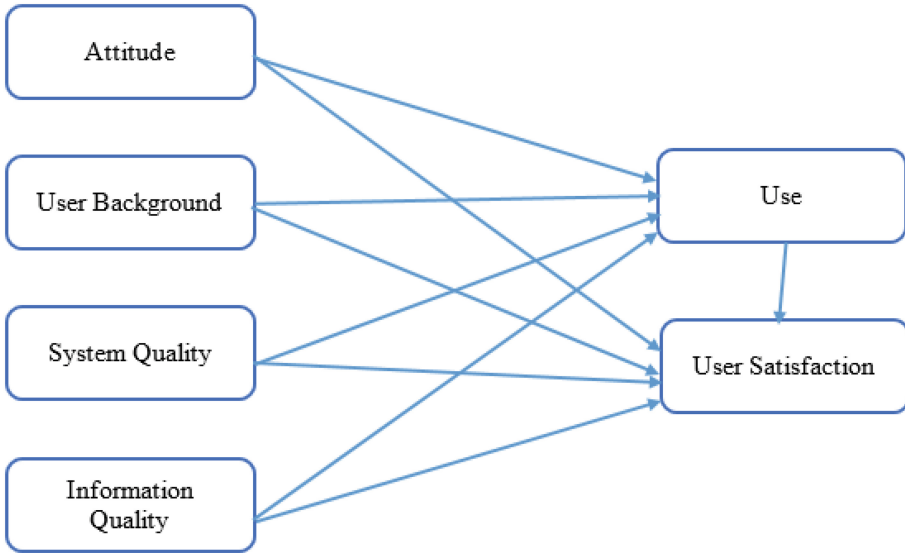


Fig. 1. Schematic representation of research model

## 4.2 Factor Definition

### 4.2.1 Attitude

DeLone and McLean [18] in their quest for the dependent variable advised that studies that measured User Satisfaction should include measure of attitude so that the potentially biasing effects of those attitudes can be controlled in analysis. Attitude was added as a factor because there was no room for subjects to form an intention for or against a behavior making it a better predictor of behavior. Brown, Massey, Montoya-Weiss and Burkman [13] say that attitude helps understand mandated use environments because it represents the degree to which users are satisfied with the system. The following hypothesis was postulated and tested for this factor:

**H1:** Attitude towards usage will have a significant influence on Use

**H2:** Attitude towards usage will have a significant influence on User satisfaction

### 4.2.2 User Background

User background was measured with items like experience, training and skills. It is also recognized that user experience is an important factor that can be associated to IS success. The need for continuously educated and experienced personnel as far as technology is concerned has been emphasized. This is shown by Igbaria that user experience is related to a decrease in computer anxiety and thus an enhancement of user's confidence and satisfaction [19]. Due to poor quality training Kuipers [14] reported that there was a failed HIS implementation in South Africa because the training focused on how to work with the system and not on why use the system. The following hypothesis was postulated and tested for this factor:

**H3:** User Back ground will positively affect use

**H4:** User Back ground will positively affect user satisfaction

#### **4.2.3 System Quality**

System Quality is the design characteristics of the system for example ease of use, reliability, accessibility, flexibility. It can be defined as the technical quality of the system [10]. It is said to measure the desirable characteristics of an IS. In this study, System Quality will be concerned with characteristics that make it easy for users to use, navigate and perform different tasks. The following hypothesis was postulated and tested for this factor:

**H5:** System quality will positively affect use.

**H6:** System quality will positively affect user satisfaction

#### **4.2.4 Information Quality**

Information Quality is users' perception of the accuracy, timeliness, completeness, reliability, conciseness and relevance of information output. It is defined as the input and output of the system [10]. It is said to deal with content issues and characteristics of IS output. It has been measured by examining the output of an IS in terms of timeliness, accuracy, reliability and trustworthiness [15]. The study defines IQ in terms of correctness, usefulness and timeliness of the information generated by the system. The following hypothesis was postulated and tested for this factor:

**H7:** Information quality will positively affect use.

**H8:** Information quality will positively affect user satisfaction

#### **4.2.5 Use**

DeLone and McLean [10] suggested that researcher when looking at use should consider the nature, extent, quality and appropriateness of use. Nature is addressed by looking at whether the full functionality of a system is being used for intended purposes. Extent of use can be based on various states of use that is use or nonuse of basic or advanced system capabilities. System Use is concerned with assessing the manner in which an information system is used. Studies have measured use by looking at actual usage or frequency of use [15]. Since it is mandated to use the ETL register, this study focused on nature of use and level of use. It also relates to who uses the system, training, level of use, belief and acceptance. The following hypothesis was postulated and tested for this factor:

**H9:** Use will positively affect user satisfaction

#### **4.2.6 User Satisfaction**

Gelderman [20] says that users will only use the system if they accept it and they will only accept it if they are satisfied with it to a certain extent. Therefore the measurement of usage may be a proxy for the measurement of US. In this study, US was operationalized by looking at overall user satisfaction with the ETL register.

## 5 Findings

### 5.1 Demographics Analysis

Results show data of 337 completely filled questionnaires. Descriptive data on users' shows 77.7% of the respondents were male and 22.3% were female. 10.4% of the respondents were below 30 years of age, 29.7% were between 31 and 40 years of age, 33.2% were between 41 and 50 years, 25.5% were between 51 and 60 and 1.2% were above 60 years. Sixty percent of the respondents were District or Regional Leprosy Coordinators.

### 5.2 Reliability Analysis

It is important to verify that items are consistent in measuring a given factor, thus to ensure reliability Cronbach's Alpha ( $\alpha$ ) was used to estimate internal consistency reliability. The reliability of data in this test was analysed using SPSS. A reliability test was done on all 44 items for this study and results showed  $\alpha = .919$ . In addition, reliability test was done for each factor in respect to its items. Results shown in Table 1.

**Table 1.** Cronbach's alpha coefficients

Factor	Number of items	Cronbach's alpha ( $\alpha$ ) = .919, N = 337
User Background (UB)	4	0.571
Use (USE)	9	0.857
System Quality (SQ)	13	0.831
Satisfaction (SAT)	6	0.585
Attitude (ATT)	6	0.829
Information Quality (IQ)	6	0.895

Based on Table 1, SAT and UB had alpha scales below the recommended 0.70 [21, 22]. This can be explained by having a very high variability within questionnaire items.

### 5.3 Factor Analysis

Factor analysis was done on the 44 items using principal component analysis as a method of extraction and direct Oblimin as the method of rotation. The number of factors was specified as 6 based on the research questionnaire. Two items for different factors were loading  $>0.3$  however they were not deleted from the analysis. Kaiser-Meyer-Olkin's (KMO) sampling adequacy with a value of 0.914 for the dataset is high enough to support factor analysis.

## 5.4 Regression Analysis

Multiple regression analysis was done to test the hypothesis and determine factors that influence the use and satisfaction of the ETL register to facilitate successful implementation of the system. Based on the results, the research model explained variance with adjusted  $R^2 = 0.414$  which indicates 41.4% of system satisfaction can be explained by 5 factors that UB, USE, SQ, IQ and ATT. Furthermore, adjusted  $R^2 = 0.393$  indicating 39.3% of system use can be explained by factors that is UB, SQ, IQ and ATT. Tables 2 and 3 shows standard beta coefficients and significance level factors against USE and Satisfaction respectively.

**Table 2.** Standard coefficients and significance levels of factors on USE

Factors	Standardized coefficients ( $\beta$ )	Significance level ( $p$ )
UB	0.028	0.508
IQ	0.085	0.097
ATT	0.328	0.000
SQ	0.317	0.000

**Table 3.** Standard coefficients and significance levels of factors on satisfaction

Factors	Standardized coefficients ( $\beta$ )	Significance level ( $p$ )
UB	-0.027	0.526
IQ	0.094	0.062
ATT	0.323	0.000
SQ	0.249	0.000
USE	0.121	0.025

In order for a factor to be significant in influencing users' satisfaction or use of the DHIS2 Tracker, the level of significance ( $p$ ) has to be  $<0.05$ . Results in Table 2 show that  $p$  value for ATT and SQ was  $<0.05$  making them significant while the  $p$  value for UB and IQ was  $>0.05$  thus not significant in influencing use of the DHIS2 Tracker. Results in Table 3 show  $p$  value for USE, SQ, and ATT was  $<0.05$  thus significant and  $p$  value for IQ and UB was  $>0.05$  thus not significant in influencing satisfaction of DHIS2 Tracker. Figure 2 shows the final factors that influence use and satisfaction of DHIS2 Tracker in Tanzania.

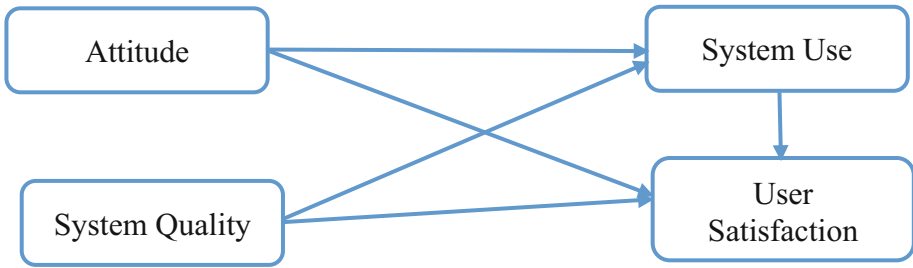


Fig. 2. Final research model

### 5.5 Hypothesis Testing

A summary of tested hypothesis is shown in Table 4, it demonstrates hypothesis that were supported and those that were not supported.

Table 4. Summary of hypotheses

Hypothesis	Results	Conclusion
<b>H1:</b> Attitude towards usage will have a significant influence on Use	$\beta = 0.328,$ $p = 0.000 > 0.05$	Supported
<b>H2:</b> Attitude towards usage will have a significant influence on User satisfaction	$\beta = 0.323,$ $p = 0.000 > 0.05$	Supported
<b>H3:</b> User Background will positively affect use	$\beta = 0.028,$ $p = 0.508 < 0.05$	Not supported
<b>H4:</b> User Background will positively affect user satisfaction	$\beta = -0.027,$ $p = 0.526 < 0.05$	Not supported
<b>H5:</b> System quality will positively affect use	$\beta = 0.317,$ $p = 0.000 > 0.05$	Supported
<b>H6:</b> System quality will positively affect user satisfaction	$\beta = 0.249,$ $p = 0.000 > 0.05$	Supported
<b>H7:</b> Information quality will positively affect use	$\beta = 0.085,$ $p = 0.097 < 0.05$	Not supported
<b>H8:</b> Information quality will positively affect user satisfaction	$\beta = 0.094,$ $p = 0.062 < 0.05$	Not supported
<b>H9:</b> Use will positively affect user satisfaction	$\beta = 0.121,$ $p = 0.025 > 0.05$	Supported

## 6 Discussions

Based on the results in Table 3, User Background and Information quality could not explain either use or satisfaction of DHIS2 Tracker. In other wards 4 hypotheses that is H3, H4, H7 and H8 were non-significant and thus were not supported.



Furthermore, with factor analysis, it can be stated that KMO value is above the 0.500 threshold for all the factors varying between 0.500 and 0.900. The Cronbach's (a) showed low values of 0.571 and 0.585 for both User background and satisfaction respectively which can be explained by the high variance in items of these questions. For example, User background was looking at experience, skills and training, although users had obtained the experience and skills from previous encounters with other systems, they had not received any form of computer training.

In relation to satisfaction, although a large number of users agreed that the system was to their satisfaction, when asked whether it was complicated they were equally divided in response, 51% felt it was complicated to use and the rest felt it was not. Despite the above, no items were deleted from the analysis. Sub sections below will further explain results of the hypothesis.

## 6.1 Attitude

Results from the study show that Attitude had a positive significant effect in influencing Use and Satisfaction of DHIS2 tracker. With p value  $<0.05$  and  $\beta = 0.328$  and  $0.323$ , implies that users feelings to use and satisfaction towards DHIS2 Tracker were highly positive and significant.

In fact some of the users felt that the system made their work so easy they said, during one of the training sessions one trainee said *"when it comes to leprosy, we can just sit with our clients and fill in this information while they are present because the paper based register is so complicated to use most of us do not understand it."* Furthermore, results showed that 95% of users were willing to use the system if given a choice because it was efficient, easy to use, helped in planning and intervention development, helped improve the referral system, made communication with colleagues easier and would improve program performance.

## 6.2 User Background

Results also showed that user background was not significant in influencing use or satisfaction of DHIS2 tracker.

## 6.3 System Quality

Results showed that system quality significantly influences use and user satisfaction of DHIS2 Tracker in a positive manner. This means that users were impressed with the various features of the system like accessing information at anytime and anywhere, following up clients, communication within the system and notification and the fact that all necessary registers and information about their clients can be found in one storage system. This finding is similar to Ojo [15], who suggests that for continued use of the system, at most focus should be on system quality.

Some users, especially regional officers said that,

*"... because the system was web based, we do not have to move around districts with flash drives to collect and compile data from each district for the ministry anymore, data can easily be found in the system which gives us time to do other things."*

However some users felt that the system was still error prone as it did not have all the data quality checks in place.

#### 6.4 Information Quality

Results showed no significant effect of information quality on use or satisfaction of DHIS2 Tracker. This could be attributed to the fact that during the time the questionnaire was administered users may not have fully grasped the reporting features of system.

Contrary to the results above, interviews showed that users were highly appreciative of the reporting features because they felt that all the indicators they needed could be found in the system and reports could be generated automatically in a flexible (as charts or tables) and timely manner. One of the users who has worked with TB and Leprosy for more than 30 years and had used 2 other similar systems said that in comparison to legacy systems, the ETL register facilitated both data entry and automatic report generation.

*“...This is because the legacy systems we had to enter data in the system and in the paper registers and during time to generate reports we had to go back to our paper registers and tally we were not able to get reports from those old systems, the process of report generation was highly manual and this duplicated the work load.”* Furthermore, it was noticed that although training sessions did not cover much about report analysis tools, some users had taken the initiative to orient themselves in using the different report analysis apps of the system.

#### 6.5 Use

Results also showed that USE had a positive significant effect on satisfaction of DHIS2 Tracker. This is similar to findings from Lin et al. [17] which means that users would keep using the system thus increase their satisfaction with the system contrary to findings from Ojo [15] whose findings showed that use did not influence satisfaction which he attributed to type and context of the system in use. He suggests that in a mandated setting, system quality should be improved in order to incentivize satisfaction.

The positive influence of use on satisfaction can be further explained with how users were using the system. Users felt that because all the registers were in one system, then they would be able to track their clients within the system with the help of message notifications in case of transfers and they would also be able to easily determine the Not Evaluated clients. They also felt that, lab results could quickly and easily be obtained from regional labs with the notification features unlike before where they had to wait for a phone call or post office to receive lab results. One user mentioned that *“... these notifications help quicken the process of administering the right drugs to clients based on results unlike before when we had to wait for EMS to deliver specimen.”* One of the superiors mentioned that *“... with the system in place we are able to know who has done their work and who has not their work unlike before when the lag was blamed on anyone who was not present at that time.”*

## 6.6 Overall Satisfaction

85% of the users responded that they were satisfied with the system, because they were able to find all the necessary registers in the system, could track patients, do transfers and referrals, receive notifications on lab results, easy to learn, understand, verify data entry and reports, retrieve and share reports, good for case management, web based, useful in day to day work and training on the system was good etc. The remaining 15% were not satisfied because they needed more practice to be conversant with the system, system did not have all the validations necessary for quality data entry, difficult to navigate and involved many clicks. Opinion on the number of clicks changed once users realized for some modules one only enters information once and then they update client information on subsequent visits. Also the availability of automatic reports seemed to positively change people's satisfaction for the system as observed during supervisions.

From observations and interviews, it was found that users were unable to transfer clients to different sites or enroll clients into more than one program. Users found it easy to enroll a client into the first program but they were not sure about the next steps when it comes to enrolling the same client into a second program.

## 6.7 Suggested Strategies Towards Successful Implementation of DHIS2 Tracker in Tanzania

Based on the results, the following strategies are proposed to facilitate successful implementation of DHIS2 Tracker in Tanzania:

- (a) Users felt that it was still error prone because some validation checks such as automatic rescheduling of visits, ensuring certain information is entered at a particular time from the time of diagnosis, previously entered data should not be re-entered were not yet in place. Therefore it is necessary for the developers and the NTLP team to ensure that all these validation checks are put in place in order to improve the quality, consistency and reliability of data and information.
- (b) Many users reported the system was complicated to use, it is necessary that NTLP and other stake holders conduct refresher courses for users, they should also have onsite support supervisions as these help management learn real issues that users experience outside of training settings.
- (c) In addition, for users to be well conversant with the system they need to practice more, so on top of support supervision it is necessary for users to enter data on a daily basis in order to improve their appreciation for the system and improve report completeness.
- (d) A web-based system is most preferred by management users for a number of reasons, however many users reported that their biggest issue is internet accessibility and availability plus laptops. Therefore, it is necessary to develop and support desktop offline data entry with automatic syncing of data to the main server. Alternatively establish an agreement with telecom companies to provide zero cost internet access to the system. This will make the process of data entry much easier and less time consuming.

- (e) Information quality did not have significant effect on Use or satisfaction contrary to interview sessions where users were happy with the reporting features. Therefore it is necessary that users be oriented on the importance of information use, ownership of information and furthermore be trained on the different report analytics apps that are present in the system.
- (f) In addition, some of the users such as M&E Officers and Project managers felt they could not do further analysis with the advanced analysis tools. Thus they suggested that existing bugs on the advanced analytic tools should be fixed to improve use of the system and also encourage information use.
- (g) In order to improve use, it is necessary to encourage users to use the system on a daily basis and not only during reporting periods. It is also important to show users how the system generally improves their work especially in terms of report generation and reduction in the number of lost to follow up cases.

## 7 Conclusion

The analyzed data supported five out of nine hypotheses and indicates that system quality and attitude have positive significant influence on both system usage and user satisfaction, while use of the system has a positive significant influence on satisfaction. However, user background and information quality do not have significant influence on either use or satisfaction of DHIS2 Tracker. Qualitative results showed that the ETL register met the needs and demand for all stakeholders involved. These findings help implementers understand areas of focus during implementation of DHIS2 Tracker.

The study then proposed strategies that might help in successful implementation of DHIS2 tracker in Tanzania such as support and onsite supervision, offline data entry, or zero cost access to the system and encourage users to use and own their information etc.





## References

1. Karimi, F., Poo, D.C.C., Ming, Y.: Clinical information systems end user satisfaction: the expectations and needs congruencies effects. *J. Biomed. Inform.* **53**, 342–354 (2015)
2. Palm, J., Colombet, I., Sicotte, C., Degoulet, P.: Determinants of user satisfaction with a clinical information system. *AMIA Annual Symposium Proceedings*, pp. 614–618 (2006)
3. Saghaeiannejad-Isfahani, S., Jahanbakhsh, M., Habibi, M., Mirzaeian, R., Nasirian, M., Rad, J.S.: A survey on the users' satisfaction with the hospital information systems (HISs) based on DeLone and McLean's model in the medical-teaching hospitals in Isfahan city. *Acta Inform. Medica* **22**(3), 179–182 (2014)
4. Karuri, J., Waiganjo, P., Orwa, D., Many, A.: DHIS2: the tool to improve health data demand and use in Kenya. *J. Health Inform. Dev. Ctries.* **8**(1), 38–60 (2014)
5. Mohammad, B., Kibria, G., Sujana, J., Santos, M., Taleb, A.: DHIS2 and e-TB manager interoperability: creating a stronger digital health system in Bangladesh, August 2017

6. Muhaise, H., Habinka, A.: Factors influencing district health information software version 2 success – a case of the greater Bushenyi. *Am. Sci. Res. J. Eng. Technol. Sci.* **26**, 166–176 (2016)
7. Assyne, N., Riungu-Kalliosaari, L.: A framework for implementing cloud computing for record sharing and accessing in the Ghanaian healthcare sector. In: 2014 IST-Africa Conference and Exhibition, IST-Africa 2014, pp. 1–7 (2014)
8. Petter, S., DeLone, W., McLean, E.: Measuring information systems success: models, dimensions, measures, and interrelationships. *Eur. J. Inf. Syst.* **17**(3), 236–263 (2008)
9. Calisir, F., Calisir, F.: The relation of interface usability characteristics, perceived usefulness, and perceived ease of use to end-user satisfaction with enterprise resource planning (ERP) systems. *Comput. Human Behav.* **20**(4), 505–515 (2004)
10. DeLone, W.H., McLean, E.R.: The DeLone and McLean model of information systems success: a ten-year update. *J. Manag. Inf. Syst.* **19**(4), 9–30 (2003). Springer
11. Amin, I.M., Hussein, S.S., Isa, W.A.R.W.M.: Assessing user satisfaction of using hospital information system (HIS) in Malaysia. In: 2011 International Conference on Social Science and Humanity, vol. 5, pp. 210–213 (2011)
12. Yoon, H., Nah, J., Chin, W.: Measuring end user satisfaction with hospital’s mobile health system in Korea. *Int. J. Sci. Technol.* **6**(6), 21–30 (2013)
13. Brown, S.A., Massey, A.P., Montoya-Weiss, M.M., Burkman, J.R.: Do I really have to? User acceptance of mandated technology. *Eur. J. Inf. Syst.* **11**(4), 283–295 (2002)
14. Kuipers, B.: Evaluation of a hospital information system (HIS) implementation success from a users’ perspective: a mixed method research. University Utrecht (2016)
15. Ojo, A.I.: Validation of the DeLone and McLean information systems success model. *Heal. Inf. Res.* **23**(1), 60–66 (2017)
16. Aggelidis, V.P., Chatzoglou, P.D.: Hospital information systems: measuring end user computing satisfaction (EUCS). *J. Biomed. Inform.* **45**(3), 566–579 (2012)
17. Lin, H.-H., Wang, Y.-S., Li, C.-R., Shih, Y.-W., Lin, S.-J.: The measurement and dimensionality of mobile learning systems success. *J. Educ. Comput. Res.* **55**(4), 449–470 (2017)
18. DeLone, W.H., McLean, E.R.: Information systems success: the quest for the dependent variable. *Inf. Syst. Res.* **3**(1), 60–95 (1992)
19. Doumpa, T.: Hospital information system evaluation. The University of Greenwich (2009)
20. Gelderman, M.: Factors affecting the success of management support systems: analysis and meta-analysis. IS/MAS Forum American Accounting Association, May 1995
21. Karahanna, E., Straub, D.W., Chervany, N.L.: Information technology adoption across time: a cross-sectional comparison of pre-adoption and post-adoption beliefs pre-adoption and post-adoption beliefs. *MIS Q.* **23****23468**(2), 183–213 (1999)
22. Tan, P.J.B.: Applying the UTAUT to understand factors affecting the use of English e-learning websites in Taiwan. *SAGE Open* **3**(4) (2013). <https://doi.org/10.1177/2158244013503837>



# Contemporary Challenges in Street Trader-Customer Interaction Through Mobile Devices in Dodoma, Tanzania

Joel Rumanyika<sup>1</sup> , Matti Tedre<sup>3</sup> , Mikko Apiola<sup>2</sup>,  
Solomon Sunday Oyelere<sup>3</sup> , and Nasibu Rajabu Mramba<sup>1</sup> 

<sup>1</sup> College of Business Education, Dodoma, Tanzania  
{j.rumanyika, n.mramba}@cbe.ac.tz

<sup>2</sup> Department of Future Technologies, University of Turku, Turku, Finland  
mikko.apiola@ieee.org

<sup>3</sup> School of Computing, University of Eastern Finland, Joensuu, Finland  
{matti.tedre, solomon.oyelere}@uef.fi

**Abstract.** Street trading is a common form of informal work carried out by almost one million Tanzanians. Majority of street traders use mobile devices to interact with customers. Despite this interaction, there is no abundant information showing if their interaction is mainly effective and does not face challenges. This study investigated the challenges faced by street traders and customers interacting through mobile devices in Dodoma, Tanzania. Qualitative data were collected using in-depth interviews with 42 street traders and 32 customers, followed by focus group discussion with eight street traders and six customers. Thematic analysis was used to analyze the data. The results show that street traders and customers occasionally interact using mobile phones. However, that interaction is challenged by issues connected to financial, technical and social aspects. These challenges are; lack of reliability among mobile phone interacting customers, mobile network problems, lack of business communication transparency, deep-rooted customary practices and perceptions of street trading, poor customer care, lack of consensus over mobile business etiquette, poor quality of product pictures, short mobile internet bundle validity, mobile phone battery life, and costs of mobile handset, transactions, vouchers, packages, and transport. The results call for the option of bundle and transaction cost reduction, network infrastructure improvement and provision of education to street traders and customers so that they realize the significance of business interaction using mobile devices contrary to what is happening recently, as well as abiding by communication ethics to minimize the likely challenges.

**Keywords:** Street trading · Customers · Mobile device

## 1 Introduction

There is a wealth of literature describing the challenges associated with mobile device use for informal workers in developing countries [1, 2]. These challenges involve the cost of handsets, charging cost, airtime, repair, and network problems [1, 2]. Street

traders are one type of informal workers who use mobile devices to interact with customers. However, it is not known if they face similar or dissimilar challenges. According to Wongtada [3], street traders are “*persons who offer goods for sale to the public without having a permanent built-up structure*”. They are commonly referred to as, hawkers, peddlers, petty traders, street vendors, or “Machinga” in Tanzania [4]. In a large city of Dar-es-Salaam there are more than one million street traders [5]. In Dodoma urban, they comprise about 7.1% of the entire population in the area [6].

In Sub-Saharan Africa (SSA) countries, there are a number of studies reporting on the benefits perceived by informal workers through mobile technology use [7, 8]. For example, in Tanzania, a number of studies report on how access to mobile phones has radically changed the means through which small scale farmers and other informal workers interact and transact using mobile services, such as voice calls, SMS, social media and, mobile money [9, 10]. There is a scarcity of studies on challenges faced by informal workers with reference to mobile device use and customer interaction; although there are some studies reporting the challenges faced by small scale farmers and women entrepreneurs [9, 11]. This implies that street trading as one form of the informal sector is not fully studied with regard to customer interaction and mobile devices use.

A study by Mramba et al. [12] in Dar-es-Salaam show that street traders use mobile devices, especially mobile phones, to interact with customers. Although street traders use mobile phones to interact with customers, still do not have a reliable information technology strategy for maintaining long-term customer relationships. Thus, the customer-seller relationship usually ends after the initial transaction, and if it happens to be in contact, does not last for a longer duration. This phenomenon could be attributed to lack of knowledge on the significance of prolonged customer-seller relationship or lack of awareness on the opportunities being offered by mobile devices to maintain the relationship. Mramba et al. [12] have shown obstacles that interfere with further interactions between street traders and customers through mobile devices. Mramba et al. [12] study was conducted in Dar-es-Salaam, but the results might be similar or dissimilar to all street traders and customers across the country. This study investigated the challenges faced by street traders and customers when interacting through mobile devices in Dodoma, where the market environment is not similar to that of Dar-es-Salaam. We posed the following research questions to tackle the research gaps identified earlier.

*RQ1:* How do street traders and customers establish business interaction relationship through mobile devices?

*RQ2:* What are the challenges faced by street traders and customers interacting using mobile devices?

## 1.1 Significance of the Study

The motivation for carrying out this study is attributed to the recent broad diffusion and adoption of information and communication technologies (ICTs), particularly mobile devices. These technologies have opened new opportunities for informal workers’ activities [13]. There are signs that street traders have adopted mobile phones to interact

with customers and indeed they understand the potentials of ICTs in business. E.g. the recent technological innovation of developing mobile applications which are contextualized in ordinary informal workers' languages has reduced communication barriers among buyers and sellers in most areas in the world. This is the initial study that leads to further ICT innovations that might improve street trader and customer interactions.

## 2 Literature Review

### 2.1 Theoretical Review

There are a number of theories which guide the studies related to understanding the informal sector activities, behaviours, attitude, intention and impact of ICT for their business. First, is the transaction cost theory (TC) which describes the costs incurred by the participants in a commercial exchange. This implies that the higher the cost of exchange the lower the interaction between street traders and customers. The costs referred in TC theory are associated with the costs of running the supporting systems which are of two categories namely: costs of coordination and actors' motivation [14]. Coordination costs comprise information access and communicating costs experienced during pre-transaction, during-transaction and post-transaction. The coordination costs are such as products' searching, service acquisition, seller-buyer interaction, bargaining and contracts' fulfilment. The actors' motivation costs include: the costs of incomplete transactions which might occur due to ICT system failure or human errors. The costs addressed in TC theory are equated with challenges faced by street traders and customers interacting through mobile devices. In this study, these challenges are summarized as technical, social, and financial. The TC theory is related in this study because it postulates the number of costs which is somehow similar to the challenges which affect the business interaction between street traders and customers through the mobile-enabled information system.

The theory of trust. Trust is defined by Hosmer [15] as "*the reliance by one person, group, or firm upon a voluntarily accepted duty on the part of another person, group, or firm to recognize and protect the rights and interests of all others engaged in a joint endeavor or economic exchange*". Trust is the confidence both parties in the relationship have that one party cannot do something harmful or risky to another. Trust is an aspect of most socio-economic contacts in which ambiguity exists e.g. the electronic commerce environments [16]. This indicates that if there is high trust between two parties there is also high interaction and vice versa is distrust which hinders successfully interaction. Trust theory fits in this study because the components of trust which are: competence, openness, care, and reliability are important for the partners whose interaction relationship is aligned with business value exchange. The commercial interaction between street traders and customers which is conducted using mobile devices need to be regulated by ensuring there is high trust. High trust in both parties interacting keep them from developing negative attitudes towards each other. This will reduce the misuse of mobile contact, poor customer care, and business communication transparency.



## 2.2 Street Traders and Mobile Technology Use

Street traders are found in most countries of the world [17]. In SSA, street trading accounts for 15%–25% of total informal employment. In some examples from Africa's cities, it contributes between 46% and 70% of total trade value added in countries like Benin, Burkina Faso, Chad, Kenya, and Mali [18]. In SSA, most literature report on the perceived benefits received by informal workers through mobile technology use [19, 20]. The limited number of studies generalize their findings once reporting on challenges faced by informal workers related to technology use. The reported challenges include; use of foreign language, network fluctuation, technical illiteracy, as well as, cost of handsets, bundles, transactions, and airtime [21]. In Tanzania, some studies have explicated just the contribution of mobile phones for street traders' business activities [12, 22]. A study by Mramba et al. [23] found foreign language, mainly English, to be one of the challenging features to street traders' mobile technology use.

## 3 Methodology

This qualitative research explored the challenges faced by street traders and customers while interacting through mobile devices. The choice of qualitative research approach was due to paucity of prior research on related topic in the chosen area. Exploratory research is usually employed when one wants to clarify and define the nature of a problem on which later studies can be conducted [24]. Purposive sampling was used to select 42 street traders, from four wards within the central business district for face-to-face interviews and eight street traders for focus group discussions (FGD). Neither number was decided in advance, but purposive sampling was applied in this study because it enables one to base sampling upon reaching a saturation point: that is, continuing to add participants until no new substantive information is acquired [25]. The criteria for selection of street traders were: (1) he/she should be mobile (2) with at least one-year experience in street trading, (3) possessing a mobile device and, (4) offering services or selling products such as, food or drinks, clothes, home utensils, cosmetics, spices, electronics, stationaries, pesticides, detergents, newspapers, plastic bags, and toys. In the case of customers, the majority of interviewed traders managed to identify one or two phone numbers of their potential customers and present them to the researcher. Eventually, 33 customers' phone numbers were identified and the researcher contacted the customers through mobile calls or SMS. The majority agreed to participate in the study, with just one dropping out on the day of the interview. Additionally, six customers agreed to participate in FGD. The interviews with street traders and customers lasted between 15 and 20 min, and the FGD lasted for 70 min.

### 3.1 Study Area

The study was carried out in four closest wards to the central business district (CBD) of Dodoma. These wards are, Madukani, Majengo, Viwandani, and Makole. The criteria for selecting Dodoma city is the exponential growth of its urban population due to government shift of administrative activities from Dar-es-Salaam to Dodoma, as well as

the availability of street traders who operate their activities mostly in the CBD or in the nearby neighbourhoods.

### 3.2 Data Analysis

Thematic analysis was used to categorize respondents' opinions and ideas into themes. The initial stage was to label research questions with anchor codes in order to help in the organization of initial codes. Using selective coding, data were analyzed according to pre-defined coding procedures, which followed one another in their degree of intensity. All recorded interviews and FGD were transcribed into verbatim and then major themes were obtained by combining the sub-themes. Finally, categories were developed to reflect the responses, and also to cover the various themes present in the interview guide. Thematic analysis was used because it facilitates understanding participants' attitudes and reflections on issues which could be mostly used as the measure for best statements and provides also the opportunity for researchers to move beyond calculating statements or expressing the ideas [26].

## 4 Findings

The findings from this exploratory study are divided into two categories, each describing one of the two major themes regarding the experiences of street traders and experiences of customers. These results are structured by the research questions RQ1 and RQ2.

### 4.1 How Street Traders and Customers Establish Business Interaction Through Mobile Devices (RQ<sub>1</sub>)

Majority of street traders reported that establishing business interaction with customers through mobile devices is influenced by the different circumstances involved during the interaction. These situations include a trader and customer meeting several times in one route, a trader selling products or services a customer prefers, customer and trader meeting by coincidence, and the customer has not planned to buy but he/she likes the products. One street trader of pillowcases explained how she started business interaction with some customers *"...When I meet customers on my daily business routes I convince them to buy my products, some of them purchase and sometimes they request for my mobile contact for further communication in case they need to buy my products once again; it is by that means we start business interactions..."* Other circumstances are such as, a trader referring his/her fellow trader to potential customers or the customer referring the street trader to his/her fellow customers and both buyers and sellers meeting in a wholesaler's office.

## 4.2 Challenges of Street Trader-Customer Interaction Using Mobile Devices (RQ<sub>2</sub>)

Customers and street traders shared some challenges in their interactions but also had some unique challenges too, as summarized in Table 1.

**Table 1.** Challenges facing street traders and customers

Category of challenge	Challenges faced by street traders and customers		Unique challenges faced by each group	
	Street traders	Customers	Street traders	Customers
Financial	Costs of voucher, bundle, handset, and transaction	Costs of voucher, bundle, handset and transaction	Transport costs	_____
Technical	Mobile network problems, and short mobile internet bundle validity	Mobile network problems, and short mobile internet bundle validity	Mobile phone battery life	Poor quality of product pictures
Social	_____	_____	Lack of reliability among mobile phone interacting customers, customary practices and perceptions, mental stress, misuse of mobile contacts by customers	Lack of business communication transparency, poor customer care

These challenges are sub-divided into three categories which are, financial, technical, and social, each discussed below.

**Financial Challenges Facing Street Traders.** A number of street traders explained to have faced challenges related to money spending. Such challenges included costs of handset, credit, bundle, transaction, and transport.

*Handset Costs.* Majority of street traders reported that the costs of the handset, especially smartphones, is too high to afford, and therefore it is difficult to justify the purchase of these electronic gadgets. This is connected to the majority being low-income earners and spending much on basic needs, family, and taxes. One street trader stated “...I prefer to own a smartphone because it has a lot of up-to-date functions and features which can enable me to communicate thoroughly, the problem is my low income; unless otherwise I have to cut the ratios of some expenditures to acquire it...”.

*Credit, Charging and Bundle Cost.* Large number of street traders explained that they incur costs from recharging their mobile phones and also had their bundle run out before the subscribed time. These challenges destabilize the planned communication targets and budgets. Also, smartphone owners reported that the costs of data packages

are too high, affecting their daily interactions with customers. One trader revealed “... *Every day I purchase credit and subscribe to a service provider to obtain data package that worth to my money, surprisingly my bundle expires before the time limit, this actually adds extra communication costs...*”.

**Transport Costs.** Many street traders mentioned the costs of travelling, in case a trader is obliged to use public or private transportation to move from one point to another to meet some customers who are not located on the vending route plan. They spend their personal income to attend to some customers while they are not even assured of a sale.

The following representative statement depicts views of participants in the FGD “...*Sometimes we are obliged to travel to meet customers who call or send SMS requesting for our products or services, we pay transport fares which actually is not refunded by the customers ...*”.

**Transaction Costs.** A number of street traders reported having used mobile money services for various transactions, including receiving payments from customers. Despite the importance of mobile money, the service costs seem to be a deterrent to street traders. This is because the majority of customers do not top up the withdrawing charges. Others were worried about the security of mobile transactions. One street trader explained “...*Mobile money service is very helpful because it simplifies life, although some customers are not fair, they either send the actual payments without topping up money for withdrawing charges and others may send you fake mobile money messages to escape the payments...*”.

**Social Challenges Faced by Street Traders.** The social challenges addressed during the study were related to issues such as lack of business communication transparency, fatigue, customs and practices of street trading, misuse of mobile contacts by customers, and poor time management.

**Lack of Reliability Among Mobile Phone Interacting Customers:** Some participants explained that some customers make calls or send normal SMS or social media messages to street traders, showing interest to buy some products while their real intentions are different. As a result, street traders incur travel costs and fatigue without selling. A newspaper seller said “...*Some customers do call or send SMS and pledge to purchase products, but when you reach the meeting point they change their minds or disappear from the meeting point, therefore a street trader ends up wasting time and getting stressed...*” They reported that some customers have a tendency of calling or texting while their intention is just looking or touching products, known as “Fahari ya macho” (an informal Swahili phrase in Tanzania for viewing, and touching without buying).

**Deep-Rooted Customary Practices and Perceptions of Street Trading.** Many street traders described that it is not common to initiate customer-seller relationship because of deep-rooted customs and practices regarding street trading on both sides. Many customers are unwilling to give their mobile contacts to street traders because of poor or nonexistent practices on what kinds of messages can be communicated by street traders. Street traders reported that customers may pose many questions to them. This was identified by several respondents who explained “...*It is not our culture to ask customers their mobile contacts after the initial sale because many of them start questioning; it is always a customer who can start asking for mobile contacts...*”

*Misuse of Mobile Contacts by Customers.* Some female traders reported sexual harassment attempts by some customers through voice calls, SMS, and social media applications. Similarly, some male traders explained to have faced problems whereby female customers tried to lure them for discounts.

### **Technical Challenges Faced by Street Traders**

*Mobile Network Fluctuation.* Some traders reported technical challenges, such as network fluctuation or complete absence of network coverage. These had led to dropped calls, signal scrambling, message failure, and high call setup time, leading to ineffective communication between customers and sellers.

*Mobile Battery Life.* Mobile phone battery life is also a challenge, especially for those street traders who use smartphones. They explained that they are always on the move trying to find customers and consequently, they do not charge their mobile phones during day times, only during the night. Therefore, they rely on the charged battery for the whole day while many smartphone batteries do not last throughout the work day. Others explained that battery discharges slowly when the battery charge level indicator is high and discharges fast when the charge level indicator is low.

### **4.3 Challenges Faced by Customers**

The study found that some of the challenges facing street traders also face customers in one way or another. Such challenges include the cost of credit, bundles, transactions, and network fluctuations. Other challenges, such as lack of business communication transparency, poor customer care, or poor quality of pictures are unique and mostly affect customers.

*Lack of Business Communication Transparency.* Majority of customers reported that street traders are not straightforward when they are being requested to deliver products to them. Through voice calls or SMS, they always respond positively confirming to have the requested products while sometimes it is not in their stock. Alternatively, they use this chance to go to wholesalers to look for the products. This process keeps the customers waiting for a long time for product delivery. One customer said “...*Street traders do not tell the truth when you communicate with them to bring products, they will always agree to have those products while they do not have them and therefore you keep waiting for a long time; some of us get despair and withdraw from that business...*”. This implies that street traders do not observe time management.

*Poor Customer Care.* A number of customers explained that sometimes street traders do not show concern to customers. Occasionally, they use impolite language mainly when there is misunderstanding related to price negotiations. One customer explained “...*Street traders offer essential services at cheapest costs, however, there are moments they use impolite language and disregard customers due to failure to meet business consensus, they forget that customer care must be shown for all people whether they like their products or not...*”

*Poor Quality Pictures.* Majority of customers reported that street traders post unclear product photos or photos of a different product instead of the actual photos of the products they sell. Consequently, customers fail to identify their products well. When customers decide to buy the product after seeing it through social media, it may happen that the product delivered to the customer is very different from the photos shared in social media.

## 5 Discussion

### 5.1 Research Question (RQ1)

The results show that street traders and customers exchange mobile contacts in different situations. Surprisingly, the study found that in most cases customers initiate the requests to exchange mobile contacts, compared to street traders who rarely do the same. These results are similar with the results by Mramba et al. [27] in which the participants explained that very rare they ask for customers' mobile numbers in order to contact them later, for instance, informing them about new products. Additionally, the reluctance of customers is the main source for street traders' failure to initiate further communication after the initial sale. Customers do not prefer to give their mobile phone numbers to street traders because most of them prefer to keep mobile phones for private communication only. They are also afraid that street traders may interfere, disturb, or violate their privacy. Only those customers who are sure of their communication privacy and have the reasonable volume of interactions are willing to share their contact details. These results are similar with the results by Wahab et al. [28] in Jordan which reports that companies sometimes use customers' information without customers' consent, leading to customers feel their privacy has been violated. This implies that customers can provide mobile contacts themselves but street traders have to know how to handle their customers' contacts responsibly.

### 5.2 Challenges Faced by Street Traders and Customers During Customer-Seller Interaction Using Mobile Devices (RQ2)

The challenges faced by both street traders and customers are divided into two categories. The first category includes the challenges which negatively affect street traders and customers while the second category are unique challenges specifically affect one group at large compared to the other.

**Common Challenges Faced by Street Traders and Customers.** These challenges involve cost of handsets, vouchers, bundle, transactions, mobile network problems, and short mobile internet bundle validity.

*Cost of Handsets, Vouchers, Bundle, and Transactions.* The challenges related to money spending mostly affect street traders' financial expenditures. Majority of street traders are low-income earners, marginalized, or very poor compared to customers. Therefore, the high cost of, for instance, handset typically smartphones, transactions vouchers and bundles is a critical challenge. GSMA [29], reported the cost of a

smartphone to range between (TZS 150,000–300,000, or 65.67\$–135\$)-although it is believed that the handset quality is determined by the value of money. Similarly, Mothobi and Moshi [30] in ICT Africa (RIA) report showed that 62.5% of Tanzanians do not own smartphones due to financial constraints.

*Transaction Charges.* The transaction charges are high to both street traders and customers for e.g. recently if a customer sends (TZS 100,000 or 43.78\$) using TIGOPESA would be charged (TZS 900 or 0.39\$) while the receiver of the same amount would be charged (TZS 3550 or 1.55\$). The same amount for the customer is charged (TZS 1000 or 0.44\$) and (TZS 3600 or 1.58\$) for a receiver if both use M-PESA and are registered. The transaction costs are actually a burden to street traders. The results by Mpogole et al. [31] also reported transaction charges for sender and receiver to be high.

*Mobile Network Problems.* It is a common challenge facing customers and traders. The results by Mtaho and Ishengoma [32] report that 44.6% of network failure in Dodoma, is caused by limited coverage and network nodes capacity. There is low number of base transceiver stations (BTS) compared to the increasing population. Taking an example of the University of Dodoma, where there are more than 60,000 subscribers, the area has only ten BTS of different telecommunication companies, which is too small to serve the entire population. Nwaobiala and Ubor [33] also report that similar problems limit small scale farmers communicating with other stakeholders in Nigeria.

*Bundle Expiry and Validity.* Internet bundle validity has a discrepancy with regards to the expiry date and the service level agreement. This is caused by improper use of the bundle and lack of awareness on the type of use to control and to avoid. Example, there are unnecessary use such as, unknown advertisements, google apps, social chats, and other possible online activities which contribute to rapid bundle expiry. The similar results are reported by Smith and Croxson [34] in Côte D'ivoire and Tanzania.

*Lack of Business Communication Transparency.* This occurs because there are still ubiquitous viewpoints of doing business as traditionally instead of using technology. It affects negatively other business processes such as, timely delivery of products, timely electronic transaction and business trust. These results are similar to those by Misaki et al. [35], who report the lack of trust and transparency between small scale farmers and buyers, hinder smooth communication using mobile phones.

**Unique Challenges Faced by Each Group.** These challenges are such as, mobile battery life, travel costs, deep-rooted customs, practices, and perceptions of street trading, poor customer care and poor quality of product pictures.

*Mobile Battery Life.* This challenge mostly faces street traders who use smartphones. Smartphones are highly desirable communication gadgets, but are unstable in terms of battery life sustainability. This is due to the design nature with typical battery capacity hardly above 1500 mAh and limited charge voltage of  $4.35 \pm 0.05$  V. Therefore, processing power, feature-sets, sensors and social applications have battery life limitations. There are more factors such as user failure to switch-off power consuming interfaces of Bluetooth and Wi-Fi, display brightness, user's battery charging behavior, battery age and other usability practices. It is advised that the users should switch-off

unnecessary functions which drain the battery. Rahmati et al. [36] reported switching-off unnecessary applications to have saved power for many mobile users who faced with low battery conditions in U.S.A, China and India.

*Deep-Rooted Customs, Practices and Perceptions of Street Trading.* When these are combined with poor quality product pictures, as well as pictures of wrong products, the street traders' mobile business practices greatly undermine a sense of trust by customers. These results are similar to the results by Bhanot [37] who shows that 40% of customers using social media to purchase products experienced either wrong pictures or unclear images from sellers.

*Poor Customer Care.* The main cause is the lack of mobile business etiquette and poor time management by street traders. Customers often felt being treated unfairly for various reasons. Similar results were found by Mramba et al. [27] whose quantitative study showed strong agreement that weak customer care is one of the most serious problems facing street traders (mean 5.69, mode 7- "completely true").

*Travel Costs.* It is a frequently recurring challenge facing street traders because of the market competition among themselves. When a street trader is guaranteed of selling he/she does not hassle the travel costs to meet customers. Street traders' first priority is obtaining the daily bread; other things are optional.

## **6 Recommendation and Conclusion**

### **6.1 Recommendation**

This qualitative study was limited to investigating the contemporary challenges faced by street traders and customers interacting through mobile devices in a geographically small, urban area of Tanzania. The study found a number of challenges faced by both street traders and customers. The results support a number of recommendations. First, the early interactions between street traders and customers through mobile devices should be mutually initiated to create a feeling of equality and mutual trust. This implies that both parties should have the right to ask for mobile contacts, as well as decline sharing their contacts for no explanation needed. Second, stakeholders responsible for regulating mobile communication as well as connection providers should find means to minimize the costs incurred by street traders such as, vouchers, bundles, and transactions similarly to special packages offered to companies and university students. Third, education and awareness campaign to both street traders and customers should be provided to enable them to understand benefits of using mobile communication for business effectively.

### **6.2 Conclusion**

Street traders are one form of informal workers who play an important role in Tanzania's economy. This study aimed at investigating the challenges faced by street traders and customers interacting through mobile devices. The results show that the majority of street traders use mobile devices to communicate with customers. However,



both parties face overall or unique challenges in one way or another. Therefore, we call upon various stakeholders to think of the technological innovation which might support and minimize these challenges in order to help street traders' efforts in this important economic sector.

## References

1. Wyche, P.S., Murphy, L.: Powering the cellphone revolution: findings from mobile phone charging trials in off-grid Kenya. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems (2013)
2. Wyche, S., Dillahunt, R.T., Simiyu, N., Alaka, S.: If god gives me the chance i will design my own phone: exploring mobile phone repair and postcolonial approaches to design in rural Kenya. In: Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing (2015)
3. Wongtada, N.: Street vending phenomena: a literature review and research agenda. *Thunderbird Int. Bus. Rev.* **56**(1), 55–75 (2014)
4. Ogawa, S.: “Earning among friends”: business practices and creed among petty traders in Tanzania. *Afr. Stud. Q.* **9**(1–2), 24–38 (2006)
5. Mramba, N.: The conception of street vending business in income poverty reduction in Tanzania. *Int. Bus. Res.* **8**(5), 120–129 (2015)
6. URT. United Republic of Tanzania: Basic Demographic and Socio-Economic Profile Dodoma Region, NBS (2016)
7. Perekwa, B.G., Tania, P., Van Deventer, J.P.: The impact of mobile technology on micro and small enterprises in Zimbabwe in the post-hyperinflation economic era. *Afr. J. Inf. Syst.* **8**(3), 45–66 (2016)
8. Tettey, C.: The use of the mobile phone in a farmer's business. *Int. J. Acad. Res. Bus. Soc. Sci.* **3**(9), 156–164 (2013)
9. Kapinga, F.A., Montero, C.S., Mbise, E.R.: Mobile technology for women entrepreneurs in Iringa, Tanzania: user requirements and architectural design. In: AFRICON 2017. IEEE (2017)
10. Mawona, A., Mpogole, H.: ICT and financial inclusion: adoption of mobile phone banking among small business owners in Iringa, Tanzania. In: IST-Africa Conference and Exhibition (IST-Africa) (2013)
11. Furuholt, B., Matotay, E.: The developmental contribution from mobile phones across the agricultural value chain in rural Africa. *Electron. J. Inf. Syst. Dev. Ctries.* **48**(7), 1–16 (2011)
12. Mramba, R., Apiola, M., Sutinen, E., Msami, P., Tina K., Haule, M.: Empowering street vendors through technology: an explorative study in Dar es Salaam, Tanzania. In: International Technology Management Conference, Belfast, (2015)
13. Mramba, N., Rumanyika, J., Apiola, M., Suhonen, J.: ICT for informal workers in Sub-Saharan Africa: systematic review and analysis. In: IEEE Africon 2017 Proceedings, Cape Town (2017)
14. Pare, J.D.: Does this site deliver? B2B e-commerce services for developing countries. *Inf. Soc.* **19**(2), 123–134 (2003)
15. Hosmer, T.L.: Trust: the connecting link between organizational theory and philosophical ethics. *Acad. Manag. Rev.* **20**(2), 379–403 (1995)
16. Choi, H., Choi, Y.-J., Kim, K.-M.: The understanding of building trust model on smartphone application: focusing on users' motivation. In: Kim, K.J., Ahn, S.J. (eds.) Proceedings of the International Conference on IT Convergence and Security 2011. LNEE, vol. 120, pp. 13–20. Springer, Dordrecht (2012). [https://doi.org/10.1007/978-94-007-2911-7\\_2](https://doi.org/10.1007/978-94-007-2911-7_2)

17. Roever, S., Skinner, C.: Street vendors and cities. *Environ. Urban.* **28**(2), 359–374 (2016)
18. Skinner, C.: Street trade in Africa: a review. Working Paper no. 51, School of Development Studies (2008)
19. Svensson, J.: Situated empowerment: mobile phones practices among market women in Kampala. *Mob. Media Commun.* **4**(2), 205–220 (2016)
20. Boateng, R., Robert, H., Galadima, R., Olumide, L.: Preliminary insights into the influence of mobile phones in micro-trading activities of market women in Nigeria. *Inf. Dev.* **30**(1), 32–50 (2014)
21. Deen-Swarray, M., Mpho, M., Stork, C.: ICT access and usage among informal businesses in Africa. *Info* **15**(5), 52–68 (2013)
22. Molony, T.: Carving a niche: ICT, social capital, and trust in the shift from personal to impersonal trading in Tanzania. *Inf. Technol. Dev.* **15**(4), 283–301 (2009)
23. Mramba, N., Tulilahti, J., Apiola, M.: Bookkeeping for informal workers: co-creating with street traders. In: Parsons, J., Tuunanen, T., Venable, J., Donnellan, B., Helfert, M., Kenneally, J. (eds.) *DESRIST 2016. LNCS*, vol. 9661, pp. 97–113. Springer, Cham (2016). [https://doi.org/10.1007/978-3-319-39294-3\\_7](https://doi.org/10.1007/978-3-319-39294-3_7)
24. Emory, W.C., Cooper, D.R.: *Business Research Methods*, 4th edn. Homewood, Illinois (1991)
25. Miles, B.M.B., Huberman, A.M.: *Qualitative Data Analysis: An Expanded Sourcebook*, 2nd edn. Sage, Thousand Oaks (1994)
26. Ibrahim, M.A.: Thematic analysis: a critical review of its process and evaluation. *West East J. Soc. Sci.* **1**(1), 39–47 (2012)
27. Mramba, N., Apiola, M., Kolog, E.A., Sutinen, E.: Technology for street traders in Tanzania: a design science research approach. *Afr. J. Sci. Technol. Innov. Dev.* **8**(1), 121–133 (2016)
28. Wahab, S., Zahar, A.S.M., Momani, K.A., Nor, N.A.M.: The influence of perceived privacy on customer loyalty in mobile phone services: an empirical research in Jordan. *Int. J. Comput. Sci. Issues (IJCSI)* **8**(2), 45–52 (2011)
29. GSMA. *Disaster response: mobile is life: research from Nyarugusu refugee camp, Tanzania*. GSM Association (2017)
30. Mothobi, O., Moshi, G.C.: *Cost of smartphones continues the digital divide in Tanzania*. Policy Brief (2017)
31. Mpogole, H., Tweve, Y., Mwakatobe, N., Mlasu, S., Sabokwigina, D.: Towards non-cash payments in Tanzania: the role of mobile phone money services. In: *Proceedings of IST-Africa 2016 Conference* (2016)
32. Mtaho, A.B., Ishengoma, F.: Factors Affecting QoS in Tanzania Cellular Networks. arXiv preprint [arXiv:1410.0533](https://arxiv.org/abs/1410.0533), pp. 29–36 (2014)
33. Nwaobiala, U.C., Ubor, V.U.: Effectiveness of electronic wallet system of growth enhancement support scheme distribution among arable crop farmers in Imo state, south eastern Nigeria. *Sci. Pap. Ser. Manag. Econ. Eng. Agric. Rural. Dev.* **16**(1), 355–360 (2016)
34. Smith, A., Croxson, H.: *Triggering Mobile Internet Use in Côte D’ivoire and Tanzania*. GSMA, London (2018)
35. Misaki, E., Apiola, M., Gaiani, S., Tedre, M.: Challenges facing sub-Saharan small-scale farmers in accessing farming information through mobile phones: a systematic literature review. *Electron. J. Inf. Syst. Dev. Ctries.* **84**, e12034, 1–12 (2018)
36. Rahmati, A., Qian, A., Zhong, L.: Understanding human-battery interaction on mobile phones. In: *9th Proceedings of the International Conference on Human Computer Interaction with Mobile Devices and Services, Singapore* (2007)
37. Bhanot, S.: A study on impact of social media on company performance. In: *3rd Proceedings of International Research Conference held at MGMIMS, Mumbai* (2014)



# Value Co-creation in Design of mHealth Applications for Maternal Healthcare Service Delivery

Hawa Nyende<sup>(✉)</sup> 

University of Gothenburg, 412 96 Gothenburg, Sweden  
hawa.nyende@ait.gu.se

**Abstract.** mHealth has potential to improve maternal healthcare in low resource contexts. Several mHealth applications have been developed but are not implemented nor can they be scaled up partly due to their methodological quality. Although mHealth applications have been designed to improve maternal healthcare service delivery, it is still unclear on how to design mHealth applications for maternal healthcare that drive value co-creation from a service dominant logic (SDL) perspective. In this paper, a case study approach is used to investigate designs of four mHealth applications from Uganda and Cameroon. Interviews were held with developers and health workers involved in the design process of the applications. Results were analyzed using SDL value co-creation model. Overall findings show that designs of existing mHealth applications for maternal healthcare include some aspects of value co-creation but still lack design guidelines that would better support value co-creation. Guidelines for designing mHealth applications that co-create value in maternal healthcare are proposed. Future investigations on how proposed guidelines influence the use of mHealth applications to trigger value co-creation in maternal healthcare are suggested.

**Keywords:** Value co-creation · mHealth · Design guidelines

## 1 Introduction

Improving maternal healthcare is a high priority for the world health organization [1]. The rapidly growing presence of mobile phones in Sub-Saharan Africa provides a unique opportunity in transforming the way maternal healthcare services are delivered [2]. Mobile technologies have supported the delivery of health interventions through mHealth. mHealth is defined as “medical and public health practice supported through mobile devices to practitioners, researchers, and beneficiaries, real-time monitoring of beneficiary vital signs and direct provision of care” [3]. mHealth has improved utilization of maternal healthcare services and is supported by funding bodies, the mobile phone industry and public health authorities.

Design of mHealth interventions is becoming increasingly important [4]. Most studies on mHealth for maternal healthcare in low and middle income countries are of poor methodological quality and few have evaluated impacts on patient outcomes [5]. This makes them difficult to replicate [6], scale and to translate research into practice [5].

Many mHealth interventions are designed on existing traditional health system constructs [7] in which, patients cooperate by accepting information provided by the doctors without questioning it (i.e. passive compliance) [8]. Such interventions may not be as effective as those that involve end-users in the design process [7] and may lead to low quality of life [8]. In addition, there are few studies that describe the features of maternal health related mHealth interventions comprehensively [9]. Premature adoption of untested mHealth technologies may limit positive behavior change and fail to accomplish their objectives or may yield adverse outcomes [10].

Applications need to be designed with adequate consideration of their intended users to obtain best value out of them [11]. To improve healthcare management and services, health systems are being transformed to actively engage patients in healthcare service experiences as they co-create value with health workers [8]. Service dominant logic (SDL) [12, 13] enables us to explore the process of value co-creation which is defined as “the processes and activities that underlie resource integration and incorporate different actor roles in the service ecosystem” [14]. It is still unclear on whether the designs of mHealth apps (applications) for maternal healthcare incorporate value co-creation aspects from an SDL perspective. Using data from mHealth app developers and health workers in Uganda and Cameroon, SDL is adopted to address this gap by exploring the research question: In what ways are the designs of existing mHealth apps incorporating value co-creation aspects and, how can mHealth apps be designed to improve value co-creation in maternal healthcare?

The main contribution of this paper is to propose guidelines for understanding and improving value co-creation in the design process of mHealth apps for maternal healthcare within the context of SDL. This paper addresses the need for further developmental work concerning the application of SDL to healthcare and, the support required for value co-creation in healthcare [15]. It also addresses the need to pay attention to the role of stakeholders in the design of healthcare services [16].

In the following sections, literature on mHealth apps in maternal healthcare, SDL and value co-creation in healthcare is reviewed. The method used in the study is described, results are presented and proposed design guidelines are discussed. Finally, the paper summarizes findings, provides limitations and directions for future research.

## **2 Literature Review**

### **2.1 mHealth Applications in Maternal Healthcare**

Mobile phones have the potential to transform healthcare especially in low resource contexts where healthcare infrastructure and services is insufficient [17]. Mobile technology provides opportunities to permit safe, accessible, coordinated and effective maternal healthcare [18]. mHealth can overcome challenges associated with the delivery of maternal healthcare services including distance, limited computer access, lack of healthcare workers and healthcare delivery costs [19]. mHealth plays a role of improving communication and enhancing the integration of care processes [20].

A systematic review on the role of mHealth in maternal healthcare by Feroz et al. [21] shows that mHealth is mainly used for client education and behavior change communication through SMS reminders but less used on registries and vital event tracking, data collection and reporting, enabling a provider to provider communication and electronic health record. mHealth plays a role of improving communication and enhancing the integration of care processes [20]. In addition, mHealth increases the productivity of health care providers and systems, and empowers patients [22]. mHealth enhances the quality of life and appropriateness of care [23].

Most of the mHealth interventions are designed for healthcare beneficiaries other than healthcare providers [9]. mHealth helps to pursue new healthcare models thereby shifting from inpatient to outpatient care, which enables care to be delivered in rural settings and other places without access to medical personnel [24]. mHealth technology makes it possible to design patient-centered health service that encourages the role of patients in medical treatment [9] but many mHealth apps are designed with minimal input of users to be supported [25]. Various models of mHealth interventions are being used to support pregnant women through safe pregnancy and childbirth in low and middle-income countries [9]. Braa and Sanner [3] developed a reference typology that advocates for the use of hybrid solutions to deliver mHealth services in low resource settings. There are limited mHealth studies that use theoretical understanding to explain adoption and appropriation of technology for measurable health outcomes [26].

## 2.2 Service Dominant Logic and Value Co-creation in Healthcare

SDL views customers as co-creators of value [14, 27] and suggests that organizations should design their value offerings as a service platform that enables service exchange and value co-creation [14]. Service platform is “a modular structure that consists of tangible and intangible resources and facilitates the interaction of actors and resources” [14]. Vargo and Lusch [27] elaborate on the narrative of value co-creation in SDL which is composed of institutions and institutional arrangements, service ecosystem, actors, resource integration and service exchanges. They define institutions as “humanly devised rules, norms and beliefs that enable and constrain action” and institutional arrangements as “a set of interrelated institutions”.

Actors are “resource integrators in a network of other actors” [14]. Resource integration is the process of combining resources for usefulness of value while service exchange is the process of coordinating, sequencing and integrating tasks and activities [14]. Service ecosystem is “a self-contained, self-adjusting system of loosely coupled social and economic resource integrating actors constrained by shared institutional logics and mutual value creation through service exchange” [14]. SDL focuses on the broader role and functions of the ecosystem to include ways in which the digital infrastructure holds together diverse actors and enables collaboration in the ecosystem [14]. This paper considers this broader role of an ecosystem and applies SDL as an analytical lens in order to foreground perceived use-value. However, doing so does not explicitly attempt to background the exchange value which is a valid critique on how SDL is sometimes adopted [28]. The important work of developing, hosting and ensuring financial sustainability of the mHealth apps are not in focus of this paper.

Value co-creation in healthcare improves the quality of life through better healthcare management and services [8]. The need to “understand what customers do when they co-create value in healthcare” [8] has attracted research in healthcare value co-creation. McColl-Kennedy et al. [8] provides a typology of customer value co-creation styles in healthcare. In addition, Pinho et al. [29] identify factors that support value co-creation among actors and how they relate to healthcare outcomes. Loane et al. [30] elaborate on how the exchange of social support enables customers to co-create value within online health communities. Sharma et al. [31] identify capabilities required by healthcare organizations to facilitate customer participation in value co-creation. There is little guidance to explain the capabilities and resources healthcare organizations should develop to facilitate co-creation of value [31]. There is need for more research on value co-creation in healthcare [15].

### 3 Method

#### 3.1 Selection of Research Approach and Study Setting

A case study approach [32] was used to examine the design of mHealth apps. The high maternal mortality rates in developing countries inspired the selection of cases of mHealth apps that were developed with a purpose of reducing maternal deaths in these countries. Uganda and Cameroon were selected cases because of their high maternal mortality rates of 343 and 596 per 100,000 live births respectively [33]. Another reason for selection was because it was easy to get access to the developers of the apps. In addition, the two apps in Uganda, referred to as App A and App B in this article, operate in districts with high rates of teenage pregnancies with a likelihood of 1 to 4 teenage girls getting pregnant per year and the district is hilly. Therefore, pregnant women are located in hard to reach areas with poor road infrastructure and have to walk long distances to health facilities. Another reason for selecting the other two apps, referred to as App C and App D in this article, was because of their wider coverage. App C covers 25 districts in Uganda while App D was developed in Cameroon and is used in 5 African countries including Uganda.

#### 3.2 Selection of Participants and Data Collection

To gain an understanding of the mHealth apps used for maternal healthcare, meetings were held with Professors at one of the universities in Uganda. The professors recommended four mHealth apps that were developed in Uganda and one app that was developed in Cameroon. Follow up meetings were held with consultants and a program manager from three of the five apps to gain an understanding of how the idea of developing the apps was conceived. The information collected from the meetings led to the development of interview guides. Participants from only four mHealth apps were interviewed because it was difficult to get access to the developers of the fifth app. Each of the four apps had only one developer which limited the sample size. For App D, a Medical Director was interviewed instead of a developer, due to access limitations (Table 1).

**Table 1.** Data collection and study participants.

Data collection method	Participants	No. of participants
Interviews	mHealth application developers	3 (App A, B and C)
	Medical director	1 (App D)
Focus group discussion	Health workers	6 (App B and C)
Meetings	Professors, consultants	2, 2 (App B and C)
	Program manager	1 (App A)
Document reviews	PDF files and Presentations	–

Qualitative methods of data collection were used as shown in Table 1. Methods involved interviewing app developers and conducting a focus group discussion (FGD) with health workers who were involved in the design process. Meeting minutes together with documentation which included workplans, proposals and monthly reports of the apps were reviewed to complement the interview data.

### 3.3 Data Analysis Methods

Data was analyzed using thematic analysis method [34]. Interviews and FGD were recorded and transcribed. Transcriptions were used to identify, label and categorize keywords which led to the generation of initial codes. Generated codes were grouped into themes. Themes were reviewed iteratively and refined. Final themes were compared and mapped to the components of the value co-creation model [27]. Although institutions and institutional arrangements are part of the model, they were excluded from the analysis because the focus of the paper was on the design of the apps other than the supporting institutions. Therefore, themes for service ecosystem included: architecture of supporting digital infrastructure, limitations of the architecture, and rewards for participation. Themes for actors included: actors involved in the design of the apps and their roles. Themes for service platform included: value offerings of the mHealth app, design models and valuable features. Themes for service exchange and resource integration included: sharing of health information, providing app reviews, accessibility, content relevance and presentation and rules of service exchange.

## 4 Results

### 4.1 Service Ecosystem of the Supporting Digital Infrastructure

**Architecture of the Digital Infrastructure.** mHealth apps service ecosystem is mainly determined by funders, mentors and app developers. The scope in the ecosystem determines the kind of architecture that was used for designing apps. App A, C and D have a modular architecture and use a cloud-based server for Microsoft to store the data collected by the app while App B stores information on a memory card attached to the device. App D uses application programming interfaces (APIs) to connect to other platforms such as those of mobile telecom operators. The reasons

behind the selection of the architecture of mHealth apps were mainly to reduce costs, for convenience, to increase usability, and for connection to other APIs. It was also noted that despite the existence of the district health information system (DHIS) in the two countries from which the investigated mHealth apps are being used, these apps do not connect to the DHIS. As indicated by the medical director of App D: *“We are not linked to the DHIS because it does not collect individual data, it can provide the number of women vaccinated without their details, connecting to it does not help us”*. In addition, while App B, C and D were developed from scratch, App A was developed from an existing open source technology called SANA from Massachusetts institute of technology (MIT), therefore, the SANA framework was customized to suit the needs of the developers.

**Limitations of the Architecture.** Limitations to the architecture being used by the app developers include: the customization of the SANA platform is time consuming and requires a lot of training due to the use of different concepts for various modules, lack of flexibility especially for App B which runs on a configured device, high power consumption for the sensors, the integration process with other platforms through APIs causes a lot of errors and is time consuming especially in cases where the APIs do not match. In addition, the architecture is limited by performance issues as quoted from the application developer of App C: *“...as we keep on adding more modules, we need to get better android phones that have high speed but these are costly”*.

**Architecture of Participation.** For all the mHealth apps, users are facilitated with data bundles and credit to make calls to pregnant women however, no specific rewards are provided to the users. For App A and B, the architecture of participation is not transparent enough to enable developers to provide rewards to the participants. As indicated by the app developer of App A: *“There is no way we can know that so and so posted this information since the logins are facility based, there is no rewards for midwives. For village health team members (VHTs), we have personal login .. but we do not give them rewards.”* For app C and D, there is a transparent architecture of participation, the users of the app are rewarded for their participation as quoted from the medical director for App D: *“Once you download the app, you earn a coin and we ask questions in form of quizzes to test your knowledge, if you get them right, you receive more coins. Once you share the information on whatsapp or facebook, you still earn a coin”*. The developers of App D are working on a module where pregnant women can retrieve these coins to pay for bills at hospitals. App D also has a provision where pregnant women can be rewarded for best practices. App C has a targets tab that counts the achievements for each community health promoter (CHP) per month depending on the set targets. The targets are used to provide monetary rewards to the CHPs. As quoted from the developer of App C: *“We communicate every month across all our branches that we are going to attach this amount to this activity. The targets tab marks off completed tasks during the month and the CHPs know how much they have worked for”*.



## 4.2 Actors and Their Roles

The design process for mHealth apps for maternal healthcare includes funders, mentors, social media marketing staff, content development guiders (CDG), Health Information Advisers (HIA) health workers (HW), midwives, medical personnel (MP), CHPs, VHTs, pregnant women (PW), district health officers (DHO), regulatory body/government, mHealth application developers and sales people. Two of mHealth apps were designed to have pregnant women as the final users while the other two had health workers as users of the mHealth apps. The roles of these actors in the design process are illustrated in Table 2.

**Table 2.** Actors and actor roles in design process of mHealth apps

mHealth app	Functions	Actors	Actor roles	End users
App A (used since 2016)	Register, follow up and refer PW, track missed appointments	App Developer	Design and code the application	VHTs and Midwives
		Funders	Fund app development and establish scope	
		Mentors	Oversee and guide the development process for quality and effectiveness	
		Social Media Marketing Staff	Carry out media marketing and update the public on the new additions to the app	
		CDG	Ensure appropriateness of content developed	
App B (used since 2017)	Assess pregnancy condition, sense condition of the baby, notify health workers about pregnancy condition	App Developer	Configure the device and code the app	PW and VHTs
		Pregnant Women	Provide requirements for the app	
		Health Workers	Provide information about current practices and features to include in the tool	
		DHO	Provide access to health facilities	
		Funders	Provide training and funds	
		Regulatory Body	Check if the device meets the set standards	
App C (used since 2016)	Register, assess, follow up and refer PW, reward for participation, calculate due	App Developer	Design and code the app	CHPs
		Owner of the Idea	Idea conception	

(continued)

**Table 2.** (continued)

mHealth app	Functions	Actors	Actor roles	End users
	date, share pregnancy tips, notify for appointments	CEO	Oversees the development process	
		DHO	Provide feedback on app upgrades	
		CHPs	Use the app to interact with PW	
		Pregnant Women	Provide feedback during interactions	
		Funders	Provide funds and requirements for modules	
App D (used since 2017)	Same as App C and provides a platform for dialogues between PW and doctors and search for specialists	App Developer	Design and code the application	PW and HW
		MP	Identify problems and gaps in the field	
		Sales Personnel	Provide feedback from the field	
		Pregnant Women	Provide feedback to developers	
		Health Workers	Provide relevant information	
		HIA	Review all developed SMS for significance and ethical relevancy to pregnant women	

**4.3 Service Platform**

**Value Offerings for the Designed mHealth Applications Service Platform.** The service platform of the mHealth apps was designed with a purpose of supporting pregnant women in order to reduce high maternal mortality rates. The support given to pregnant women is in form of monitoring their health status, providing them with timely information, improving their antenatal care (ANC) seeking behaviors and enabling them to ask questions when needed. As quoted from the medical director for App D: *“The problem we noted was that lots of pregnant women forget their appointments and they don’t have the right information or have limited information about pregnancy and don’t have easy access to ask questions on what they are facing at that point in time”*. In addition, mHealth apps were designed to strengthen the follow up system in order to encourage more girls to visit the health centers. A developer for App A: *“These are pregnant teenage girls and have that stigma since it is their first time and we thought if we could follow them up, they might be able to attend ANC”*.

**Design Models of mHealth Service Platform.** Based on the results, the service platform requirements depend on the model used to deliver services to the pregnant women. Two models were identified, the web-based model and the mobile application model. As quoted from the medical director of App D: *“To reduce the gap between class A and class B mums, we use both SMS model and the smart phone application”*. For App D, the web-based model was used to automatically deliver SMS messages to pregnant women to remind them to go for ANC, it also sends educative messages automatically based on the age of the pregnancy and in addition, a woman can send a message and receive a response from the medical personnel. The mobile based model which is used by all apps to deliver other services that include exchange of health information and interactions between the pregnant women and healthcare professionals, and interactions between the healthcare workers and pregnant women. The mobile based model requires users to have smart phones that run on Android 4.4 and above, having internet connection, having a phone to receive SMS from the app, memory of at least 500 MB and sometimes Bluetooth connection to sensors. While mHealth apps A, B and D were simple and easy to use, App C required extensive training before it can be used because it is designed for people who have knowledge about healthcare. As quoted from the developer for App C: *“We take CHPs through 1-month training and we run two refresher trainings every month...they also sit for certification exams that is recommended by the ministry of health”*.

**Valuable Features of the mHealth Service Platform and Derived Value.** The most valuable features in the design put forward include: registering pregnant women, assessment of the pregnancy, sensing the condition of the baby, recording of follow up notes, availability of health information, a platform for pregnant women that connects directly to a doctor, pregnancy due date calculator, searching for a specialist and a nanny, responding to questions in form of quizzes to earn coins. As quoted from the medical director of App D: *“About 58% will return just to read the health content for that week and to get information about pregnancy for that week”*.

In addition, the perceived value derived from the mHealth apps is measured in terms of completed recommended ANC visits, increased deliveries at health facilities, predicted complications, increased number of pregnant women registered on the platform, health facilities that have subscribed to the services offered by the app, SMS messages sent out to pregnant women and dialogues with pregnant women, improved attitude and practices of women, reduced deaths of pregnant women, improved interactions between midwives and VHTs and tracked missed appointments.

#### 4.4 Value Co-creation via Resource Integration and Service Exchange

Pregnant women co-create value as they share information with others through social media and are rewarded for participation and sharing own experiences. In addition, they ask questions to medical specialists either through SMS or through direct talks. In this way, services are exchanged. As quoted from the medical director of App D *“We have a shot code whereby a woman can send a message and receive a response from a medical doctor in form of an SMS, that’s for the SMS model. The smart phone application offers a platform where women can talk directly to a medical doctor”*.

User reviews of the application is one way in which users can integrate resources in form of knowledge and skills to improve the app. App A, B and C have no provision for users to provide app reviews. However, developers obtain feedback from the users during monthly visits or through individual calls made to the users or through in-service trainings or to the health workers at the health facilities. For App D, users provide app reviews on the Google play store where the app is downloaded from or review directly when they download the app. As quoted from the developer of App C *“Review and feedback is gathered during in-service trainings. The users have actually helped us in modeling this app for instance they tell us which sections of the app are crowded”*.

Users of the app have access to all features that provide the needed health information but technical information is limited to administrators and app developers. As quoted from the developer of App A *“The dashboard is used daily by the DHO to access information about the number of pregnant girls mapped to health centers and VHTs use it weekly to see which women are due for ANC”*. Accessibility of health information empowers them to provide the required services. As quoted from the developer of App C *“The app enables community health promoters to interact with the pregnant mothers and recommend medicines or referrals to the government hospital depending on the situation”*.

Applications designed for use by the VHTs and CHPs have different content presentations. For instance, App A provides summary content for both VHTs and midwives at registration. For VHTs, the app enables them to assess the risk of the pregnant women at registration and the app provides detailed information during ANC visits to the midwives. Content which is knowledge resources provided by the medical professionals are presented in different formats including text, video and images. As quoted by the medical director for App D *“You can watch a video that gives you steps to prepare lemon water and also has written information that you can read but most of it has images and illustrates things that you are reading”*. SMS sent out in form of educational messages or health tips are reviewed to ensure that they are relevant to women.

Regarding the rules of exchange of services, the apps provide a platform for pregnant women to exchange messages with medical specialists. As quoted from the medical specialist for app D *“When pregnant women post questions to the app platform, these questions are responded to by medical professionals who have login credentials. However, pregnant women do not know which doctor has responded to them.*

In addition, exchange of information happens between VHTs and midwives. VHTs share records of pregnant women with the midwives in charge but they cannot share information with other VHTs. As quoted by the developer of App A *“When the VHT maps a girl, she appears in the list of mapped girls assigned to the midwife in charge of that VHT”*. Midwives at the same health facility share a phone and health information because they use a general login credential attached to that health facility, but midwives from different parishes cannot share information. It makes it difficult for these health workers to collaborate especially in cases where supported women shift to other areas. CHPs are assigned specific areas of operation and are given login credentials which are mapped to a branch for that area. The logins are used to identify their contributions

which are rewarded accordingly. But these CHPs do not share information with other CHPs. As quoted from the developer of App C “*CHP logins are tagged to the details of that health worker, there is no sharing of what is happening where, coz there is a lot of privacy information to hide, once logged in you stick on what you post*”.

## 5 Discussion

Based on the value co-creation model by Vargo and Lusch [27], designs of existing mHealth apps include some aspects of value co-creation but still lack some of the design guidelines that would better support value co-creation. Five guidelines are proposed to support designs of mHealth apps for maternal healthcare.

**Guideline 1: Integration of mHealth Apps with Local Digitized Health Information Systems.** The scope and architecture of the apps is determined by various actors. A good practice is the use of application programming interfaces (APIs) to connect apps to networks of mobile telecom operators. It was also noted that among investigated apps, no app connects to other HIS including the local digitized district health information system (DHIS), which the government uses to plan for resources at health facilities. The underutilization of mHealth could be due to a failure to embed it into broader information systems [24]. Existing HIS can be strengthened through mHealth solutions by leveraging on the backbone DHIS that is already shared in the current HIS setup and work practices [3]. The integration would provide more innovation opportunities to improve work practices in maternal healthcare.

Each app stores data differently and there is no integration nor sharing of modules among apps. The lack of integration of the existing apps hinders maternal health workers to have a shared view of the status of pregnant women in different districts and makes it difficult to plan for resources needed to support them. In addition, if a woman migrates from one place to another, their details may be recaptured by another app leading to duplication of data and limits resource integration. The lack of a shared awareness among actors limits their service ecosystem to capitalize on the diverse set of expertise and capabilities offered by other actors in the network [14]. This limits innovation opportunities and hinders scaling up of the mHealth apps.

SDL suggests a layered-modular architecture which provides more opportunities for innovative resource combinations hence potential for service innovation [14]. Designs of mHealth apps use a modular architecture in which the addition of new modules slows down the apps. Performance could be improved if resources, i.e. knowledge, skills and technology from various app developers are combined to match the problem context. Resources can be exchanged with app developers and customized to suit their needs.

**Guideline 2: Involvement of Actors with Different Roles in the Design Process.**

Evidence shows that various actors were involved in the design process of mHealth apps including end users of the apps. Each of these actors plays a role in the process hence supporting other actors. SDL identifies three broad roles of actors in the co-creation process which include ideator, designer and intermediary [14]. In the design process of the apps, health workers, pregnant women, medical personnel, idea

owners and funders play the role of ideators because they bring knowledge about their needs and unique work context. They also provide feedback which guides the upgrade process through new service requests hence, opportunities for innovations. Incorporation of end-user feedback and expert opinion in the development process improves app usability and improves health behaviors [25].

App developers, content development guiders and health information advisors play the role of designers in the design of mHealth apps. They develop platforms or communication mechanisms that enable actors to mix and match resources which lead to new services. Mentors, social media marketing staff, sales personnel, district health officers and regulatory bodies play the role of intermediary. Intermediary role actors make nonobvious connections across service ecosystems in ways that provide value for themselves and others [14]. These actors explore connections among diverse resources offering knowledge exchange across service ecosystems such as social media, community and health facilities.

**Guideline 3: Transparent Architecture of Participation and Rewards.** For some apps, a good practice of having a transparent architecture in which app users are rewarded for participation is noted. The architecture of participation enables participants' contributions to be coordinated, integrated and synchronized coherently through transparent rules of exchange [14]. One way of rewarding participation is to base rewards on successful execution of monthly targets and on active participation of users in various activities. Mechanisms are needed on how such rewards can be used to pay for medical bills at health facilities. Rewarding participation motivates users of the apps and leads to collaborative value co-creation. The architecture of participation enables app developers to establish different types of incentives that drive participation in networks and provides an opportunity to design new methods to share value among participants [14] hence leading to new innovations that support value co-creation.

**Guideline 4: Mixed Model Designs with Different Value Offerings.** The perceived value offered by the mHealth apps is to reduce maternal deaths. Mixed model designs including web-based, SMS and smartphone-based models, are developed to enable different classes of actors to easily access resources and participate in resource integration and service exchange. The nature of avenues provided for interaction and exchange directly affects service innovation [14]. mHealth solutions need to cope with situations that lack wireless communication to enable data storage on the phone for later upload when connectivity is available, therefore hybrid solutions improve service delivery [3]. The mixed models have valuable features that enable actors to exchange services which include registration, assessment, communication and information sharing. Perceived value from these features are directed towards PW and CHPs/VHTs and include improved health seeking behaviors, attitudes and practices of PW, predicted complications, improved knowledge sharing through interactions between PW and CHPs, using features such as pregnancy due date calculator. This value is measured in terms of completed ANC visits, number of deliveries at health facilities, predicted complications, dialogues, and pregnant women registered on the platform. However, this study did not measure real value achieved due to time constraints.

**Guideline 5: Mechanisms for Resource Integration and Service Exchange.** The apps provide mechanisms through which users share knowledge and experiences. Knowledge and skills enhance human viability to create new resources through resource integration [14]. Actors co-create value as they share knowledge with others. mHealth apps enable pregnant women to share knowledge and experiences with peers and doctors. Loane et al. [30] argue that participants create and obtain value through generalized exchange of social support among peers. Actors are provided an opportunity to conduct app reviews which encourages them to provide feedback to developers thereby exchanging services and provides opportunities for innovation. In addition, enabling users to access health information empowers them to provide the required services or to practice the health tips provided by the app.

The different ways in which content is presented to actors greatly affects the way they engage in the value co-creation process. Evidence shows that health content is presented in various formats for easy understanding by different actors. Repackaging of knowledge to make it more appropriate to the actors enables them to engage in the co-creation process. Content that is presented to a healthcare professional, may not be appropriate for presentation to a pregnant woman because of the cognitive distance between the two actors. The need to obtain a common perspective from actors with cognitive distance creates innovative ways hence enabling value to be co-created.

mHealth apps should provide a platform with transparent rules of service exchange. Implementation of rules of exchange facilitates the coordination of actor contributions and their interactions [14]. Evidence shows that the rules of service exchange hinder the value co-creation process by limiting information sharing among actors and, making it difficult to know the value propositions from various actors.

## 6 Conclusion and Future Work

Using the value co-creation model of SDL provides an opportunity to improve the designs of mHealth apps for maternal healthcare through the proposed guidelines. The guidelines include: integration of mHealth apps with local digitized HIS, involvement of actors with different roles in the design process, transparent architecture of participation and rewards, mixed model designs with different value offerings and mechanisms for resource integration and service exchange.

The study is limited by a small number of mHealth apps from developing countries and with few developers whose views may vary from other app developers. Future work on how proposed guidelines influence the use of mHealth apps to trigger value co-creation in maternal healthcare is recommended.

## References

1. WHO: WHO | Maternal mortality (2016)
2. Oyeyemi, S.O., Wynn, R.: Giving cell phones to pregnant women and improving services may increase primary health facility utilization: a case-control study of a Nigerian project. *Reprod. Health* **11**, 8 (2014). <https://doi.org/10.1186/1742-4755-11-8>




3. Braa, K., Sanner, T.: Making mHealth happen for health information systems in low resource contexts. In: Proceedings of the 11th International Conference on Social Implications of Computers in Developing Countries, pp. 530–541 (2011)
4. Fiordelli, M., Diviani, N., Schulz, P.J.: Mapping mHealth research: a decade of evolution. *J. Med. Internet Res.* **15**, e95 (2013)
5. Lee, S.H., Nurmatov, U.B., Nwaru, B.I., et al: Effectiveness of mHealth interventions for maternal, newborn and child health in low- and middle-income countries: systematic review and meta-analysis. *J. Glob. Health* **6** (2016). <https://doi.org/10.7189/jogh.06.010401>
6. Hurt, K., Walker, R.J., Campbell, J.A., Egede, L.E.: mHealth interventions in low and middle-income countries: a systematic review. *Glob. J. Health Sci.* **8**, 183 (2016). <https://doi.org/10.5539/gjhs.v8n9p183>
7. McCurdie, T., Taneva, S., Casselman, M., et al.: mHealth consumer apps: the case for user-centered design. *Biomed. Instrum. Technol.*, no. Suppl., 49–56 (2012). <https://doi.org/10.2345/0899-8205-46.s2.49>
8. McColl-Kennedy, J.R., Vargo, S.L., Dagger, T.S., et al.: Health care customer value cocreation practice styles. *J. Serv. Res.* **15**, 370–389 (2012). <https://doi.org/10.1177/1094670512442806>
9. Chen, H., Chai, Y., Dong, L., et al.: Effectiveness and appropriateness of mHealth interventions for maternal and child health: systematic review. *J. Med. Internet Res.* **20**, e7 (2018)
10. Kumar, S., Nilsen, W.J., Abernethy, A., et al.: Mobile health technology evaluation. *Am. J. Prev. Med.* **45**, 228–236 (2013). <https://doi.org/10.1016/j.amepre.2013.03.017>
11. Brown, W., Yen, P.Y., Rojas, M., Schnell, R.: Assessment of the Health IT Usability Evaluation Model (Health-ITUEM) for evaluating mobile health (mHealth) technology. *J. Biomed. Inform.* **46**, 1080–1087 (2013). <https://doi.org/10.1016/j.jbi.2013.08.001>
12. Vargo, S.L., Lusch, R.F.: Evolving to a new dominant logic for marketing. *J. Mark.* **68**, 1–17 (2004). <https://doi.org/10.1509/jmkg.68.1.1.24036>
13. Vargo, S.L., Lusch, R.F.: Service-dominant logic: continuing the evolution. *J. Acad. Mark. Sci.* **36**, 1–10 (2008). <https://doi.org/10.1007/s11747-007-0069-6>
14. Lusch, R.F., Nambisan, S.: Service innovation: a service-dominant logic perspective. *MIS Q.* **39**, 155–175 (2015)
15. Hardyman, W., Daunt, K.L., Kitchener, M.: Value co-creation through patient engagement in health care: a micro-level approach and research agenda. *Public Manag. Rev.* **17**, 90–107 (2015). <https://doi.org/10.1080/14719037.2014.881539>
16. Barello, S., Triberti, S., Graffigna, G., et al: eHealth for patient engagement: a systematic review. *Front. Psychol.* **6**, 2013 (2016)
17. Kahn, J.G., Yang, J.S., Kahn, J.S.: “Mobile” health needs and opportunities in developing countries. *Health Aff. (Millwood)* **29**, 252–258 (2010). <https://doi.org/10.1377/hlthaff.2009.0965>
18. WHO: mHealth: new horizons for health through mobile technologies. *Observatory* **3**, 66–71 (2011). <https://doi.org/10.4258/hir.2012.18.3.231>
19. Watterson, J.L., Walsh, J., Madeka, I.: Using mHealth to improve usage of antenatal care, postnatal care, and immunization: a systematic review of the literature. *Biomed. Res. Int.* **2015**, 1–9 (2015)
20. Cucciniello, M., Guerrazzi, C., Nasi, G.: Coordination mechanisms for implementing complex innovations in the health care sector. *Public Manag. Rev.* **17**, 37–41 (2015). <https://doi.org/10.1080/14719037.2015.1029348>
21. Feroz, A., Perveen, S., Aftab, W.: Role of mHealth applications for improving antenatal and postnatal care in low and middle income countries: a systematic review. *BMC Health Serv. Res.* **17** (2017). <https://doi.org/10.1186/s12913-017-2664-7>



22. Catan, G., Espanha, R., Veloso Mendes, R., et al.: The Impact of eHealth and mHealth on doctor behavior and patient involvement: an Israeli and Portuguese comparative approach. *Stud. Health Technol. Inform.* **12**, 813–817 (2015)
23. Rincon, E., Monteiro-Guerra, F., Rivera-Romero, O., et al.: Mobile phone apps for quality of life and well-being assessment in breast and prostate cancer patients: systematic review. *JMIR mHealth uHealth* **5**, e187 (2017). <https://doi.org/10.2196/mhealth.8741>
24. Nasi, G., Cucciniello, M., Guerrazzi, C.: The role of mobile technologies in health care processes: the case of cancer supportive care. *J. Med. Internet Res.* **17** (2015). <https://doi.org/10.2196/jmir.3757>
25. Schnall, R., Rojas, M., Bakken, S., et al.: A user-centered model for designing consumer mobile health (mHealth) applications (apps). *J. Biomed. Inform.* **60**, 243–251 (2016). <https://doi.org/10.1016/j.jbi.2016.02.002>
26. Chib, A., Van Velthoven, M.H., Car, J.: mHealth adoption in low-resource environments: a review of the use of mobile healthcare in developing countries. *J. Health Commun.* **20**, 4–34 (2015). <https://doi.org/10.1080/10810730.2013.864735>
27. Vargo, S.L., Lusch, R.F.: Institutions and axioms: an extension and update of service-dominant logic. *J. Acad. Mark. Sci.* **44**, 5–23 (2016). <https://doi.org/10.1007/s11747-015-0456-3>
28. Hietanen, J., Andéhn, M., Bradshaw, A.: Against the implicit politics of service-dominant logic. *Mark. Theory* **18**, 101–119 (2018). <https://doi.org/10.1177/1470593117692023>
29. Pinho, N., Beirão, G., Patrício, L., Fisk, R.P.: Understanding value co-creation in complex services with many actors. *J. Serv. Manag.* **25**, 470–493 (2014). <https://doi.org/10.1108/JOSM-02-2014-0055>
30. Loane, S.S., Webster, C.M., D’Alessandro, S.: Identifying consumer value co-created through social support within online health communities. *J. Macromark.* **35** (2014). <https://doi.org/10.1177/0276146714538055>
31. Sharma, S., Conduit, J., Hill, S.: Organisational capabilities for customer participation in health care service innovation. *Australas. Mark. J.* **22**, 179–188 (2014)
32. Yin, R.K.: *Case Study Research: Design and Methods*, 4th edn. SAGE Publications, Thousand Oaks (2009)
33. WHO: WHO | Maternal mortality country profiles (2015). [http://www.who.int/gho/maternal\\_health/countries/en/](http://www.who.int/gho/maternal_health/countries/en/). Accessed 25 Nov 2017
34. Braun, V., Clarke, V.: Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**, 77–101 (2006). <https://doi.org/10.1191/1478088706qp063oa>



# A Framework for Understanding the Empowerment Effects of Telecentres on Rural Communities in Developing Countries

Sellina Khumbo Kapondera<sup>1</sup> , Roberta Bernardi<sup>2</sup> ,  
and Niki Panteli<sup>1</sup> 

<sup>1</sup> Royal Holloway University of London, London, UK  
skapondera@gmail.com, Niki.Panteli@rhul.ac.uk

<sup>2</sup> University of Bristol, Bristol, UK  
roberta.bernardi@bristol.ac.uk

**Abstract.** This paper proposes a framework for understanding how individuals empowered by telecentres, in return, empower their rural communities. The issue is that although ICT4D projects such as telecentres are viewed as a vital way to foster social economic development, their effectiveness on reducing digital exclusion is continuously being questioned. This research suggests that the way telecentres users empower communities is key to understanding how communities can harness ICTs (Information and Communication Technologies) to fight against digital exclusion. The study adopts qualitative research methods and targets two telecentres in Malawi. The study will help understand how individuals empowered by the use of ICTs such as telecentres can then empower members of their community. Hence, this study will provide insights of how ICTs can also become means to generate collective empowerment.

**Keywords:** Digital exclusion · Empowerment · Telecentres · ICT4D

## 1 Introduction

Telecentres provide public access to Information and Communication Technologies (ICTs) such as Internet and computers [22] in order to foster social economic development and reduce digital exclusion. Digital exclusion is the gap between those who have access and ability to use and benefit from ICTs and those who do not [13, 24, 38]. Yet, the issue of telecentres being effective in removing digital exclusion remains unresolved. Some scholars claim that telecentres are removing digital exclusion by fostering social economic development. For example, telecentres give users easy access to information on various aspects of life such as education, agriculture, and health [45, 48]; increase incomes by, for example, providing users with information on jobs and helping users start-up businesses [8]; and train people in the use of ICTs [3, 6]. On the other hand, some scholars argue that telecentres do not reduce digital exclusion because they are only used by a few people, most of whom are already advantaged such as the youths, males, and the relatively educated [12, 32]. The purpose of this paper is to

---

The original version of this chapter was revised: The name of the second author has been corrected. The correction to this chapter is available at [https://doi.org/10.1007/978-3-030-18400-1\\_64](https://doi.org/10.1007/978-3-030-18400-1_64)

propose a framework that furthers our understanding of the empowerment effects of ICT4D interventions on communities.

The divergent opinions about the development impact of telecentres highlight how existing research fails to view digital exclusion as a multi-layered phenomenon. This paper argues that the opponents to the benefits of telecentres only concentrate on the first two layers of digital exclusion: (i) access and usage patterns divide, also known as economic divide, which looks at the groups of people who can own or afford ICTs [5, 36]; and (ii) usability divide, which looks at the skills that enable one to use the ICTs [36, 48, 50], frequency of using the ICTs [5], and how users that belong to different groups use and engage with ICTs [50]. However, the third layer, which is the empowerment divide, has been ignored. This layer is about making full and meaningful use of ICTs [36, 48]. Even when people have access to and use ICTs, some would not make use of all the opportunities offered by such ICTs. For example, some people do not participate in online community discussions even when they belong to them. On meaningful use, some people would use ICTs for activities that would not change their lives such as playing games. The third layer of digital exclusion could be associated with the changes that people experience after using ICTs. Even though existing research has investigated the measurable impact that telecentres can have on socio-economic development (e.g. how telecentres increase incomes), it has not given full consideration of the impact of telecentres on empowerment as a means of achieving socio-economic development [27, 45, 54, 55]. For example, someone who is empowered by having increased confidence may be able to start up a business that would lead to increase in the finances. Although some aspects of individual empowerment have been identified by some scholars (such as [4], [38] and [40]), little attention has been paid to community empowerment. Secondly, little is known about the relationship between individual empowerment and collective empowerment in rural communities. Specifically, thorough literature review shows that no efforts have been done to understand how individuals empowered by telecentres lead to community empowerment.

This research suggests that the way telecentre users empower communities is key to understanding the empowerment effects of ICTs on communities and, consequently, the impact of ICTs on digital exclusion. Empowerment in this case is the process that enables people to do things that they were unable to do previously [2, 25]. However, the literature lacks a sound theoretical framework that would help us understand the empowerment effects of ICT4D such as telecentres on communities. Therefore, this paper proposes a framework (henceforth the Proposed Research Framework) for understanding how individuals empowered by telecentres can also empower rural communities. In particular, the Proposed Research Framework, is based on Zimmerman's [59, 60] Psychological Empowerment Framework while taking elements from Giger's [14, 15] Alternative Evaluation Framework and the empowerment literature. The proposed framework theorises about the link between ICTs and community empowerment.

The significance of the proposed framework is that it may provide insights into how ICTs and, specifically, telecentres can benefit the communities by, for example, benefiting indirectly the people who do not access and use the ICTs due to lack of resources and skills. It may also provide insights into how individuals empowered by

the ICTs empower communities and, thereby, become means to generate collective empowerment. The study framework may extend the existing theory by focusing empowerment outcomes at individual as well as community levels and by focusing on the empowerment process.

The paper is structured as follows: Sect. 2 discusses how the proposed framework has been developed; Sect. 3 discusses the proposed framework; Sect. 4 discusses the methodology and data analysis before providing preliminary results in Sect. 5.

## 2 Conceptual Foundations

### 2.1 Zimmerman's Psychological Empowerment Framework

Zimmerman's Psychological Empowerment Framework allows us to understand individual empowerment, which is also known as psychological empowerment (PE). In particular, it divides PE into three components: intrapersonal empowerment, interactional empowerment, and behavioural empowerment. **Intrapersonal empowerment** is the basic element of empowerment concerning the way individuals view or think about themselves [51, 52, 59], which, ultimately, enhances their ability to control their environment and goal achievement [2, 59]. Some of the elements include: self-esteem referring to the evaluation component of the self [53]; self-efficacy, namely, peoples' belief in their ability to successfully accomplish a task essential for achieving desired goals [39]; impact, referring to the extent to which a person may influence outcomes [56]; competence, referring to one's belief in being able to perform activities given the skills they possess [53]; and meaningfulness, which is the "value of task goal or purpose, judged in relation to individuals' own ideals" [56: 672]. **Interactional empowerment** is how individuals understand and relate to their environment. The elements of interactional empowerment are critical awareness, decision making skills, leadership skills and problem solving skills [41, 51, 59]. Although some scholars such as [43] consider interactional empowerment as collective empowerment, this study considers it as individual empowerment because its elements do take place at the individual level. **Behavioral empowerment** is about the activities or actions that people engage in to address specific needs in a specific environment [2, 38, 51, 52]. Some of the behavioral elements include organizational participation, community involvement and coping mechanisms [52, 59], although the behavioral elements vary based on available opportunities [2]. Behavioral empowerment occurs as a result of developing intrapersonal and interactional empowerment. For example, after becoming confident (the *intrapersonal component*) and being aware of the social services in the community (the *interactional component*), people can participate in writing proposals for funding so as to improve their communities. The interactional component acts as a bridge between perceived ability to control their lives (the *intrapersonal component*) and actually taking control (the *behavioral component*) [59]. A thorough review also indicates that the behavioural component of PE is not just about individual empowerment as it appears in the Psychological Empowerment Framework, but it could well be associated with the mechanisms by which individuals empower communities. Therefore, this study considers this component and its elements (i.e. organizational

participation and community involvement) as mechanisms of empowering communities. For example, community involvement in empowerment literature in the field of health and psychology is about taking part in active citizenship that may include engaging in socio political activities like demonstrations, which aim at bringing positive political and social change in a particular community. It can be said that the Psychological Empowerment Framework is useful to partly understand the empowerment process. The empowerment literature in the fields of health and psychology shows that there are more factors including sense of community and social cohesion that may lead to community empowerment as I discuss in Sect. 2.3. In addition, the Psychological Empowerment Framework is only good in understanding indicators of empowerment at individual level and not at community level. The paper is interested in proposing a framework for understanding how individual empowerment may translate into community empowerment. Therefore, the proposed framework addresses this limitation through the Alternative Evaluation Framework and empowerment literature from psychology and healthcare.

## 2.2 The Alternative Evaluation Framework

The Alternative Evaluation Framework mainly comes from Amartya Sen's Capability Approach which evaluates development based on what people can do or be depending on what they value [3, 11, 21, 47]. The Alternative Evaluation Framework also incorporates the Sustainable Livelihoods Framework, which offers an analytical way of understanding the lives of the poor by focusing on capitals or assets (social, human, financial, natural and physical) that are critical for people's livelihoods [19]. Based on the principle of capabilities, which are things that a person thinks is able to achieve [26, 47, 49, 57] and the focus of the Capability Approach on what people value [37, 47], the Alternative Evaluation Framework considers empowerment as capabilities. Indeed, empowerment is considered as a process that helps people gain substantial and new capabilities to perform some specific actions that people could not previously do [11, 25]. In addition, empowerment is a process that enables people and communities to gain mastery over issues that are important to them [60].

The Alternative Empowerment Framework suggests that people can achieve individual empowerment when they have access to resources and when there are favourable contextual conditions (e.g. ICT policies) that allow access and use of ICTs. The framework also suggests that ICTs can lead to community empowerment. Given its interest in how ICTs can lead to community empowerment, elements from the Alternative Evaluation Framework will be borrowed to compensate for the lack of community empowerment in Zimmerman's Psychological Empowerment Framework.

In particular, the use of the Alternative Evaluation Framework gives five indicators of community empowerment, namely, information, organisational, political, cultural, and psychological indicators [14, 15]. The theory is only useful in understanding empowerment indicators at community level which helps to address the limitation of lack of community empowerment indicators in the Psychological Empowerment Framework.

However, much as the Alternative Evaluation Framework considers empowerment at both individual and community level, the framework lacks the link between

individual empowerment and community empowerment. In other words, it lacks the factors or mechanisms that can enable individuals to empower communities. Therefore, the theory is only good for understanding empowerment indicators but not empowerment process.

### 2.3 Mechanisms of Achieving Community Empowerment

The empowerment literature especially in the fields of health and psychology shows that for community empowerment to take place, three main conditions are needed: individual empowerment; the mediating factors such as mutual groups and community involvement; and community empowerment [28, 29, 46]. Therefore, even when people are empowered, community empowerment cannot take place unless they engage in mechanisms that would lead to collective action. As stated above, these mechanisms could also be partly linked to the Psychological Empowerment Framework, particularly, the behavioural component of the framework which is about things people engage in to change their lives as well as their community [59]. The literature shows that there are four main mechanisms through which empowered individuals empower communities namely: *community participation*, *community organisations*, *social cohesion* and *sense of community* [1, 9, 31, 33, 39, 41].

*Community organisation* involves people defining themselves as community members and involving themselves in strategic discussions with an aim of achieving the vision of the community. Through community organisations, groups identify problems affecting the community at large and common goals and collectively mobilise resources for solving collectively identified problems and achieving collectively set goals [31]. *Community participation* is concerned with being involved in active citizenship by participating in wider socio political activities such as demonstrations and writing a letter influencing policy in one's community, and being a member of an organisation [9, 33, 39, 52]. Community participation increases the feelings of people that they can influence decisions and leads to community action [46]. In addition, participation increases PE such as confidence [17, 23] and promotes critical awareness of social issues through communication (interactional empowerment) [9]. *Social cohesion* expands the concept of participation by incorporating notions of trust or shared emotional commitment and connectedness [41, 42, 44]. Connectedness is the state of belonging to a larger world which increases opportunities in one's life. It helps people to be aware of what is happening around them, be in touch with people and learning and being informed [6]. Social cohesion empowers communities by, for example, helping individuals to be aware of what is happening around them and to acquire high competence [6]. *Sense of community* is a feeling that a person has that they belong to a larger community which is reinforced by interpersonal sharing and emotional connection and that their needs can be met when they stay together [7, 33]. Sense of community aids problem coping behaviour and achieving common objectives for the betterment of the community [1, 43, 46]. Both sense of community and social cohesion deal with connectedness and are sometimes used interchangeably.

### 3 The Proposed Research Framework

As already stated, the Proposed Research Framework uses the Psychological Empowerment Framework as its foundation and combines it with the Alternative Evaluation Framework. Specifically, the Proposed Research Framework aims at proposing the effects of ICTs such as telecentres on empowerment at individual and community levels as well as the link between individual and community empowerment, which is missing in the literature.

By drawing on the Psychological Empowerment Framework, the Proposed Research Framework helps our understanding of empowerment as an intangible aspect and, partly, aids an understanding of the empowerment process. It addresses the weaknesses of the Psychological Empowerment Framework, namely, its lack of community empowerment indicators, by borrowing elements from the Alternative Evaluation Framework and the empowerment literature. In addition, it adds the link between individual and community empowerment not fully addressed in the Psychological Empowerment Framework and the Alternative Evaluation Framework. The Proposed Research Framework addresses this weakness by combining the behavioural component of individual empowerment with the healthcare and psychology literature on mechanisms that lead to community empowerment.

The main elements of the Proposed Research Framework include: access and use of telecentre services/ICTs; individual empowerment; mechanisms of empowering communities; and community empowerment (Fig. 1).

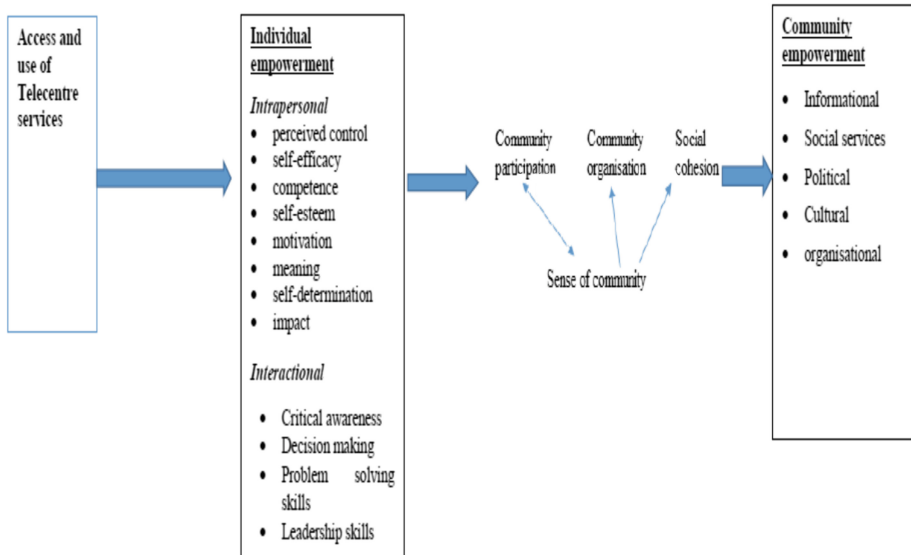


Fig. 1. The proposed research framework

In summary, the Proposed Research Framework suggests that there is a link between ICTs and community empowerment. This link starts with physical access to ICTs such as telecentre services as a means for achieving empowerment [19, 20]. However, the presence of ICTs alone will not enable empowerment but rather, the use of it. Therefore, to achieve individuals as well as collective empowerment, people have to use the telecentres services/ICTs which may lead to individual empowerment such as increasing self-esteem and awareness of community problems.

Furthermore, the framework suggests that the psychologically *empowered individuals* may empower communities such as families and friends and collective community. However, this link is not direct as the community empowerment may take place when the empowered individuals engage in activities such as *community organisation, sense of community, social cohesion and community participation*, which, eventually, may lead to collective action. The empowered individuals may empower their communities through *community organisation*. Psychologically empowered telecentre users may engage in discussions pertaining to the vision of the community [34], thereby fostering a number of community empowerment indicators such as social empowerment. Furthermore, telecentres users can empower communities through *community participation* which will allow them to be involved in political and social activities aiming at fostering change in their communities. Through community participation, telecentre users may also empower their fellow community members as participation increases psychological empowerment such as confidence (intrapersonal empowerment) [17, 23] and promotes critical awareness of social issues (interactional empowerment) [9]. In addition, through *social cohesion*, psychologically empowered telecentre users may empower communities because their connectedness and trust may lead them to work together which, in the end, may lead to collective action like improving community health conditions hence leading to social services empowerment which is one of the community empowerment indicators. Through social cohesion, users may also be interacting with other community members and empower them by increasing their awareness of what is happening in their environment. This implies that when telecentres increase users' psychological empowerment, through social cohesion, empowered users can benefit members of their social groups and their local communities. Finally, telecentre users may lead to community empowerment if they have a *sense of community*. The sense of community may help them to engage in collective action. Therefore, as argued by [33], sense of community in this framework is positively related to participation. Moreover, according to [9], sense of community is higher in those who participate as compared to their counterparts. The relationship between sense of community and participation is reciprocal, i.e. sense of community leads to participation [33], which, in turn, leads to sense of community [9]. In addition, sense of community is important for forming and strengthening interpersonal relationships and for belonging to organisations and, thereby, it affects social cohesion and community organisation respectively. Therefore, in the Proposed Research Framework, sense of community is linked to all the other three mechanisms. The link between empowered individuals and the community through the described mechanisms may be constrained or enabled by a number of factors such as norms, education and incomes. For example, some communities would require members to fulfil certain conditions such as qualifications to take part in community activities (community participation). In some



contexts, norms would restrict women from using the ICTs. In addition, regardless of the fact that social cohesion may have positive impact on community empowerment, this mechanism may also serve as a hindrance to achieving community empowerment as some would be negatively advised by their peers or families not to use the ICTs, and some empowered users may transfer the benefits of ICTs only to those considered in their social circles [35].

A community may be made of families, language groups or clan. In addition, a community may be composed of heterogenous people who take an action together to achieve collective goals [29]. Community empowerment is a broader view of empowerment whereby individuals are able to form groups, community organisations and partnerships with an aim of achieving common goals [14, 46]. Empowered individuals may empower communities which could be through empowering individuals such as family and friends leading to individual empowerment (intrapersonal and interactional empowerment); and collective empowerment (community empowerment). The collective or community empowerment indicators come from the Alternative Evaluation Framework. These include:

- *Information*: some of the indicators include strengthened traditional information systems; improvement in information flow within the community; and improved information exchange with other communities.
- *Organisational*: this is about how things take place within a community. Some indicators include transparency in selecting leaders, improvement in information flows, better coordination among different organizations that exist within a community and increased efficacy in community operations.
- *Social services*: this is about whether ICTs have improved access to social services such as health and education services within the communities.
- *Political*: this is associated with improved participation in political systems and increased transparency in political institutions among others.
- *Cultural*: some of the indicators include strengthened indigenous systems and languages and improved dissemination of communities of culture [14, 15, 28].

To sum, this study has four main domains reflected in the Proposed Research Framework which include: telecentre services/ICTs, empowered individuals, mechanisms for empowering communities; and community empowerment. The focus on this will help understand how individuals empowered by telecentres empower their communities.

## 4 Methodology

The study adopts an interpretive qualitative approach [18] to understand subjective experience on the role of telecentres in empowering rural communities. Moreover, in order to understand the 'How' problem as is the case in this study, qualitative methodology is appropriate [58]. Currently, discussions are taking place with two telecentres in Malawi whereby the users of the telecentres who have had impact on their communities will be identified to participate in the study. The study is being conducted in Malawi because it is one of the developing countries where telecentres are

being established to reduce digital exclusion. The study targets users empowered by telecentres, in-direct beneficiaries such as families and friends of users, managers, and key informants, especially leaders within the communities served by the selected telecentres and Malawi Communications Regulatory Authority (MACRA) officials who are responsible for implementing telecentres in Malawi as study participants.

The study adopts individual interviews, focus groups, and observations as data collection methods. Preliminary interviews will be conducted with telecentre managers. Furthermore, early 2019, we will conduct focus groups and individual interviews with purposively selected users of the two telecentres will be interviewed. The Most Significant Change [30] technique will be employed to some of the purposively chosen participants. For example, the users who are empowered by the telecentres would be asked to indicate the most significant change in their participation aiming at bringing social or political change resulted from using the telecentres. Key informants such as leaders within the community and MACRA officials will also be interviewed to get their views on how users have empowered their respective communities. In-direct beneficiaries such as users' families, friends and colleagues will also be interviewed. The interviews will be useful in getting in-depth individual information. We plan to conduct 50 interviews. In addition, observation will be done with at least 10 purposively chosen users. One of the researchers will spend at least a week with each of the purposively chosen users through 'living with them' in their communities, learning their life to ably understand how they empower their communities.

The study adopts Gioia method for data analysis [10, 16], using Nvivo software for data analysis. This involves identifying first order codes from the participants data; followed by identifying themes in the first order quotes and labelling the themes; and finally aggregating dimensions and building the relationships in the aggregate dimensions which later form a theory [10, 16].

## 5 Preliminary Findings

At the time of writing, contacts with two telecentre managers have been made with an aim of selecting two cases for the study. Through the preliminary telephone interview with one of the telecentres manager, it was found that some users have been able to empower rural communities. For example, after obtaining computer literacy skills, individuals gained confidence such that they have been able to write proposals leading to formation of organisations within the community. For example, the users have formed Prison Fellowship Malawi, an organisation which targets the ex-convicts to be transformed and responsible community members. It is envisaged that more data will be collected early 2019 from users, managers and key informants as already stated above, which will be presented at the conference.

## References

1. Ahmad, M.S., Talib, N.B.A.: Analysis of community empowerment on projects sustainability: moderating role of sense of community. *Soc. Indic. Res.* **129**(3), 1039–1056 (2016)
2. Aji, Z.M., Yusof, S.A.M., Osman, W.R.S., Yusop, N.I.: A conceptual model for psychological empowerment of telecentre users. *Comput. Inf. Sci.* **3**(3), 71–79 (2010)
3. Alampay, E.: Beyond access to ICTs: measuring capabilities in the information society. *Int. J. Educ. Dev. ICT* **2**(3), 4–22 (2006)
4. Alao, A., Lwoga, T.E., Chigona, W.: Telecentres use in rural communities and women empowerment: case of Western Cape. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017. IAICT*, vol. 504, pp. 119–134. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_11](https://doi.org/10.1007/978-3-319-59111-7_11)
5. Attewell, P.: Comment: the first and second digital divides. *Sociol. Educ.* **74**(3), 252–259 (2001)
6. Baron, L.F., Gomez, R.: Relationships and connectedness: weak ties that help social inclusion through public access computing. *Inf. Technol. Dev.* **19**(4), 271–295 (2013)
7. Chiessi, M., Cicognani, E., Sonn, C.: Assessing sense of community on adolescents: validating the brief scale of Sense of Community in adolescents (SOC-A). *J. Community Psychol.* **38**(3), 276–292 (2010)
8. Chilimo, W.: Information, communication technologies, & sustainable livelihoods: a case of selected rural areas of Tanzania. Doctoral Dissertation, University of Kwazulu-Natal (2008)
9. Cicognani, E., Mazzoni, D., Albanesi, C., Zani, B.: Sense of community and empowerment among young people: understanding pathways from civic participation to social well-being. *Voluntas* **26**(1), 24–44 (2015)
10. Corley, K.G., Gioia, D.A.: Identity ambiguity and change in the wake of a corporate spin-off. *Adm. Sci. Q.* **49**(2), 173–208 (2004)
11. Dasuki, S.I., Abbott, P., Azerikatoa, D.: ICT and empowerment to participate: a capability approach. *Inf. Dev.* **30**(4), 321–331 (2014)
12. Faroqi, M.G., Siddiquee, N.A.: Impacts of telecentre on users: the experience of the Union Digital Centre in Bangladesh. In *Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance*, pp. 149–156 (2017)
13. Gamage, P., Halpin, E.F.: E-Sri Lanka: bridging the digital divide. *Electron. Libr.* **25**(6), 693–710 (2007)
14. Gigler, B.S.: Including the excluded-can ICTs empower poor communities? Towards an alternative evaluation framework based on the capability approach. In: *Paper for 4th International Conference on the Capability Approach*, 5–7 September 2004. University of Pavia, Italy (2004)
15. Gigler, B.S.: Informational capabilities-the missing link for the impact of ICT on development (2011). [https://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=2191594](https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2191594). Accessed 10 Apr 2018
16. Gioia, D.A., Corley, K.G., Hamilton, A.L.: Seeking qualitative rigor in inductive research: notes on the Gioia methodology. *Organ. Res. Methods* **16**(1), 15–31 (2013)
17. Gomez, R., Fawcett, P., Turner, J.: Lending a visible hand: an analysis of infomediary behavior in Colombian public access computing venues. *Inf. Dev.* **28**(2), 117–131 (2012)
18. Gray, D.E.: *Doing Research in Real World*. Sage, London (2013)
19. Grunfeld, H.: The contribution of Information and Communication Technologies for Development (ICT4D) projects to capabilities, empowerment and sustainability: a case study of iREACH in Cambodia, Ph.D. thesis. Victoria University, Melbourne (2011)

20. Hatakka, M., De, R.: Development, capabilities and technology: an evaluative framework. In: Proceedings of the 11th International Conference on Social Implications of Computers in Developing Countries, Kathmandu (2011)
21. Hatakka, M., Andersson, A., Grönlund, Å.: Students' use of one to one laptops: a capability approach analysis. *Inf. Technol. People* **26**(1), 94–112 (2013)
22. Ibrahim, Z., Ainin, S.: The influence of malaysian telecenters on community building. *Electronic J. e-Gov.* **7**(1), 77–86 (2009)
23. Itzhaky, H., York, A.S.: Empowerment and community participation: does gender make a difference? *Soc. Work Res.* **24**(4), 225–234 (2000)
24. Khan, F., Ghadially, R.: Empowerment through ICT education, access and use: a gender analysis of Muslim youth in India. *J. Int. Dev.* **22**, 659–673 (2010)
25. Kabeer, N.: Resources, agency, achievement: reflections on the measurement of women's empowerment. *Dev. Change* **30**(3), 261–302 (1999)
26. Kleine, D.: ICT4WHAT?—Using the choice framework to operationalise the capability approach to development. *J. Int. Dev.* **22**(5), 674–692 (2010)
27. Laizu, Z., Armarego, J., Sudweeks, F.: The role of ICT in women's empowerment in rural Bangladesh (2010). <http://researchrepository.murdoch.edu.au/id/eprint/4342/>. Accessed 03 Aug 2018
28. Laverack, G.: Using a 'domains' approach to build community empowerment. *Commun. Dev. J.* **41**(1), 4–12 (2005)
29. Laverack, G., Wallerstein, N.: Measuring community empowerment: a fresh look at organizational domains. *Health Promot. Int.* **16**(2), 179–185 (2001)
30. Lennie, J.: The most significant change technique. A manual for M&E staff and others at Equal Access. Equal Access, São Francisco (2011)
31. Leung, L.: User-generated content on the internet: an examination of gratifications, civic engagement and psychological empowerment. *New Media Soc.* **11**(8), 1327–1347 (2009)
32. Mamba, M.S.N., Isabirye, N.: A framework to guide development through ICTs in rural Areas in South Africa. *Inf. Technol. Dev.* **21**(1), 135–150 (2015)
33. Mannarini, T., Talò, C., Gelli, B.: Sense of community, empowerment and social action: an analysis across political orientations. *Psicología Política* **48**, 7–24 (2014)
34. Minkler, M., Wallerstein, N.: Improving health through community organization. In: *Community Organizing and Community Building for Health*, pp. 26–51 (2005)
35. Mullins, L.J.: *Management and Organisational Behaviour*, 8th edn. Pearson Education Limited, Essex (2007)
36. Nielsen, J.: Digital divide: the 3 stages (2016) <https://www.nngroup.com/articles/digital-divide-the-three-stages/>. Accessed 15 June 2018
37. Nkhoma, P.: Understanding child prostitution in Malawi: a participatory approach. Doctoral dissertation, Durham University (2017)
38. O'Bryant, R.L.: Low-income communities: technological strategies for nurturing community, empowerment and self-sufficiency at a low-income housing development. Doctoral dissertation, Massachusetts Institute of Technology (2003)
39. Ohmer, M.L.: Citizen participation in neighborhood organizations and its relationship to volunteers' self-and collective efficacy and sense of community. *Soc. Work Res.* **31**(2), 109–120 (2007)
40. Osman, M.A., Tanner, M.: The influence of telecentre components on the psychological empowerment of underserved community members in the Western Cape, South Africa. *Electron. J. Inf. Syst. Dev. Ctries.* **81**(1), 1–29 (2017)
41. Peterson, N.A., Hughey, J.: Social cohesion and intrapersonal empowerment: gender as moderator. *Health Educ. Res.* **19**(5), 533–542 (2004)

42. Peterson, N.A., Lowe, J.B., Aquilino, M.L., Schneider, J.E.: Linking social cohesion and gender to intrapersonal and interactional empowerment: support and new implications for theory. *J. Community Psychol.* **33**(2), 233–244 (2005)
43. Petrič, G., Petrovčič, A.: Individual and collective empowerment in online communities: the mediating role of communicative interaction in web forums. *Inf. Soc.* **30**(3), 184–199 (2014)
44. Reimer, B.: *Understanding and Measuring Social Capital and Social Cohesion*. Canadian Rural Restructuring Foundation, Concordia University, Montréal (2002)
45. Rega, I., Vannini, S., Fino, E., Cantoni, L.: Exploring the meanings of community multimedia centers in Mozambique: a social representation perspective. *Inf. Technol. Int. Dev.* **9**(4), 35–54 (2013)
46. Rissel, C.: Empowerment: the holy grail of health promotion? *Health Promot. Int.* **9**(1), 39–47 (1994)
47. Robeyns, I.: The capability approach: a theoretical survey. *J. Hum. Dev.* **6**(1), 93–117 (2005)
48. Selwyn, N.: Reconsidering political and popular understandings of the digital divide. *New Media Soc.* **6**(3), 341–362 (2004)
49. Sen, A.: *Development as Freedom*. Oxford University Press, Oxford (1999)
50. Shank, D.B., Cotten, S.R.: Does technology empower urban youth? The relationship of technology use to self-efficacy. *Comput. Educ.* **70**, 184–193 (2014)
51. Speer, P.W.: Intrapersonal and interactional empowerment: implications for theory. *J. Community Psychol.* **28**(1), 51–61 (2000)
52. Speer, P.W., Jackson, C.B., Peterson, N.A.: The relationship between social cohesion and empowerment: support and new implications for theory. *Health Educ. Behav.* **28**, 716–732 (2001)
53. Spreitzer, G.M.: Psychological empowerment in the workplace: dimensions, measurement, and validation. *Acad. Manag. J.* **38**(5), 1442–1465 (1995)
54. Tabassum, G., Yeo, A.: Measurement of tangible and intangible impacts of telecentres on rural communities. Paper presented at the ICTD 2015, 15–18 May 2015, Singapore, pp. 1–4 (2015). <https://doi.org/10.1145/2737856.2737882>
55. Tabassum, G., Kulathuramaiyer, N., Harris, R., Yeo, A.W.: True value of telecentre contribution to Barrio community development. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017*. IAICT, vol. 504, pp. 640–653. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_52](https://doi.org/10.1007/978-3-319-59111-7_52)
56. Thomas, K.W., Velthouse, B.A.: Cognitive elements of empowerment. *Acad. Manag. Rev.* **15**(4), 666–681 (1990)
57. Uys, C.S.: *Framework for evaluation information technology in local communities*. Doctoral thesis, Cape Peninsula University of Technology, South Africa (2016)
58. Yin, R.K.: *Case Study Research Design and Methods*, 2nd edn. Sage Publications, Thousand Oaks (1994)
59. Zimmerman, M.A.: Psychological empowerment: issues and illustrations. *Am. J. Community Psychol.* **23**(5), 581–599 (1995)
60. Zimmerman, M.A.: Empowerment theory: psychological, organizational and community level of analysis. In: Rappaport, J., Seidman, E. (eds.) *Handbook of Community Psychology*, pp. 43–63. Kluwer Academic, New York (2000)



# Leveraging Digital Health Platforms in Developing Countries: The Role of Boundary Resources

Brown Msiska, Petter Nielsen<sup>(✉)</sup>, and Jens Kaasboll

Department of Informatics, University of Oslo, Oslo, Norway  
bmsiska@gmail.com, {pnielsen, jensj}@ifl.uio.no

**Abstract.** The pervasiveness of digital platforms has resulted in the emergence of digital health platforms addressing various health care needs globally. Digital platforms, typically, bring about an international division of labor between platform owners in developed countries where they are usually developed and platform consumers in developing countries leveraging them. In this relationship, boundary resources, such as documentation and application programming interfaces, are critical elements in the efforts to leverage digital health platforms in developing countries. This paper uses the case of the digital health platform DHIS2 in Malawi to elucidate and discuss the enabling and restricting roles played by boundary resources towards efforts leveraging digital health platforms in developing countries.

**Keywords:** Digital platforms · Digital health platforms · Boundary resources · Developing countries

## 1 Introduction

In the advent of platformization (Helmond 2015; Nieborg and Poell 2018), digital platforms are permeating into different spheres of modern life. Social media platforms such as WhatsApp, Instagram, Twitter and Facebook have transformed people's modes of interaction and sharing experiences. Mobile operating system platforms like Android and iOS have transformed the computing industry leading to an era of computing on the go. In the same vein, mobile payment platforms such as mPesa and Airtel Money are disrupting the financial industry in sub-Saharan Africa. Similarly, digital platforms at the heart of the sharing economy, such as Uber and Airbnb have, respectively, transformed the age-old transportation and hotel industries. Consequently, digital platforms have become an omnipresent research phenomena in the information systems (IS) landscape (de Reuver et al. 2018).

The term platform is used in diverse ways (Gawer 2009) and platforms can be digital or non-digital (de Reuver et al. 2018). Nevertheless, Baldwin and Woodard (2009), define platforms as modular systems comprising of a set of stable core components and a complementary set of variable peripheral components. Gawer (2009) further elaborates this perspective by stating that all platforms, digital and non-digital, share the same fundamental architecture comprising of a set of core components with

low variety and a complementary set of peripheral components with high variety, and taken together the low variety components are what constitutes the platform.

From this underlying perspective of a platform emerges the common understanding of what constitutes a digital platform. In line with this perspective, Tiwana et al. (2010) and later on Tiwana (2013) define a software platform as an extensible software-based system comprising of components and interfaces that work together to provide core functionality shared by complementary applications (or “apps” for short) that inter-operate with it through the said interfaces. Therefore, a software platform serves as a foundation on which outside parties, other than the platform owner, can build derivative and complementary products or services that often come in shape of applications.

An application, in this context, is an add-on software subsystem that connects to the software platform to extend its functionality (Tiwana 2013). Software platforms and their complementary applications are key elements of software ecosystems. A software ecosystem consists of a software platform, a set of complementary applications, a set of internal and external developers, a community of domain experts, and community of end-users whose needs are met by composing the software platform and application specific to it (Bosch and Bosch-Sijtsema 2010).

The pervasiveness of digital platforms has led to software ecosystems emerging as a dominant model for software development (Tiwana et al. 2010) and just like in other industries, digital platforms built for various purposes are emerging in health care (de Reuver et al. 2018), giving rise to what have been labelled *digital health platforms* or *e-health platforms* (Vassilakopoulou et al. 2017). As a result of this global trend, some existing e-health applications commonly used in developing countries, for example the District Health Information Software version 2 (DHIS2), have been subjects of platformization which has turned them from mere applications to digital platforms (Msiska 2018; Polak 2015). Leveraging (i.e., taking advantage of) existing digital health platforms such as DHIS2 affords developing countries the opportunity to save on the cost, time and effort required to implement e-health solutions.

Digital platforms fundamentally change the international division of labour by creating a new model of collaboration between developed and developing countries (Tatsumoto et al. 2009). A majority of contemporary digital platforms originate (or are developed) in developed countries and subsequently appropriated for use in developing countries. This potentially shifts the construction of finished products from platform owners in developed countries to platform consumers in developing countries (Tatsumoto et al. 2009). A similar observation is made by Dittich (2014) who labels platforms as “half-products” because they defer part of the effort required to compose a finished product to actors in the context where they are actually used.

While digital platforms come with the opportunity to build applications on top of them, local innovation does not come by itself. Boundary resources (Ghazawneh and Henfridsson 2013, 2010), have been identified as critical elements to innovations on top of digital platforms (de Reuver et al. 2018). This paper based on the case of the DHIS2 software platform in Malawi, a developing country in sub-Saharan Africa, explores the role of boundary resources in efforts leveraging digital health platforms in developing countries. In line with this, the paper addresses the question *in what ways do boundary resources facilitate the leveraging of digital health platforms in*

*developing countries?* The rest of the paper contextualizes boundary resources in the frame of generative collectives, presents the methodology used and the case, and winds up with a discussion and a few concluding remarks.

## 2 Generative Collectives and Boundary Resources

Notably, platform-centric software ecosystems are associated with a collective of human actors that includes, among others, platform owners, third-party developers, and end-users. In line with this observation, Osch and Avital (2010) define *generative collectives* as groups of people with shared interests whose mutual rejuvenating, reconfiguring, reframing, and revolutionizing acts drive creativity and innovation. The potential of such collective to generate innovations, with respect to the software platform, is referred to as *collective generative capacity* (*ibid.*).

Such collective capacity stems, in part, from the generative capacities of individuals making up the collective. In this respect, *generative capacity* denotes an individual's ability to produce something in a particular task-driven context (Avital and Te'eni 2009). In other words, generative capacity is a person's ability to engage in acts that lead to innovation or production of value in a given context (Osch and Avital 2010). With respect to a software platform, generative capacity can be used to denote the ability of an individual to leverage the platform as a basis for constructing applications as derivative innovations.

Hierarchically, Osch and Avital (2010) observe that collectives encompass a small esoteric community and a larger exoteric community, each consisting members of the collective sharing certain traits and interests. With respect to software ecosystems, the internal esoteric community is represented by the platform owners and the external exoteric community is represented by platform consumers at large. Implicitly, these two communities are separated by a boundary. Boundaries are a separation of two groups of people arising from differences in interests and identity (Wenger 2000). Boundaries, typically, constitute channels through which competences, experiences and resources are exchanged resulting in enrichment of generative capacities on either side. The ensuing exchange, according to Wenger (2000), is facilitated by three bridges: *boundary objects*, *boundary interactions*, and *brokers*, as described in the Table 1 below.

**Table 1.** Boundary bridges

1. <b>Boundary Objects:</b> artefacts, including tools and documents for example, that link or are shared by communities across a boundary
2. <b>Boundary Interactions:</b> events or encounters, for example visits and meetings, that provide direct exposure to members of another community
3. <b>Brokers:</b> human actors operating between communities and engaged in the import and export of competences, knowledge and resources



Since software platforms represent a division of labour between platform owners and platform consumers (Tatsumoto et al. 2009), they also necessitate the shifting of generative capacity between the two communities (Prügl and Schreier 2006; von Hippel and Katz 2002). Therefore, the bridges between communities within a software ecosystem as a collective – boundary objects, boundary interactions and brokers – can be instrumental in deriving insights with respect to this shift and help shape our understanding of potential implications for leveraging digital health platforms in developing countries.

In relation to this, Ghazawneh and Henfridsson (2010) define *boundary resources* as software tools and regulations, such as application programming interfaces (APIs) and software development kits (SDKs), that facilitate an arms' length relationships between platform owners and external actors leveraging software platforms to create derivative innovations. Through boundary resources platform owners allow external actors to exploit the platform to meet their needs (Karhu et al. 2018). In agreement with this, Eaton et al. (2015) observe that software ecosystems constitute distributed actors collectively leveraging boundary resources in their efforts to extract value from an underlying software platform. Therefore, boundary resources have the potential to play a significant role towards the leveraging of digital health platforms in developing countries.

### 3 Methodology

Empirical data on which this paper is based came from a case study (Myers 1997; Walsham 1995) focusing on efforts in Malawi leveraging the DHIS2 software platform carried out between 2015 and 2017. DHIS2 is a digital health platform developed under the Health Information System Programme at University of Oslo (HISP UiO) in Norway. HISP is a global action research project (Braa et al. 2004) made up of national and regional nodes across the world. Besides HISP UiO, other nodes in the project include HISP India, HISP South Africa, HISP Tanzania, HISP Malawi, HISP East Africa and HISP West Africa to name just a few.

Action research is a collaborative research where the researcher joins research subjects in efforts aimed at solving a problematic situation and conducts research while effecting change (Cornford and Smithson 2005). In this respect, the overarching aim of HISP is to strengthen health information systems in developing countries by using a participatory development approach (University of Oslo 2016). As part of HISP efforts in Malawi various interventions are being undertaken to strengthen the national health management information system leveraging DHIS2 as the underlying digital health platform.

The case study employed a qualitative approach anchored by an interpretivist paradigm (Orlikowski and Baroudi 1991; Walliman 2011). In interpretive case studies, data is usually collected through interviews complemented by observations, document reviews and web-based data sources such as emails, mailing lists and websites (Creswell 2009; Myers 1997; Walsham 2006). In this particular case study, empirical data was collected using interviews, participant observations, document reviews and web-based data sources.

Interviews involved staff from different stakeholder organizations involved in the efforts leveraging DHIS2 in Malawi. The key stakeholder organization around DHIS2 in Malawi is the Central Monitoring and Evaluation Division (CMED) under the country's Ministry of Health (MoH). Stakeholder organizations collaborating with CMED in this endeavor include, among others, HISP Malawi, Baobab Health Trust (BHT), University of Malawi, International Training and Education Center for Health (I-TECH), Luke International – Norway (LIN) and D-Tree International. Respondents for interviews were purposefully sampled (Creswell 2009) from these stakeholder organizations depending on their involvement with respect to the efforts leveraging DHIS2 in Malawi. Altogether, 25 respondents drawn from these organizations were interviewed.

Further data was collected through participant observations carried out with respect to various DHIS2 related interventions in Malawi. Such interventions included, for example, the DHIS2 reconfiguration and data migration project that was carried out between August 2015 and May 2017, the DHIS2 web applications development workshop in March 2016, the DHIS2 android applications development workshop in October 2017 and the mHealth4Afrika application development project between January 2015 and December 2017. Complementing interviews and participant observations, data was also collected using document reviews and web-based data sources such as the DHIS2 Malawi mailing list and websites for HISP UiO, HISP Malawi and MoH.

Data analysis in the study involved an iterative review of textual representations, for example transcripts and fieldnotes, of data collected. Thematic analysis (Braun and Clarke 2006; Maguire and Delahunt 2017; Vaismoradi et al. 2013) which involves assigning *codes* to segments of textual data as means to identify *themes* which would form the basis of interpretation (Walliman 2011) was employed as an analytical technique during the study. The outcome of this process was a corresponding coding structure from which interpretations could be elicited.

## 4 DHIS2 in Malawi

Efforts to leverage the DHIS2 digital health platform in Malawi commenced in 2009 as a pilot project in three districts: Blantyre, Zomba and Lilongwe. After three years of intermittent piloting, DHIS2 was rolled out to all the 28 districts of Malawi in 2012. As part of efforts to leverage the DHIS2 digital health platform in Malawi several key activities have been undertaken. These include, among others, deployment and regular updates of DHIS2 instances, creating custom data entry forms to preserve familiarity in transition from paper-based forms and development of new applications not readily available as part of the DHIS2 bundle. In these activities actors in Malawi have been interfacing with HISP UiO as the platform owner through various boundary resources. Such boundary resources are not limited to Malawi alone but other countries that form DHIS2 platform consumer community. At this point we use a frame composed of boundary objects, boundary interactions and brokers to highlight the various boundary resources we identified.

#### 4.1 DHIS2 Boundary Objects

In the DHIS2 ecosystem there exists different boundary objects that external actors in Malawi and other countries interface with. First among these are DHIS2 manuals. With each version of DHIS2, HISP UiO releases an end-user manual, an implementers manual and a developer manual to convey requisite knowledge to enable respective human actors leverage the platform. While the manuals are pivotal in global efforts leveraging DHIS2, the case in Malawi shows that, sometimes they are “*a source of problems if they are out of sync with their corresponding version*” [HISP Malawi, Technical Assistant].

Besides manuals, other key boundary objects, include APIs, an Android SDK, D2 Libraries, DHIS2 app stores and code repositories that enable development and distribution of apps by external actors. The state of these boundary resources determines their usability or readiness for use. For example, the Android SDK is, largely, still work in progress which means currently there is limited support for Android application development within the DHIS2 ecosystem except through the available APIs.

#### 4.2 DHIS2 Boundary Interactions

While leveraging the DHIS2 platform, actors in Malawi have had a wide range of boundary encounters with HISP UiO representatives. As a common tradition within the DHIS2 ecosystem, such boundary interactions include DHIS2 academies and workshops. DHIS2 academies are training events held within countries at both national and regional levels attracting participants from both the hosting country and other countries leveraging DHIS2.

In Malawi, boundary encounters have also involved various academic exchanges between the University of Oslo and institutions in Malawi. As part of efforts to leverage DHIS2 in Malawi, several PhD and masters students from Malawi have been trained at University of Oslo granting them an exposure to DHIS2 and bringing them into the HISP fold. These students have been critical in establishing a collective of expertise to support CMED and other stakeholders around DHIS2 in Malawi.

At the same time, several PhD students and master’s students from University of Oslo have undertaken various assignments around DHIS2 in Malawi. In addition to these, HISP UiO is offering internships to app developers from Malawi and Mozambique through a new agreement involving the University of Oslo (Norway), the University of Malawi (Malawi) and Eduardo Mondlane University (Mozambique). All these boundary encounters have been essential conduits for various expertise required to leverage DHIS2 in Malawi, and similarly other countries.

#### 4.3 DHIS2 Brokers

In addition to boundary objects and interactions earlier described, different human actors are deployed to serve as brokers of requisite capacity between HISP UiO and actors in Malawi and other countries leveraging DHIS2. Predominantly, these include

facilitators of DHIS2 academies and workshops. Apart from academy and workshop facilitators, researchers, including PhD and master’s students, at different times serve as brokers between HISP UiO and actors in developing countries leveraging DHIS2. Occasionally, this role has been undertaken by consultants engaged by HISP UiO or its collaborating partners.

These human resources crisscrossing the boundary between HISP UiO and stakeholders in Malawi play an essential role in mitigating capacity gaps and propagating requisite competences for DHIS2 in Malawi and, similarly, in other countries that are currently leveraging the platform. While endeavoring to establish adequate local expertise, CMED and stakeholders in Malawi, have intermittently been reliant on the boundary human resources engaged by HISP UiO. Through them there has been an import and export of knowledge, resources and competences related to DHIS2 between HISP UiO and stakeholders in Malawi.

### 5 Discussion

Taking examples from the case of DHIS2 in Malawi, described in Sect. 4 above, Table 2 below categorizes boundary resources according to their underlying role within the software ecosystem. In this regard, boundary resources either serve as means of building requisite capacity for leveraging the digital platform or means for developing complementary applications on top of the digital platform. This enables a demarcation between *capacity building boundary resources* and *software development boundary resources*. Drawing on the work of Ghazawneh and Henfridsson (2013) we propose an extended boundary resources model that captures both capacity building and software development boundary resources as illustrated below (Fig. 1).

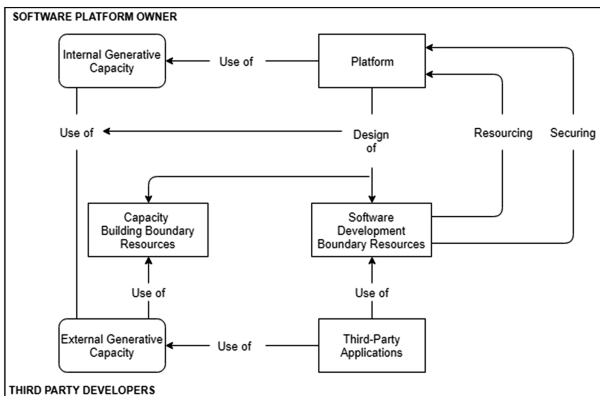


Fig. 1. Extended boundary resources model

**Table 2.** Summary of boundary resources in DHIS2 ecosystem and their roles

Resource	Form	Role	Resource category
DHIS2 academy or workshop	Boundary interactions	Capacity building	Capacity building boundary resources
DHIS2 manuals	Boundary objects	Capacity building	Capacity building boundary resources
Academy/workshop facilitators	Brokers	Capacity building	Capacity building boundary resources
DHIS2 APIs, libraries and SDKs	Boundary objects	Facilitating app development	Software development boundary resources

In this respect, software development boundary resources comprise of boundary objects, such as SDKs and APIs, that regulate and facilitate development of complementary applications on top of a digital platform (Ghazawneh and Henfridsson 2013; Msiska 2018). Capacity building boundary resources, on the other hand, comprise of boundary objects, boundary interactions and brokers deployed within a platform's ecosystem to facilitate propagation of generative capacity between platform owners and platform consumers at large. The implicit capacity shift that digital platforms introduce between platform owners and platform consumers (Prügl and Schreier 2006; von Hippel and Katz 2002) necessitates the existence of both software development boundary resources and capacity building boundary resources.

For developing countries, capacity building boundary resources are necessary to overcome age-old human capacity challenges which have been the cause of failure and unsustainability of health information systems in such countries (Kimaro and Nhampossa 2005). Therefore, to enable developing countries effectively leverage digital health platforms, software development boundary resources must be accompanied with appropriate capacity building boundary resources to facilitate the propagation of requisite human capacities.

For digital health platforms in developing countries, boundary resources serve as agents of technology appropriation – the taking of a piece of technology and making it one's own (Draxler and Stevens 2011). Drawing on the work of Ghazawneh and Henfridsson (2013), we suggest a platform appropriation model, depicted in Fig. 2. The model illustrates the complementary roles played by software development and capacity building boundary resources in relation to the appropriation of digital health platforms, and digital platforms in general, by platform consumers in developing countries. Applications required within context of use cannot be developed without relevant application development capacity. In addition to application development capacity, requisite capacities for leveraging digital health platforms also include: deployment capacity, customization capacity, usage capacity and system administration capacity (Msiska and Nielsen 2017). Hence, capacity building boundary resources play an essential role as conduits of these requisite capacities without which it would be difficult for developing countries to leverage digital health platforms despite the promises they hold.

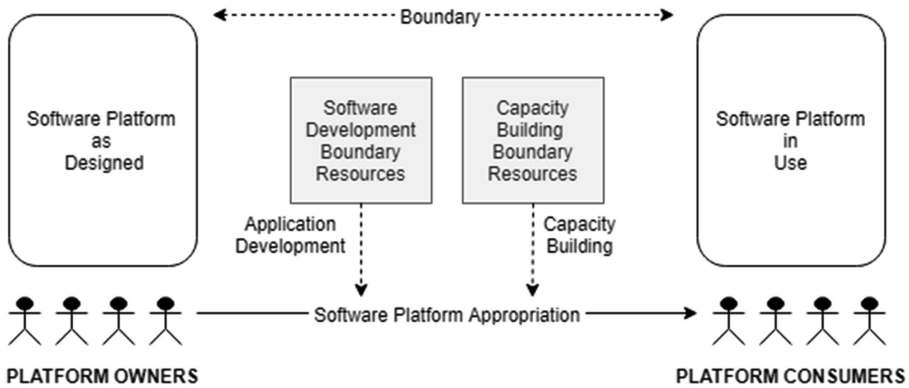


Fig. 2. Software platform appropriation model

Depending on their state boundary resources can act both as enablers or constraints towards appropriation of digital platforms in developing countries. In agreement with this, Ghazawneh and Henfridsson (2013) use the terms *resourcing* and *securing* to reflect the enabling and restricting roles of boundary resources. The extent to which developing countries can leverage digital health platforms hinges on the range of capacity building and software development boundary resources that come with such platforms.

## 6 Conclusion

The pervasiveness of digital platforms has seen them permeating several industries across the globe, including the healthcare industry. This has given rise to digital health platforms addressing different health concerns in both developed and developing countries. Digital platforms bring about an international division of labor between platform owners and platform consumers. In leveraging such platforms, boundary resources play a critical role. In this respect, using the case of DHIS2 in Malawi, this paper demarcates between software development and capacity building boundary resources which collectively aid the appropriation of digital health platforms in developing countries like Malawi.

Because of the inherent division of labour that comes with digital platforms, both capacity building and software development boundary resources are equally important. If any of these boundary resources are lacking it would be challenging for developing countries to take full advantage of the platforms despite the promises they hold. Consequently, the state of boundary resources provided can either enable or restrict various efforts in leveraging digital health platforms in developing countries. Therefore, platform owners must pay attention not only to the platform features but also the capacity building and software development boundary resources associated with the platform.

## References

- Avital, M., Te'eni, D.: From generative fit to generative capacity: exploring an emerging dimension of information systems design and task performance. *Inf. Syst. J.* **19**, 345–367 (2009)
- Baldwin, C.Y., Woodard, C.J.: The architecture of platforms: a unified view. In: Gawer, A. (ed.) *Platforms, Markets and Innovation*. Edward Elgar Publishing, Cheltenham (2009). <https://doi.org/10.4337/9781849803311>
- Bosch, J., Bosch-Sijtsema, P.: From integration to composition: On the impact of software product lines, global development and ecosystems. *J. Syst. Softw. SI: Top Scholars* **83**, 67–76 (2010). <https://doi.org/10.1016/j.jss.2009.06.051>
- Braa, J., Monteiro, E., Sahay, S.: Networks of action: sustainable health information systems across developing countries. *MIS Q.* **28**(3), 337–362 (2004)
- Braun, V., Clarke, V.: Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**, 77–101 (2006). <https://doi.org/10.1191/1478088706qp063oa>
- Cornford, T., Smithson, S.: *Project Research in Information Systems: A Student's Guide*. Macmillan International Higher Education, London (2005)
- Creswell, J.W.: *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage, Thousand Oaks (2009)
- de Reuver, M., Sørensen, C., Basole, R.C.: The digital platform: a research agenda. *J. Inf. Technol.* **33**, 124–135 (2018). <https://doi.org/10.1057/s41265-016-0033-3>
- Dittrich, Y.: Software engineering beyond the project – sustaining software ecosystems. *Inf. Softw. Technol.* **56**, 1436–1456 (2014). <https://doi.org/10.1016/j.infsof.2014.02.012>
- Draxler, S., Stevens, G.: Supporting the collaborative appropriation of an open software ecosystem. *Comput. Supported Coop. Work* **20**, 403–448 (2011). <https://doi.org/10.1007/s10606-011-9148-9>
- Eaton, B., Elaluf-Calderwood, S., Sørensen, C., Yoo, Y.: Distributed tuning of boundary resources: the case of Apple's iOS service system. *MIS Q.* **39**(1), 217–244 (2015)
- Gawer, A.: Platforms, markets and innovation: an introduction. In: Gawer, A. (ed.) *Platforms, Markets and Innovation*. Edward Elgar Publishing, Cheltenham (2009)
- Ghazawneh, A., Henfridsson, O.: Balancing platform control and external contribution in third-party development: the boundary resources model. *Inf. Syst. J.* **23**, 173–192 (2013). <https://doi.org/10.1111/j.1365-2575.2012.00406.x>
- Ghazawneh, A., Henfridsson, O.: Governing third-party development through platform boundary resources. In: *The International Conference on Information Systems (ICIS)*, pp. 1–18. AIS Electronic Library (AISeL) (2010)
- Helmond, A.: *The platformization of the web: making web data platform ready*. SAGE J.: Soc. Med. Soc. (2015). <https://doi.org/10.1177/2056305115603080>
- Karhu, K., Gustafsson, R., Lyytinen, K.: Exploiting and defending open digital platforms with boundary resources: android's five platform forks. *Inf. Syst. Res.* **29**, 479–497 (2018). <https://doi.org/10.1287/isre.2018.0786>
- Kimaro, H.C., Nhampossa, J.L.: Analyzing the problem of unsustainable health information systems in less-developed economies: case studies from Tanzania and Mozambique. *Inf. Technol. Dev.* **11**, 273–298 (2005). <https://doi.org/10.1002/itdj.20016>
- Maguire, M., Delahunt, B.: Doing a thematic analysis: a practical, step-by-step guide for learning and teaching scholars. *AISHE-J: All Ireland J. Teach. Learn. High. Educ.* **9**(3), 3351–3364 (2017)
- Msiska, B.: Cultivating third party development in platform-centric software ecosystems: extended boundary resources model. *Afr. J. Inf. Syst.* **10**, 348–365 (2018)

- Msiska, B., Nielsen, P.: A framework to assess and address human capacities needed to leverage open source software platforms in developing countries. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017*. IAICT, vol. 504, pp. 81–92. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_8](https://doi.org/10.1007/978-3-319-59111-7_8)
- Myers, M.: Qualitative research in information systems. *MIS Q.* **21**(2), 241–242 (1997)
- Nieborg, D.B., Poell, T.: The platformization of cultural production: theorizing the contingent cultural commodity. *SAGE J.: New Med. Soc.* (2018). <https://doi.org/10.1177/1461444818769694>
- Orlikowski, W.J., Baroudi, J.J.: Studying information technology in organizations: research approaches and assumptions. *Inf. Syst. Res.* **2**, 1–28 (1991). <https://doi.org/10.1287/isre.2.1.1>
- Osch, W., Avital, M.: Generative collectives. In: *ICIS 2010 Proceedings* (2010)
- Polak, M.: Platformisation of an open source software product: growing up to be a generative software platform. University of Oslo, Oslo (2015)
- Prügl, R., Schreier, M.: Learning from leading-edge customers at the Sims: opening up the innovation process using toolkits. *R&D Manag.* **36**, 237–250 (2006)
- Tatsumoto, H., Ogawa, K., Fujimoto, T.: The effect of technological platforms on the international division of labor: a case study of Intel’s platform business in the PC industry. In: Gawer, A. (ed.) *Platforms, Markets and Innovation*. Edward Elgar Publishing, Cheltenham (2009)
- Tiwana, A.: *Platform Ecosystems: Aligning Architecture, Governance, and Strategy*, 1st edn. Morgan Kaufmann, Amsterdam (2013)
- Tiwana, A., Konsynski, B., Bush, A.A.: Research commentary—platform evolution: coevolution of platform architecture, governance, and environmental dynamics. *Inf. Syst. Res.* **21**, 675–687 (2010)
- University of Oslo: HISP - Health Information Systems Project, Department of Informatics [WWW Document] (2016). <http://www.mn.uio.no/ifi/english/research/networks/hisp/>. Accessed 4 Oct 2015
- Vaismoradi, M., Turunen, H., Bondas, T.: Content analysis and thematic analysis: implications for conducting a qualitative descriptive study. *Nurs. Health Sci.* **15**, 398–405 (2013). <https://doi.org/10.1111/nhs.12048>
- Vassilakopoulou, P., et al.: Building national eHealth platforms: the challenge of inclusiveness. In: *ICIS 2017 Proceedings*. Presented at the ICIS 2017, p. 16 (2017)
- von Hippel, E., Katz, R.: Shifting innovation to users via toolkits. *Manag. Sci.* **48**, 821–833 (2002). <https://doi.org/10.1287/mnsc.48.7.821.2817>
- Walliman, N.: *Research Methods: The Basics*. Routledge, Abingdon (2011)
- Walsham, G.: Doing interpretive research. *Eur. J. Inf. Syst.* **15**, 320–330 (2006). <https://doi.org/10.1057/palgrave.ejis.3000589>
- Walsham, G.: Interpretive case studies in IS research: nature and method. *Eur. J. Inf. Syst.* **4**, 74–81 (1995). <https://doi.org/10.1057/ejis.1995.9>
- Wenger, E.: Communities of practice and social learning systems. *Organization* **7**, 225–246 (2000)





# ICT Enabled Peace Network: Case Study of Conflict Early Warning System in Kenya

Arunima Mukherjee<sup>1,2</sup>  and Festus Mukoya<sup>1</sup>

<sup>1</sup> University of Oslo, Oslo, Norway  
arunimam@ifi.uio.no, festusmukoya@gmail.com

<sup>2</sup> HISP India, Noida, India

**Abstract.** Building peace in post-conflict societies is a contemporary and urgent humanitarian challenge facing the world. ICTs can potentially play a role in this process, but how and why this can be done has not attracted adequate research attention, especially in the ICT4D domain which should naturally be at the forefront of such efforts. Drawing upon Castells' notion of counter-networks, this paper based on an empirical analysis of peace-building efforts in North-West Kenya, examines the role of ICTs in enabling effectively information flows to strengthen the efforts in building a "peace network." Important lessons are discerned on how such counter networks can be cultivated, and some reflections are presented on how these lessons may or not be applied to other conflict-ridden areas.

**Keywords:** Peace · Post-conflict · Early warning · Kenya

## 1 Introduction

Most countries that gained independence in 20th century have had difficult road to democracy and peace. Some of the reasons identified by various authors for this slow and difficult pace have been contradictions of colonialism and national oppression, undermining the indigenous groups and class [1]. This has later manifested into class, ethnic and social struggles, which people have used for peculation of democracy and their inclusion into political process. In Kenya, the road to democracy has been a long one. For example, it took 30 years after independence to drop ban on multi-party politics and make space for more people and indigenous groups to participate in state elections. And even today, the process of strengthening democracy is ongoing through constitutional amendments to address the ethnic nature of Kenyan society. The ethnic identity, like in many African countries, influences political and social behaviour, including who one trusts, does business with, gets married to and whom to vote for, [2]. Although it is argued that open elections can help mediate disputes among groups by installing broadly legitimate and accountable governments [2], when citizens vote primarily on the basis of identity (ethnicity, religion, class, etc.) other issues such as performance and accountability are put aside diminishing the value of democracy. Analysis of voting behaviour of 2007 Kenyan elections, which witnessed unprecedented levels of violence, based on aggregate data suggests that, since the introduction of multiparty democracy, opposition parties quickly splintered according to ethnic

groupings, and ethnicity became a dominant factor in explaining voting patterns and violent clashes [8, 11, 12, 14]. For instance, Oyugi [14] showed that ethnicity was the most defining factor of voting behaviour.

In this backdrop, there have also been community led initiatives to resolve conflict and build peace locally. Indigenous community process of peace have played pivot roles in resolving local conflicts and arresting any escalation of conflicts. Conflict early warning and early response has been a key strategy applied by community led initiatives to prevent violence [15]. Early warning consists of data collection, risk analysis, and providing information with recommendations to targeted stakeholders. Early response systems refer to timely and appropriate prevention interventions. Early warning and early response systems have been adopted by international organisations, bi-lateral agencies, research institutions and NGOs. Much of the literature available on examples of conflict early warning and early response systems comes from grey literature published by the organisations involved. Academic literature tends to focus on overviews and theoretical approaches to conflict early warning and early response systems rather than specific examples [4]. One such specific example is the CEWERS that is run by Free Pentecostal Fellowship in Kenya (FPFK). The CEWERS peace network has been running since 2012 and was introduced to help prevent electoral related violence for 2013 and continued to 2017. Though it might not be completely correct to attribute the peaceful elections of 2013 and 2017 to such a ‘peace network’, but role of these networks in long term conflict early warning and early response must be acknowledged. Understanding their role can create potential learning which can be taken to diffuse violence in other conflict-ridden areas.

Further, many of these peace building initiative are attempting to leverage upon the potential of ICTs to strengthen the peace building networks to help identify before the fact, indicators of violence, and initiate some form of response to diffuse the situation. A challenge in this process has been how to include community members who have been prior victims of violence into these peace building processes. Their prior experiences tends to leave them scarred, which inhibits their participation. Castells [3] has argued that to include such excluded groups into these “information networks” is crucial, as their exclusion will lead to their further and systematic marginalization. However, this process of inclusion is a non-trivial task for many reasons, not least their prior experiences. Drawing from Mosse and Sahay [10], we term this effort of building this inclusion as the creation of “counter networks”, the aim of this paper is to thus examine “the challenges and strategies of building peace (counter) networks and the role of ICTs in the process of conflict early warning and early response”.

The paper is organised as follows. In the next section, inspired by Manuel Castells we outline our conceptual approach to the study of communication and information flows, and analyse its role in the creation of “counter networks”. Following this, we provide some details of the context of the ethnic violence and conflict in Kenya; and discuss the process of formation of indigenous peace network, we describe the communication practices that surround the peace network. In the section that follows, we analyse the case study based on key concepts from counter networks and informational capabilities. This analysis helps to develop some implications for the implementation of ‘peace networks’ in post-conflict societies of developing countries. Finally, we draw some concluding remarks arising from the study.

## 2 Relevant Literature and Conceptual Perspective

This paper draws upon some of the ideas of Castells [3] in the analysis of this case. Castells is a contemporary sociologist who has written on a range of different topics ranging from globalization, identity, network society and the Internet. He has made an important analysis of the role of ICTs in current social dynamics leading to the articulation of the concept of information networks and related processes on how these are developed and maintained and their consequences. Another important point of difference in his writings is his focus on development problems situated both in developed and countries, and not treating it as an issue only relevant for the poor in developing countries.

Castells [3] has sought to understand some of the dialectical processes inherent in globalization. Some of these forces he has identified include inclusion and exclusion, and the net and the self where we both feel connected to the world while at the same time have questions about our identities. Castells ideas are optimistic, providing indicators on how to combat the exclusion and systematic marginalization many groups and regions experience in the contemporary world in conditions of globalization. He argues that while in the past, colonization took place by countries going into capturing other lands, in the contemporary world colonization takes place by countries not going to other places and excluding them. This in essence is his thesis of the network society that marginalized groups will only continue to get more and systematically marginalized if they don't become part of the network society and becoming an active part of it will help them to come out of this systematic marginalization trap. These social networks are a ubiquitous feature of developing countries. The 'role' of these social networks range between shaping social identity, to enhancing livelihoods, to strengthening social security and more.

Castells [3] argues that the presence of networks is a dynamic and powerful entity, and in our case we seek to understand its relevance in strengthening peace building efforts.

The network society in short, represents a structural configuration of a decentralized group of entities (rather than a hierarchy) who are linked through informational flows, like the stock markets globally connected through information flows on financial data. In Castells' writings, there is an implicit capacity of groups to join and participate in the network society. Mosse and Sahay [10] however argue against this assumption about participation, pointing out that Castells does not give adequate attention to how can groups which are marginalized, such as slum dwellers in cities or illiterate populations in rural areas, join the network society? To operationalize how these marginalized groups or organizations can join the network society, despite their constraining conditions, they coin the term of "counter networks". However, forming such networks is a non-trivial task requiring special efforts and capacities, which are counter to the general belief that we can plug and play in the network society.

Our conceptual framework thus seeks to understand the structure, processes and motivations of participating in the peace network, which we conceptualize as a counter network. We call it counter because it seeks to include marginalized groups in the peace building efforts who have inherent constraints in committing to their

participation. Next, we try to understand the role of ICTs and information in enabling their active participation. In our analysis, we are inspired by Castells argument that ICTs and information can be a key enabler in actively engaging in these networks, which can potentially be a vehicle for them to exit from their historical trap of systematic marginalization.

### 3 Research Approach

A case study design was applied in understanding the role of Conflict Early Warning and Early Response System (CEWERS) in strengthening the peace network in Mt. Elgon conflict in Kenya since 2017. The network of peace building initiatives and dialogue (peace network) brings various stakeholders including local communities, civil society organisations, police, security agencies and Humanitarian organizations together to respond to signs of violent indicators. The Peace Network was initiated by a local Faith Based NGO referred to as Free Pentecostal Fellowship in Kenya (FPFK). The CEWERS is being hosted and coordinated by FPFK. It has been successfully running since 2012 and it is still active and being expanded to other areas. The selection of this case study is based on its achievements as indicated in the unpublished evaluation report by Otieno [13]. Furthermore, one of the authors, a graduate in peace studies, and a staff at FPFK has been deeply engaged on the ground in the Mt Elgon region in Kenya and in the peacebuilding efforts for the last 9 years. He is an “insider” in this research process. The other author, with a background in ICT4D, is relatively an “outsider” in this research who since the last one year has been working with the other author, including making one field trip, to help make sense of the peace building efforts over time and in the design of the CEWERS. Together, these authors bring in a multi-disciplinary perspective that combines domain knowledge of peace building and ICT4D, and applies it in the analysis of this case.

The methods guiding this research can be classified as action research where both researchers are studying and trying to reflect and make sense of the implementation process of the peace building processes and the role of the ICTs in this. The insider researcher, as argued above, in enrolling community members in the peace network and mobilizing them to act in various activities such as early detection of indicators of violence and responding to this information. Together, they are working to understand the role of other project members who engaged in strengthening the peace network. We broadly subscribe to the action research approach of “networks of action” [21] which seeks to direct action efforts in creating linkages between different units engaged in similar development efforts, in our case related to peace building. As researchers, we reflect and draw upon the primary empirical work and also related literature to learn from other similar experiences to understand how it can help here. Understanding these peace building processes over time helps to discern both the mistakes and successes, on what works and what does not, and slowly try to make more general our principles and learnings of how to carry out such tasks in other settings, and also reflect on how we could do the same task better—with the advantage of hindsight.

Sources of data collection are varied, and mostly of informal nature such as meetings, training sessions, community dialogue sessions, and discussions with other

non-state actors. There have also been the use of formal methods of data collection such as participatory conflict analysis, indicator mapping, and project documentation, which are fundamental requirements in the design and development of the requirements for the early warning system. There have been formal presentations made to both the community and to our research colleagues in the university. Data analysis has been broadly interpretive in nature and can be seen as an ongoing process which is inextricably intertwined with data collection. For example, when presentations are made to the community, the feedback obtained helps us to reflect on our own understanding of the situation and make revisions as may be required. There have been various discussions, meetings and presentations to our colleagues in the university which has to develop in an iterative manner the theoretical learning from the case study.

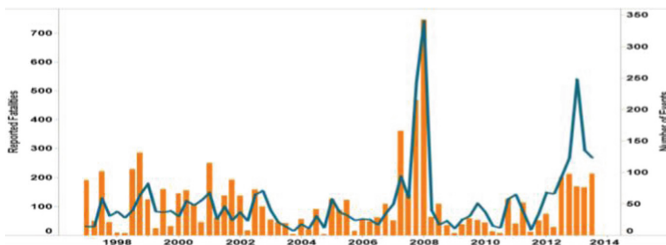
Since the study was introduced in an on-going case, the researchers observed all ethical guidelines especially by informing them about the research and their participation. They obtained informed consent from all participants, protected participants from harm, and ensured privacy.

## 4 Case Context

This section analyses the case context, which is Mt. Elgon sub county, Bungoma County in Kenya. The presentation provides an overview of the conflict situation in Kenya and going down to the specific contextual conditions in the study area.

### 4.1 Situation of Conflict in Kenya

Kenya experiences violent conflicts very often and increases during the electioneering periods. The violence manifests in the form of communal violence, militia activities and terrorism. According to the Armed Conflict report of 2015 (ACLED, 2015), Kenya is counted among most violent countries on the continent with over 3,500 recorded violent events between 1997 and 2015. Levels of violent events peaked in the three-month period of January to March 2008, [7] the quarter which also experienced the highest level of reported conflict fatalities (Fig. 1). Kenya experiences multiple, overlapping conflicts, which shape the nature of conflict and vulnerability of civilian populations in particular to violence.



**Fig. 1.** Reported fatalities associated with violent incidents in Kenya (Source: ACLED data 2015)

According to Fig. 1, the post-election violence that took place in January and February, 2008 was the highest recorded incidence of violence between the period of 1998 to 2014. The fighting resulted in 1,133 casualties, at least 350,000 internally displaced persons (IDPs), approximately 2,000 refugees, unknown numbers of sexual violence victims, and the destruction of 117,216 private properties and 491 government-owned properties including offices, vehicles, health centers and schools.

Initially, the violence was spontaneous and a reaction to the perceived rigging of the elections by the government. In areas like the Rift Valley and the Coast, members of the Kikuyu and Kisii communities (perceived to be associated with the PNU party and with President Kibaki) were targeted. In Nyanza and Western Kenya, the violence was mostly directed towards government facilities and gradually took the form of looting and destruction, and while it also targeted Kikuyus and Kisiis, the intention appeared to be not to kill them but rather to expel them and destroy their property. According to Human Rights Watch, the pattern of violence subsequently showed planning and organization by politicians, businessmen, village leaders and local leaders, who enlisted criminal gangs to execute the violence. This was particularly the case in Rift Valley and Nairobi.

The situation in Kenya began to stabilize towards the end of March 2008. As of July 2009, an estimated 61,000 IDPs remain in camps, transit sites and relocation sites. In addition, there were reports that ethnic gangs were rearming themselves with guns across the country in preparation for the next round of the 2013 elections.

People were displaced as a result of violence and threats of violence. They moved from their places of residence and business to places considered safe. Many lost means of livelihood, schools and their social support mechanisms. As always, violence too heavy toll on women and girls. According to the report by the Commission of Inquiry into the Post-Election Violence (CIPEV, 2008), sexual violence against women and girls took the form of individual and gang rapes, many of which were ethnically driven, as well as female and male genital mutilation. This official investigation into the violence documented cases of gruesome sexual violence, including genital cutting among women and forced circumcision among men and boys. There were instances in which families, including children were forced to watch their parents, brothers and sisters being sexually violated. Perpetrators of sexual violence were cited as ordinary citizens, gang members, and members of security forces. These already marginalised groups, were pushed further away.

## **4.2 Conflict Situation in Mt. Elgon Region**

Historically, there have been various violent conflicts in Mt Elgon region including in 1963, 1975, 1983, 1987, 1992, 1997, 2006 and post-election violence of 2007 and 2008. Violence had been ongoing from December 2006 following a dispute between the Soy and Mosop clans of Sabaot community over a government resettlement program being implemented in Mt. Elgon [20]. The crisis was fuelled by politicians and eventually a well-organized quasi-military outfit the Sabaot Land Defense Forces (SLDF) entered the scene. This well organized group which had good supply of arms and training has been blamed for majority of deaths in the area and for committing atrocities against the residents. Incidents of violence intensified during the closely

contested and disputed December 2007 elections, which have been described as the worst ever experienced. According to the Human Rights Report, the violence left about 600 people dead, over 84,000 people displaced and many human rights abuses inflicted on the local people. SLDF kidnapped, tortured, and raped men and women who opposed them or their political supporters, and kidnapped and tortured people who owned land that members of the militia coveted, forcing the owners to choose between mutilations or surrendering their property. They collected “taxes” from the population and they effectively ran a parallel administration, punishing civilians by cutting off their ears and sewing up their mouths if they defied the militia [6].

### 4.3 Initiation of Peacebuilding Interventions in the Region

During 2007/2008 violence, members of Peace and Rights NGO (referred here as FPFK) visited the IDP camps to offer psychosocial counselling and provide food and non-food items to families. During the counselling sessions, the victims were categorized based on age and sex. The women and other affected youths got the chance to narrate their ordeals during the violence. The affected children were categorized according to ages and classes and were taken through therapy using word games, drawing and storytelling. Members drew several things that communicated the nature of violence and their experiences. Many children played burning games where they demonstrated lighting bon fires and shouting the way militia gangs behaved. Others drew men carrying guns, houses burning, people running, others drew images of soldiers. The women, especially the widows narrated experiential stories during the violence. They were given the chance to share what they saw and witnessed. Some women told how their husbands disappeared long before the violence broke out. They mentioned that their husbands left homes three months or even earlier, and had never been seen again. This was confirmed by the Human Rights Watch Report [5]. For example one of the women narrated,

The children remember him. They ask, “*Where is our dad?*” ... *Sometimes, I don’t know what to tell them. I say, “Dad was taken by certain people ... and he wasn’t returned.” Until this moment, even I don’t know where he is. As I haven’t buried him, my thoughts trouble me.... I haven’t returned to our home. If I stay at home, I find myself wanting to call out to him.*

A lot of information was gathered concerning the experiences of the victims, some of whom had their ears chopped off as stated by one of them,

*I was coming from the market. They [the SLDF] stopped me and asked, “Do you want us to cut off your head or your ear?” ... Then they talked amongst themselves. I was silent while they cut off my ear.*

Some of the youths that escaped from the militia camps and were found in the camps also narrated their experiences during the operation. They told how they were abducted and used mutilate people and kill others.

Learning from these experiences, FPFK initiated a peace and human rights project in Mt. Elgon in January 2009. The project aimed at restoring trust, human dignity and peaceful co-existence among communities for enhanced development in the area. Their primary work focused on promoting peace through dialogue and mediations, rehabilitation and empowerment of militia groups and women, and promotion of indigenous

peoples' rights. This also included psychosocial rehabilitation of victims of violence including women, children and displaced persons. FPFK was also engaged with rehabilitation and reintegration of members of militia groups with their spouses and contribute to the restoration of mental health and economic status of widows associated with violent conflicts. They formed social support and peace groups to champion for peace and social justice in the area.

Another key activity was to build capacity of various members of the community to engage in peace processes. As a result, various peace structures were established like religious networks, councils of elders, professional bodies and various lobby and advocacy groups.

#### **4.4 Peace Network and CEWERS**

Noting the need for a strong civil society, FPFK, facilitated the formation of groups for women, youths, elders and mobilized the victims and perpetrators of violence into groups between 2009 and 2011. They were trained in lobbying and conducting advocacy for peace, conflict management with strong components of indicator mapping and monitoring, good governance in the context of devolution and the role of various security agencies including their leadership structures and sexual and gender-based violence. These members were registered with the government as legal entities and members provided with badges to identify them as community advocates and champions for peace.

The FPFK approached other NGOs and CBOs working in the region to join the 'peace network' and help expand it. Other new 'non-state members joined the peace network including the Kenya Red Cross, Handicap International, Mercy Corpse, Human Rights Watch, Catholic Peace and Justice Commission and various others. There was also the involvement of various 'state actors' such as the departments of health, child and women welfare, and internal security agencies including the police, the military and the government leaders at the county levels to strengthen coordination mechanisms. A combination of these various state, not state and citizen groups, together with the formation of mechanisms for coordination and engagement contributed to the establishment of the peace network. The FPFK was the defacto coordinating agency of the peace network.

Another important reason for inclusion of both state and non-state actors into the peace network was to better integrate components of 'response' and 'action'. Given that community members were now discussing and bringing upfront the cases of violations, it was important to link these to response mechanisms, so that the community member could associate 'value' by being part of the network. In 2012, the network expanded to cover other areas like Trans Nzoia, Bungoma North, parts of West Pokot and Turkana South. The expansion was motivated by the success of the Mt. Elgon network and the 2013 general elections that had largely been predicted to be likely more violent than the 2007/2008 elections.

In one of the meetings of the Peace Network, members raised the concern of victimization of the community members who reported the potential perpetrators of crimes and violence by the security agencies and the reported victims. It was agreed that in order to prevent violence, effective participation of the community members and



other stakeholders and communication among them was essential. The members emphasized the challenges related to communication among themselves, with the community, the security agencies and the government. Members were confronted with questions such as how can the community members be motivated to share information with the network and authorities without fear of being victimized? How can the relationship between the security agencies and the community members be improved? What is the role of the network and other non-state actors in preventing violence? How can information communication technology be used in prevention of violence?

In responding to these questions, the idea of application of ICT in violence prevention was born. Three locally based ICT specialists were incorporated in the brainstorming session around design. The project team presented to the ICT team the indicators and how they escalated towards violence. They were asked to conceptualize how a computer-based system could be used to share information in an anonymous way to the stakeholders by the community members. A technical working group was formed comprising of the conflict management practitioners and the ICT specialists to analyse the dialogue reports and extract all indicators. Participants in intra and inter community dialogues had pointed out that they were always aware whenever there were going to be attacks but when they reported these incidents to relevant authorities, they themselves became victims and the perceived victims became witnesses. This inculcated fear of reporting by the community members hindering the taking of interventions prior to the escalation of violence. It was also established from the participants that most community members were never aware of conflicts and even the indicators. They were caught unaware. The group made use of literature to refine the indicators that were validated during the training of surveillors. The indicators were coded by the system experts into Levels 0, 1, 2 and 3 respectively. At Level 0 and 1, these indicators were to signify peace and calmness. Level 2 was a bit serious and needed action while any Level 3 was treated as a serious indicator likely to trigger tribal clashes or chaos or any indicator that could cause serious security problems in an area. Response procedures were designed and responders identified.

#### **4.5 CEWERS Operations**

The early warning system enables sending and receiving simple SMS. The CEWERS has three main components:

1. Community volunteers – This comprises a team of trained community volunteers, who will send SMS whenever they notice any activity which could escalate into further violence. Their primary role is send data on the hot spot areas according to the identified indicators and relay the same to the analysis unit or the control room.
2. Communication unit – all SMSs are received in the computer/server installed here. Once the SMS are received, the messages are then manually forwarded to the stakeholders in the peace network to take action – these include both state and non-state actors.
3. Response team – comprise of all state and non-state actors. Once the analyzed reports are generated from the early warning section, they are forwarded to the response coordination unit.

4. The ICT enabled peace network has been working effectively in the region since 2012, and has gained immense credibility of all stakeholders – community, community volunteers and state/non-state actors.

## 5 Analysis and Discussion

After presenting a brief overview of a complex and ongoing peace building effort, in this section we draw upon Castells' notions of networks, information and counter networks to present our analysis. We do so by discussing the following questions.

### 5.1 Who are the Marginalised Groups and Why are they Marginalised?

In our case, the marginalised groups are victims of armed conflict and violence and are also first-hand affected by the consequences of violence. Members of the community, across ethnic groups, who have lost loved ones, livelihoods, and opportunities for wellbeing and safety. For example, a family who has not lost lives in the violence, but are starving because there is no food available, or the schools were damaged during the violence due to which the children lost precious schooling period. Though there have been state initiatives for mainstreaming the marginalised, by forming various village councils and committees etc., but given the deep rooted ethnic divide, the process of 'trusting' the state has been very slow and weak.

### 5.2 Why is it Difficult for These Marginalized Groups to Join the Information Networks?

Insecurity and uncertainty of 'peace' further aggravates their marginalisation, as it pushes their capability to 'gain' means for inclusion into the peace network. For example, unemployment is very high amongst the affected population as there are limited opportunities for work locally. There is the ongoing fear of violence and losing loved ones which stops families to send their menfolk outside the village to take up work. Also to add to this, lack of means and resources to travel out also limits the opportunities to participate in 'newer' networks.

However, there are also many strengths, most so the resilience of the members to withstand these violence incidents. This strength is also reinforced by the availability of a mobile phone in a household/family. Even though most of the phones are old feature phones, they serve as an important means to enable communication across members. It is also relevant to mention 'feature phone' as mostly members the 'big screen smart phone' is somehow understood as the default for 'mobile phone'. This availability of the phone has opened up windows of opportunity for them to connect to outside networks, which otherwise might have been tough. The individual agency of the community members to participate in the 'peace network' coupled with availability of the mobile phone, has given them the opportunity to leverage into the larger network of peace building extending beyond their immediate families and neighbours.

### **5.3 How have the Marginalised Groups Become Part of the Information Network?**

The peace network has helped to build a community of ‘volunteers’ and ‘community peace representatives’ in most villages effected by violence. They have become the primary source of information on the ‘peace situation’ in their respective areas, and have slowly become responsible to share information if they found anything contradicting their understandings or perceptions of a ‘peaceful situation’. This pivotal position have made them ‘primary’ in the peace network, even though they are part of the marginalised groups. In this case, small and simple ICT means enabled through the mobile phones, has given these people the tools to fight against their own marginalisation, and become members of the larger peace network. They have in this process also been able to ward off some of the threats of conflict and violence, which has been the source for their marginalisation. Hence, people have an ‘intrinsic’ value in becoming part of the network.

### **5.4 What have been the Determinants and Processes in Building the Counter Network?**

Our case demonstrates that an active counter network in the form of the “peace network” has been formed and is being strengthened over time. This network has been successful in mitigating violence in the region, as seen by the far fewer incidents of violence reported in the region post 2010. While there may be various contributing factors to this, we argue that the peace network has played an important and enabling role in this process. It thus becomes important to understand what have been some of the enabling conditions in terms of the structure and processes in creating this network.

**Structure:** In terms of the structure, a key feature of this peace network has been the membership of all relevant groups, including state, non-state and community. While top down state driven efforts often leads to the failure of such initiatives, the interesting point to note this network is coordinated by a local grass-roots NGO (FPFK) who is well-trusted in the community. The inclusion of relevant groups has been strengthened immensely by the engagement of groups that have historically been marginalized and who themselves are the victims of violence. Including them has been important as they are typically closest to the scene of violence, and are best placed to identify indicators of violence and send this information to actors like FPFK who are equipped to deal with the situation, either through direct intervention or by enrolling other members of the network, such as the security agencies, in engaging with the problem situation. The network is thus structured without a centre and a hierarchy, which has been conducive to enable rapid multi-faceted action.

**Processes:** The role of different processes can be seen as being vital in the creation and cultivation of this counter network. This includes; (i) identity formation – community members have been able to transform their identities from being “victims of violence” to “protectors of peace.” This transformation has been motivated by people’s intrinsic motivation to engage in this peace building process, as they have a direct stake in it – their livelihoods and the security of their families and loved ones is at stake; cultivating multi-faceted action – mitigating conflict and enhancing peace are complex processes, requiring multi-faceted action of creating indicators, collection and

transmission of relevant information to the right people, and by acting on this information. Structurally, the network includes different groups that play different roles – early detection, response, advocacy, coordination and capacity building. By ensuring that these different actors play their respective roles effectively, the peace network has become a relevant site for strengthening collective action which has helped achieve some of its peace building objectives; and, (ii) effectively harnessing the power of ICTs and information – no complex technologies have been used, only mobile phones which are anyway domesticated in the lives of people in the region. This phone allows the registration and transmission of relevant information in a timely manner to enable early detection of violence. Further, the CEWERS system allows for the consolidation of information, and also relays it to those most suited to affect response. The ICTs and information helps to not only bring the network members together, it also helps to execute collective action.

In summary, we can argue that the combination of people’s inherent interests and motivation, the structure of the network, and processes which have strengthened the “networks of action” have led to the creation of a robust and effective counter network – the peace building network.

## 6 Conclusion

Now that this counter network has been formed and is operational, two questions become relevant. One, how are these efforts to be sustained over time? Two, how can these networks be scaled to other regions which are similarly affected by violence and conflict? Both these questions have no simple answers?

With regard to the first question of sustaining, it can be seen that the success of the existing efforts of building peace should serve as a self-reinforcing mechanism for the existing members to continue the efforts. Having seen the benefits of peace on their own and their family lives, they will be motivated to carry on the efforts. However, as the situation of peace becomes stable and institutionalized, there may be the need to diversify their efforts into other domains of relevance – such as improving employment opportunities or strengthening community health. This may require in addition to FPFK other actors like health activists to also play more important and active role in strengthening the networks of action. As activities become diverse, complexity will heighten, This may require the need to reflect on the ICT solution and move towards something more substantial, such as of maintaining databases, activity specific dashboards, and integration with other systems and data sources. Bringing in these enhancements would be essential in continuing to leverage on the power of information.

With respect to the second question of scalability, it must be firstly noted that it is a bad idea to try and replicate the structure and processes as they are in other settings. As context is different, locally specific approaches would need to be designed, while however, continuing to build upon the positive learnings. These could be thought of as general principles, such as trying to build a network with people who have an intrinsic motivation in engaging with the processes. While recognizing that ICTs and information plays a central role in building the network, the particular solutions would need

to be designed to cater to the local conditions of infrastructure, capacities and to the particular problems that the systems is trying to support to address.

In conclusion, our paper has tried to make two key contributions. One, to bring the domain of peace building more in the mainstream of ICT4D research. Two, to demonstrate the value of Castells conceptualization of the network society and counter networks to the analysis of a complex socio-technical problem which is adversely affecting development processes in many parts of the world.

## References

1. Ajulu, R.: Kenya: the road to democracy (1992)
2. Burgess, R., Jedwab, R., Miguel, E., Morjaria, A., Padró i Miquel, G.: The value of democracy: evidence from road building in Kenya. *Am. Econ. Rev.* **105**(6), 1817–1851 (2015)
3. Castells, M.: *Power of Identity: The Information Age: Economy, Society, and Culture*. Blackwell Publishers Inc, New York (1997)
4. Haider, H.: *Conflict: Topic Guide*. Revised edition with B. Rohwerder. GSDRC, University of Birmingham, Birmingham (2014)
5. Human Rights Watch: *Hold your Hearts: Waiting for Justice for Mt. Elgon* (2011)
6. Human Rights Watch: *All The Men Have Gone. War Crimes in Kenya's Mt. Elgon Conflict* (2008)
7. International Crisis Group: *Kenya After the Elections. Policy Briefing 94*, Nairobi/Brussels (2013)
8. Kimenyi, M.S.: *Ethnic Diversity, Liberty and the State: The African Dilemma* (No. 12). Edward Elgar Publishing, Cheltenham (1997)
9. Merriam, S.B.: *Qualitative Research and Case Study Applications in Education*, 2nd edn. Jossey-Bass Publishers, San Francisco (1998)
10. Mosse, E.L., Sahay, S.: Counter networks, communication and health information systems. In: Korpela, M., Montealegre, R., Poulymenakou, A. (eds.) *Organizational Information Systems in the Context of Globalization*, vol. 126, pp. 35–51. Springer, Boston (2003). [https://doi.org/10.1007/978-0-387-35695-2\\_3](https://doi.org/10.1007/978-0-387-35695-2_3)
11. Muigai, G.: *Ethnicity and the renewal of competitive politics in Kenya* (1995)
12. Orvis, S.: Civil society in Africa or African civil society? *J. Asian Afr. Stud.* **36**(1), 17–38 (2001)
13. Otieno, S.: *Evaluation report of the violence prevention project* (2013)
14. Oyugi, W.O.: Ethnicity in the electoral process: the 1992 general elections in Kenya. *Afr. J. Polit. Sci./Revue Africaine de Science Politique* 41–69 (1997)
15. Rohwerder, B.: *Conflict early Warning and Early Response* (GSDRC Helpdesk Research Report 1195). GSDRC, University of Birmingham, Birmingham (2015)
16. Simiyu, R.: *Militarisation of resource conflicts: the case of land-based conflict in the Mount Elgon region of Western Kenya*. ISS Monograph No. 152, Institute for Security Studies, Pretoria (2008)
17. Stake, R.E.: *The Art of Case Study Research*. Sage, Thousand Oaks (1995)
18. Stake, R.E.: *Multiple Case Study Analysis*. Guilford, New York (2006)
19. Rausch, C.: *Trust: an essential ingredient in building peace, justice and security* (2012)
20. Wepundi, M., et al.: *Mt. Elgon Conflict: A Rapid Assessment of the Underpinning Socioeconomic, Governance and Security Factors* (2010)
21. Braa, J., Monteiro, E., Sahay, S.: *Networks of action: sustainable health information systems across developing countries*. *MIS Q.* 337–362 (2004)



# E-Commerce Institutionalisation in Mozambique: Enablers and Barriers

Fernanda Matsinhe and Salah Kabanda<sup>(✉)</sup>

Department of Information Systems, University of Cape Town,  
Cape Town, South Africa

fernanda.matsinhe@alumni.uct.ac.za,  
salah.kabanda@uct.ac.za

**Abstract.** Electronic commerce (e-commerce) has been widely discussed in academia and practice over the past years, however, its application in the specific context of women led small medium enterprises (SMEs) in developing countries has been scanty. This study aims to respond to this paucity by investigating the process of e-commerce institutionalization among women-led SMEs in Mozambican context. Using the Perceived E-readiness Model (PERM) as a sensitising lens and following an interpretive paradigm; the study identifies organisational and external factors that are perceived to be enablers and hindrances towards E-Commerce adoption and institutionalisation in women led SMEs.

**Keywords:** Electronic commerce (e-commerce) · Institutionalisation · Women-led SMEs

## 1 Introduction

Small and Medium Enterprises (SMEs) in developing countries are considered the prime providers of job opportunities. On the African continent, SMEs account for up to 50%–70% of employment opportunities [1] and are a key source of creativity that drives economic development of the continent. It is, therefore, not surprising that many governments, academics, donors, and development organizations are paying more attention and engaging in mechanisms to promote this category of business [2, 3]. One of the potential mechanisms is the usage of e-commerce by SMEs – which provides the potential for them to cope with some of the traditional barriers that hinder their professional growth, and consequently, reduce transaction costs, increase profitability, productivity and efficiency, and gain access to new markets [4].

Although these benefits to SMEs are well recognised, few studies have explored the use of e-commerce among women-led SMEs in developing countries despite the understanding that women-led SMEs, are beneficial from a social perspective and economic empowerment for women and their households [2, 5]. Women’s participation in economic activities not only reduces the likelihood of household poverty, but it also improves the distributional dynamics within the household and society because economically active women are more likely to reinvest their profits in their families and communities [5, 6]. With this backdrop as a rationale, and the fact that the United

Nations World Trade Organization identifies the need to ‘take forward the issues emerging in the discussion and the evolving application of e-commerce to enhance economic/development opportunities, with a special consideration of the situation in LDCs’ [7]; this study seeks to explore e-commerce institutionalisation in women led SMEs in LDCs and seeks to answer the question: What factors influence e-commerce institutionalisation in women led SMMEs in developing countries? This study is a response to authors [8, 9] who persistently called for additional studies that can provide a better understanding of contextual elements that affect e-commerce institutionalisation process in developing countries. This study is set in the context of a least developing country – Mozambique, where there is a scarcity of accurate ICT and e-commerce data and e-commerce adoption is still in its infancy stage and. In 2003, e-commerce activities were almost non-existent, and only very few enterprises - most of which were not owned by locals [10]. This has since improved substantially: e-commerce activities are now more common in large corporate entities and also some SMEs in the capital city, Maputo, which is relatively well supplied with telecommunication and Internet infrastructure [11]. To be considered an SME, the enterprise should have between 1 and 99 employees and record an annual turnover of less than 29 million Mozambican Meticaís [12]. The rest of the paper is structured as follows: Sect. 2, presents related work on E-Commerce, Sect. 3 illustrates the methods employed to carry out the study. Section 4 presents the findings and discussion thereof. Section 5 concludes the study.

## 2 Related Studies on E-Commerce Adoption in Developing Countries

E-Commerce is often characterized as a mechanism through which parties interact electronically to conduct business, regardless of their resources and constraints [13]. The adoption of e-commerce in Africa has been experiencing a serious growth spurt. However, its penetration is not evenly distributed; much of the success reported in the literature concerns only the biggest economies of the continent, such as Egypt, Kenya, Nigeria, and South Africa, [14, 15]. Other countries on the continent have been slower in their adoption process. This is not surprising as the continent is home to 33 of the world’s 48 Least Developing Countries (LDCs) [16]. LDCs are countries with very low national incomes facing several problems spanning low economic growth, high levels of unemployment, low income per capita, poor infrastructural development, and weak institutional capacity [17]. Given these contextual challenges, the factors affecting the adoption of e-commerce for these countries, and their counterparts, such as the biggest economies of the continent and other developing countries, could potentially be different. Understanding these differences is important for negotiating context specific solutions.

Molla and Licker [18] proposed the PERM model which gives an assessment of organisational and environmental readiness of an organisation for e-commerce adoption in a developing country context. According to the PERM model, organisational factors that hinder e-commerce adoption in developing countries include: the perception of e-commerce elements in the organization, availability of resources, management

commitment and the strategic and operational model that small businesses use to govern their business operations. Three main environmental barriers to e-commerce adoption and institutionalisation have generally been cited in literature: government's readiness to promote and support e-commerce, readiness of other members of the business ecosystem, such as consumers, suppliers, and competitors, to adopt e-commerce; and the existence, development and cost of support-giving industries such as telecommunications, finance, IT and others whose activities affect e-commerce initiatives in developing countries.

There are two categories reflecting the e-commerce maturity of an organisations: (1) organization in their initial adoption phase or entry-level adoption; and (2) those that have reached institutionalisation phase. The former reflects organisations that have considered E-Commerce but only connected to the Internet with email but no web-site or have a static website that publishes basic company information on the web without any interactivity. The latter reflects organizations whose extent of adoption accepts queries, e-mail and form entry from users; performs online selling and purchasing of products and services including customer service; and integrates organizational systems with suppliers, customers and other back office systems allowing most of the business transactions to be conducted electronically [18]. The PERM model and the maturity level of an SME will be used as a sensitising lens for this study when examining the e-commerce phenomenon in Mozambique.

### 3 Methodology

The study followed an interpretivism paradigm. SMEs were a purposively sampled, to allow for the selection of information-rich SMEs for study and specifically those that have gone through the experience of adoption and in some case institutionalised e-commerce. All SMEs that were selected were from Maputo - the capital city which has the highest urban population and concentration of SMEs in the country. It also functions as the central hub of the Mozambican economy, with most of ICT services and providers located therein. Initially, sixteen SMEs were originally contacted. Five of the contacted SMEs did not respond, and of those that did respond four were not suitable – two of them were not owned by Mozambicans and the other two had less than one year of establishment. Resulting in seven suitable SMEs that agreed to participate in the research. One of them was omitted from further analysis, due to providing incomplete information. Data collection with the remaining SMEs followed face-to-face semi-structured interviews that were informed by the PERM Model, seeking organizational and environmental eReadiness factors of SMEs to engage in Ecommerce activities. All the interviews were conducted by the first author in Portuguese, the official language of Mozambique. Thematic analysis was employed for analysis. First, the data was transcribed and then translated into English by the first author who is fluent in both languages – English and Portuguese. After transcription, the data went through a process of coding to identify emergent themes across the data corpus. Themes were identified by examining (i) recurrence of meaning; (ii) repetition of the same text/data; and (iii) text salient to the research topic.



## 4 Findings and Discussion

### 4.1 Demographic Findings

Six SMEs participated in the study as documented in Table 1. In terms of business size, 67% of the SMEs had less than 50 employees. Majority of the SMEs were in operation for 2–5 years, while only one operating for more than 20 years. The average age of the business leaders is 35 years old.

**Table 1.** Demographic details of SMEs

SME characteristics					SME owner characteristics		
Maturity stage	SME	Sector	Year established	No of employees	Education	Age	Marital
Interactive	SME D	Consulting	2010	60	Phd	45	Married
	SME E	Catering	1996	62	High school	50	Widow
Transitive	SME A	ICT	2010	17	BSc IT	29	Married
	SME B	Hair & beauty	2014	3	Msc Telecom	35	Single
	SME C	Retail	2014	12	Bsc	31	Married
	SME F	Fashion	2011	19	Bsc	23	Single

The high level of education level was a common characteristic among the women that led these businesses; with the exception of one of them (SME\_E), all of the women have completed higher education, with some having a post-graduate level. SMEs were categorized according to their level of e-commerce institutionalization, following Molla and Licker's [18] e-commerce maturity model for developing countries. None of the SMEs had reached an integrated stage, while four of them were in a transitive stage (SMEs with the capability of processing transactions online) and the other two just in an interactive stage (SMEs with basic capabilities, such as having a web presence accepting online queries form from users).

### 4.2 Emergent Themes

The findings show that six organisational and nine external factors are significant when it comes to adoption and institutionalisation of E-Commerce in women led SMEs in Mozambique.

#### 4.2.1 Organizational Context

##### (a) *E-commerce and related technologies in use*

SMEs in Mozambique use four types of technologies to conduct and fulfil their business transactions: the website, emails, mobile phone, and social media. Mobile phones were the common medium used by most SMEs because it was seen to be

particularly *useful and reliable to perform business functions. We can directly communicate with customers at any time or location* (SME\_F). Even SMEs that had reached transitive e-commerce maturity, mobile phones were still perceived to be the most effective means. According to these SMEs, the push was from their customers who often preferred mobile communication usually via a mobile phone call or texting service, specifically WhatsApp messages. For example, the manager of SME\_B estimates that only 15% of the total transactions are completed without a mobile phone call or email prior interaction. She explains: *“Customers have the habit of calling, email or send Facebook messages before finalizing any transactions. So after all the effort, money and time spend in providing a complete online experience; I realized that my customers still preferred to interact with me first, or see the product first before completing the payment”*. These findings are consistent with prior studies where e-commerce was perceived by SMEs to be a mix of a static website and mobile payment capability [19, 20]. Whilst the mobile phone seems to be the commonality amongst these findings; what differentiates the findings in the Mozambique context is in the use of the mobile phone. In this context, the mobile phone was not used to perform payments on transactions, despite the presence of mobile payment technologies such as M-Pesa, but solely for communication purposes. The most utilized methods of payments were bank transfers and cash-on-delivery *because mobile payment technologies cannot be found in every region here. There are some regions that have no such technologies* (SME\_A).

The use of social media was also widespread amongst SMEs and seen as a means to build relationship and trust with potential customers. The most common feature identified to be useful from social media was customer’s reviews about their products. This feature was perceived to be a marketing tool for their products as the manager of SME\_F explains: *“The customer usually leaves a message or a comment on the picture on Facebook saying that they like the dress. We, then give them my number of the contact, and we continue to communicate in private about price, size, fabric and other details”*. SME\_B has used the popularity of Facebook and Instagram to create a community of followers that would at a later stage become potential customers. By using such platforms, they were able to build and maintain a good relationship with the customer as she explains: *“My posts became so popular that everyone wanted to buy the products I used in my hair, we only sell products that we have already tried and tested”*. The value of social media to increase public awareness of e-commerce has been confirmed through the literature [21]. However, in this study, not all SMEs were enthusiastic about social media. For instances, SME\_D and SME\_E, which are mainly service providers did not perceive social media as an adequate channel to interact with their customers.

#### (b) *Manager characteristics and attitude*

One of the factors that differentiated how SMEs perceived E-Commerce and related technologies was age. SMEs led by relatively older women (SME\_D and SME\_E) were less knowledgeable and enthusiastic about more advanced forms of e-commerce. These SMEs were mainly at the interactive stage of E-Commerce whilst SMEs led by relatively younger women had advanced to the transitive maturity stage of E-Commerce. The implications therefore is that younger generations are more likely to

take risks and try new technologies than their counterparts [22]. Surprisingly, all owners-managers are well educated, with only the manager of SME\_E having the lowest qualification of a high school leaving certificate. Given that the SMEs were randomly selected, this is an interesting finding in a country where the percentage of the population with higher education is only one percent, and adult education levels among women are at a much lower rate than men [23].

(c) *Prior experience with E-Commerce*

It was observed that some of the women in the study had the opportunity to study or work abroad and these experiences shaped their decisions around E-Commerce. In most of the cases, the desire to mimic international e-commerce success stories was one of the main drivers to institutionalize e-commerce as SME\_C explains: *While I was studying in Brazil I use to buy everything online even groceries. It was all so convenient and easy, then made me realize that nothing similar was available in my country yet. So when we started I wanted to give my customers the same experience.*”. Given their experience with more advanced forms of e-commerce, these women were able to use their intellectual capital and experience to effect change in how they do business. This is consistent with Showunmi, et al. [24] who posits that women who have education, and possibly from a higher class have more sense of possibility and personal power than women who have not been provided with such opportunities.

(d) *High costs and E-commerce benefits inadequate for continued investment*

SMEs in this study report minimal benefits were realised from E-Commerce. SME\_F, had not updated their website since the time it was set-up because the revenue generated did not justify further investments: *“only clients from abroad buy through our website, and they are not so many. So we do not have money to do upgrades; people from here are more on Facebook, Instagram and WhatsApp, it is fine like that”*. At the time that the interviews occurred one of the SME\_A’s website was offline, the manager indicated that their security certificate was outdated due to lack of payment and they were looking for cheaper options. According to her *“It costs us more than 500 USD per annum for the security certificate, I am looking for alternatives, the number of sales completed through the website do not justify this cost.”*. SME\_B who usually maintains their websites lamented that: *“After all the effort, money and time spend in providing a complete secure online experience, I realized that my customers still preferred to interact with me first, or see the product first before completing the payment. it costs four to five times more to have a website hosted local than in an international domain, so I chose to save and host abroad”*. These findings are consistent with prior studies which suggest that cost is a barrier to E-Commerce and SMEs in Africa primarily use website for marketing purposes, even when transactional capabilities are available [25].

(e) *Lack of internal expertise*

One of the consistent claim from respondents was the lack of internal skill set to implement the e-commerce project. With the exception of SME\_A, the remaining SMEs used consulting firms for support and maintain their e-commerce applications within the organization. The manager of SME\_D explained that: *“IT is not our expertise, so we chose to subcontract all the IT services. And we assign someone to update the website and serve as the link of contact with the IT firm, however she also*

*has other duties in the company*". From prior studies, internal expertise has been shown to be a challenge for most SMEs.

#### 4.2.2 External Context

##### (a) *Institutional policies and legislation to support e-commerce*

There was a common perception amongst SMEs that there was limited and, in some cases, nonexistence support from government when it came to E-Commerce and related technology adoption. According to SME\_B, government intervention is very recent: *"After many people have lost their money with scams, and the police were not able to help, our lawmakers have finally enacted a law to regulate the online transaction"*. SMEs also considered the role of the government to encompass more than just to provide a legal framework for business conduct. Issues of financial assistance, provision of reliable network infrastructure, specific training on ICT/e-commerce, and reasonable Internet access costs were cited as important prerequisite for E-Commerce success. SME\_C manager explains: *"it is difficult to raise capital, to be honest we used our own money to start the business... to secure a leasing for the vehicles we used my husband assets as collateral. Otherwise I don't think we could have got a loan, banks here don't like to give loans to small enterprise...this is why we need financial assistance from the government"*. The role of the government's interventions in policy formulation, regulation, and facilitation of e-commerce has been well described in the literature and yet in the Mozambique context, government maintains a hands off policy by providing minimal support such as entrepreneurship training that is not specific to electronic use of ICTs and E-Commerce. Hu, et al. [26] see the "hands-off" policy approach not being appropriate for the contextual realities facing developing countries.

##### (b) *Financial institutions not ready for e-commerce transactions*

SMEs were of the view that supporting institutions and specifically banks were not well equipped to provide the necessary support for e-commerce such as providing secure and reliable methods of payment. SME\_C confirms *"can you believe that only BIM has direct payment online using EFT? Of all the banks, only they were able to provide even debit card payments. While this is already so common in other countries"*.

The manager of SME\_B reiterates on the lack of electronic and secure methods of payment: *"electronic banking? Not fully, the payment system is not fully automated in our banks. Only for credit cards, and very few people use credit cards"*. Due to these challenges, some websites only accepted credit cards, bank deposits or PayPal. However, credit cards are not widespread among the local customers. This is expected in a country with very low levels of financial inclusion, where 60% of adult population are financially excluded [27]. Given that mobile payments are not widely spread across the country, only 10% of the adult population makes use of mobile payments. The manager of SME\_E described how bank transfers added an extra burden to the process: *"majority of our customers make EFT transfers directly to our bank account. However, we take caution when receiving money from a different bank, there is a one or two days wait for the money to reflect in our account. In the past we had some unfortunate events and are unable to make the next stock pile payments"*. While direct bank transfers are not a dominant method of payment in the e-commerce literature [28], in the case of the

SMEs in this study bank transfers enabled them to fulfil their activities but also was perceived as a hindrance when recovering payment because for SMEs who usually face financial difficulties, any payment received is crucial in enabling their future transactions such as purchase of next supplies as pointed out by SME\_E.

(c) *Lack of transportation infrastructure and postal addresses*

The common grievances from SMEs was the lack of conducive physical infrastructure such as roads to deliver their customer's products and delivery addresses. Most of the SMEs only arranged delivery services for customers making large orders or living in the surrounding areas, as the costs associated with delivery are very high. The manager of SME\_E explains: *"There is no way I can deliver only one cake to a client in Matola, it is just too expensive and time-consuming. Because many neighborhoods don't have street numbers, our driver had to call and ask the client to direct him to his or her residence. We tried to do that for a while, but we are no longer doing it. We only deliver for enterprises, which are normally located here in the city...this now limits our target market"*. These results confirm other studies, in which lack of street names and postal numbers inhibited e-commerce development [13]. Whilst this remains a challenge, new evidence show that this can be addressed using for example couriers riding motorbikes, which are in constant contact by mobile phone with the customer until the delivery is completed [29].

(d) *Minimal ICT expertise professionals in the market*

SMEs reported scarcity of ICT firms and professionals with software development expertise in the country, as described by the manager of SME\_B: *"I did not find local providers able to implement all the technical features we wanted. I wanted the full package but I felt they were just wasting my time"*. However, it was noted that, SMEs that did not have e-commerce at the core of their business – SME\_D, SME\_E, and SME\_F – did present less complains about the services received by local firms.

(e) *Low customer purchasing power*

SMEs in this study reported minimal pressure from local suppliers and customers. Although there was demand from local costumers – particularly those living outside the capital Maputo– the market size was still perceived to be relatively small. In addition to the small market, customers were perceived to have a low purchasing power that is being exacerbated by the economic recession that is affecting the country since 2015 as SME\_A explains: *"2015 and 2016 were tough years for us and most small business, we were losing clients, we had to reduce or cut investments in various new projects, we just entered in surviving mode"*.

(f) *International suppliers and customers*

In some of the SMEs, business relationships with international partners helped to shape their e-commerce activities. For example, SMEs A, B, and F that have the majority of their suppliers outside of the country, felt more pressured to adopt modern ways of conducting business; whilst their counterparts with local suppliers and consumers did not have the same pressure. As outlined by SME\_D, some of their suppliers were so reluctant to modern business practices to the extent of only accepting cash payments: *"suppliers are an issue, only very few have a more practical approach. For the others,*

*we still have to go there by ourselves every time, some even don't accept POS, or electronic transfer, they want cash, it is a nightmare".*

(g) *Gender stereotypes*

All owner-managers were unanimous about the impact of societal gender stereotypes to their businesses. Nonetheless, it was noted that SMEs operating in sectors that are traditionally male-dominated faced more adversities. This was the case of SME\_A, SME\_C, and SME\_D, that described how they face prejudice when dealing with potential customers. This lack of confidence from business partners was perceived as detrimental for the business. To circumvent this obstacle, SMEs managers resorted to strategies such as: employing male business partners or working with their husbands. As SME\_D detailed: *'when I invited two former male colleagues as senior partners, previously closed doors suddenly opened'*. SMEs that operated in traditionally female-dominated industries acknowledged the practice but did not view it as a significant problem. These findings echo those in literature and show that socio-cultural expectation about the roles women play in a society further exacerbate these challenges [2, 30].

(h) *Bargaining and the need for feel and touch*

Suppliers and customers preferences have dictated the direction of e-commerce in the selected SMEs. Customer's push for face to face or mobile phone calls prior to making a transaction was common (SME\_B). For example, habits such as inspecting products or extensively discussing the service before payment, and the social connection created by physical shopping are difficult to emulate in an online environment. These customs have shaped the form of e-commerce being employed in most SMEs, which is based in one or a combination of mobile phone, e-mail, social media and website, and offline communication. These findings are consistent with those of other studies which suggest that some cultural practices do affect e-commerce adoption and institutionalisation [31].

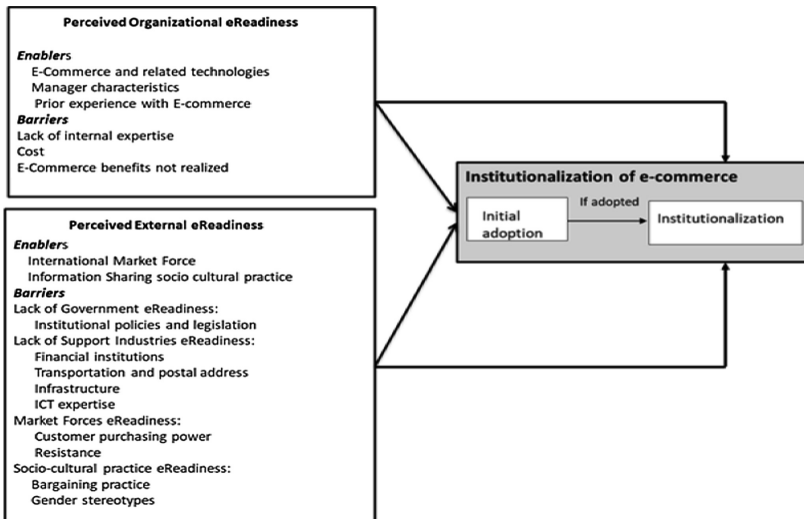
(i) *Information sharing*

The willingness to share information and advice is another feature in Mozambican social scenery that is perceived as beneficial for e-commerce. According to the interviewees, it is common to socialize with business partners to strengthen business relations, sharing information and even mentoring other women in business. For example, SME\_D runs a mentorship program for women in the informal sector, SME\_A and SME\_C often interact regarding business opportunities. This accords with previous literature [32] which states that in general women managers are more comfortable in disclosing information, engaging in informal conversations, and have a higher sense of collectivism. Taken together, these results highlight the importance of the social-cultural context to e-commerce. Entrenched social norms dictated the direction of e-commerce in many developing countries.

### 4.3 Summary of Findings

The findings of the study show that e-commerce in the Mozambique context is constrained and enabled by both organisational and environmental factors as shown in Fig. 1. What differentiates some of the findings in this study from previous studies, are some of the specific enablers and hindrance factors. Whilst most countries are now

using mobile payments as a means of facilitating electronic transactions, and consequently enabling e-commerce; findings in this study show that mobile payments were not a common practice for most SMEs because of the low penetration rate. The lack of mobile payments was therefore perceived as a hindrance towards e-commerce. Three unique enablers of e-commerce in this study were (i) the manager's prior experience with e-commerce; (ii) SMEs information sharing practice; and (iii) international market force. Being able to see how e-commerce worked and the benefits derived from it, gave these managers the aspiration of having E-Commerce institutionalised in their business. Prior experience in a developed country context was therefore a strong facilitator of manager's commitment towards E-Commerce institutionalisation. Instead of perceiving other SMEs as competitors, SMEs in this study were able to share their experiences. Information sharing amongst the various SMEs allowed them to share knowledge and become aware of new technologies that they could use to facilitate the growth of their business. In the absence of government support, these mentorship programs from other SMEs were perceived to be useful and enablers of e-commerce. Finally, it was evident that international suppliers and customer's pressure played a key role in ensuring SMEs were able to transcend to more mature forms of e-commerce. SME\_A, and SME\_B for example were able to very quick attain a transactional form of e-commerce through this interaction.



**Fig. 1.** Factors influencing E-Commerce adoption and institutionalization in Mozambique

## 5 Conclusion

The purpose of this study was to investigate the contextual factors that shape the process of e-commerce institutionalization in women-led SMEs in the Mozambique context. Following an interpretative paradigm, the findings identify organisational factors, specifically the manager's prior experience with e-commerce; and the SMEs information sharing practice as being enablers of E-Commerce adoption and institutionalisation. Further findings indicate that international market force, one of the environmental factors is an enabler whilst current government and supporting institutions were perceived as hindrances to E-Commerce. These findings extend the existing debate of e-commerce and use of ICT for development in LDCs by providing a better understanding of contextual factors affecting women led. This is particularly important because the literature on e-commerce in LDCs tend to be generalized while studies have shown that women in this context face a different set of challenges when conducting business. Furthermore, the study makes a great contribution to the scarce literature about e-commerce in Mozambique.

## References

1. Aremu, M.A., Adeyemi, S.L.: Small and medium scale enterprises as a survival strategy for employment generation in Nigeria. *J. Sustain. Dev.* **4**(1), 200 (2011)
2. Ritse, E.-E., Richard, H.: E-business adoption and use among African women-owned SMEs: an analytical study in Nigeria. In: *Proceedings of the Seventh International Conference on Information and Communication Technologies and Development*, Singapore (2015)
3. Vossenber, S.: *Women Entrepreneurship Promotion in Developing Countries: What explains the gender gap in entrepreneurship and how to close it* (2013)
4. Liu, L., Lin, A., Foster, J.: The role of e-commerce in the economic empowerment of women in China. Paper presented at the iConference (2016)
5. Kabir, N.: *Women's economic empowerment and inclusive growth: labour markets and enterprise development*. School of Oriental and African Studies, UK (2016)
6. Ahmad, S.Z., Muhammad Arif, A.M.: Strengthening access to finance for women-owned SMEs in developing countries. *Equal. Divers. Incl. Int. J.* **34**(7), 634–639 (2015)
7. United Nations Conference on Trade and Development (UNCTAD): *Information Economy Report 2015: Unlocking the Potential of E-Commerce for Developing Countries*. Information Economy Report (2015)
8. Tran, Q., Zhang, C., Sun, H., Huang, D.: Initial adoption versus institutionalization of e-procurement in construction firms: an empirical investigation in Vietnam. *J. Glob. Inf. Technol. Manag.* **17**(2), 91–116 (2014)
9. Miao, J.-J., Tran, Q.-D.: B2B E-commerce institutionalization in SMEs in less developed countries: a model and instrument. *Int. J. E-Adopt. (IJE)* **5**(4), 1–21 (2013)
10. Peña-López, I.: *SCAN-ICT. Indicators of Information and Communications Technologies* (2003)
11. Mabila, F.: Understanding what is happening in ICT in Mozambique. *Research ICT Africa* (2013)
12. Nhancale, B.: *Small and medium forest enterprises in Mozambique*, vol. 25. IIED (2009)



13. Boateng, R., Heeks, R., Molla, A., Hinson, R.: Advancing e-commerce beyond readiness in a developing country: experiences of Ghanaian firms. *J. Electron. Commer. Organ. (JECO)* **9** (1), 1–16 (2011)
14. Bwalya, K.J.: E-commerce penetration in the SADC region: consolidating and moving forward. In: *E-Business Managerial Aspects, Solutions and Case Studies*, pp. 235–253. IGI Global (2011)
15. Holm, A.E., Decreton, B., Nell, P.C., Klopff, P.: The dynamic response process to conflicting institutional demands in MNC subsidiaries: an inductive study in the Sub-Saharan African E-commerce sector. *Glob. Strat. J.* **7**(1), 104–124 (2017)
16. United Nations: *Global Sustainable Development Report*. United Nations (2015). <https://sustainabledevelopment.un.org/globalsdreport>
17. Cuervo-Cazurra, A., Genc, M.: Transforming disadvantages into advantages: developing-country MNEs in the least developed countries. *J. Int. Bus. Stud.* **39**(6), 957–979 (2008)
18. Molla, A., Licker, P.S.: eCommerce adoption in developing countries: a model and instrument. *Inf. Manag.* **42**(6), 877–899 (2005)
19. Wamuyu, P.K., Maharaj, M.: Factors influencing successful use of mobile technologies to facilitate E-Commerce in small enterprises: the case of Kenya. *Afr. J. Inf. Syst.* **3**(2), 2 (2011)
20. Kabanda, S.: “E-Commerce Institutionalization is not for us”: SMEs perception of E-Commerce in Tanzania. *Afr. J. Inf. Syst.* **3**(1), 1 (2011)
21. Jagongo, A., Kinyua, C.: The social media and entrepreneurship growth. *Int. J. Hum. Soc. Sci.* **3**(10), 213–227 (2013)
22. Agwu, E.M., Murray, P.J.: Empirical study of barriers to electronic commerce adoption by small and medium scale businesses in Nigeria. *Int. J. Innov. Digit. Econ.* **6**(2), 1–19 (2015)
23. Roby, J.L., Lambert, M.J., Lambert, J.: Barriers to girls’ education in Mozambique at household and community levels: an exploratory study. *Int. J. Soc. Welf.* **18**(4), 342–353 (2009)
24. Showunmi, V., Atewologun, D., Bebbington, D.: Ethnic, gender and class intersections in British women’s leadership experiences. *Educ. Manag. Adm. Lead.* **44**(6), 917–935 (2016)
25. Awiagah, R., Kang, J., Lim, J.I.: Factors affecting e-commerce adoption among SMEs in Ghana. *Inf. Dev.* **32**(4), 815–836 (2016)
26. Hu, Q., Wu, X., Wang, C.K.: Lessons from Alibaba. com: government’s role in electronic contracting. *Info* **6**(5), 298–307 (2004)
27. Demircuc-Kunt, A., Klapper, L., Singer, D., Ansar, S., Hess, J.: *The global finindex database 2017: measuring financial inclusion and the fintech revolution*. The World Bank (2018)
28. Huang, Z., Benyoucef, M.: From e-commerce to social commerce: a close look at design features. *Electron. Commer. Res. Appl.* **12**(4), 246–259 (2013)
29. Chiejina, C., Olamide, S.E.: Investigating the significance of the ‘pay on delivery’ option in the emerging prosperity of the Nigerian e-commerce sector. *J. Mark. Manag.* **5**(1) (2014)
30. De Vita, L., Mari, M., Poggesi, S.: Women entrepreneurs in and from developing countries: evidences from the literature. *Eur. Manag. J.* **32**(3), 451–460 (2014)
31. Kabanda, S., Brown, I.: Interrogating the effect of environmental factors on e-commerce institutionalization in Tanzania: a test and validation of small and medium enterprise claims. *Inf. Technol. Dev.* **23**(1), 59–85 (2017)
32. Maier, S., Nair-Reichert, U.: Empowering women through ICT-based business initiatives: an overview of best practices in e-commerce/e-retailing projects. *Inf. Technol. Int. Dev.* **4**(2), 43–60 (2007)



# The Influence of Telecentres on the Economic Empowerment of the Youth in Disadvantaged Communities of South Africa

Samkelo Lutho Booï<sup>1</sup> , Wallace Chigona<sup>1</sup> ,  
Priscilla Maliwichi<sup>1,2</sup> , and Khaya Kunene<sup>1</sup> 

<sup>1</sup> University of Cape Town, Rondebosch, Cape Town, South Africa  
salubooi@gmail.com, wallace.chigona@uct.ac.za,  
pmaliwichi@must.ac.mw, knnkha@myuct.ac.mw

<sup>2</sup> Malawi University of Science and Technology, Thyolo, Malawi

**Abstract.** We investigated how telecentres influence the economic empowerment of the youth in disadvantaged communities in South Africa and what factors affect their usage. For South Africa, the inequalities are greatly attributed to the apartheid government policy of segregating other races from major development activities. ICT is an enabler to development and may play a role in education, health and the economy. Interventions such as telecentres have the potential to deliver socio-economic benefits for people living in disadvantaged communities. Data for the study was collected through interviews with users of the Smart Cape and a privately-owned telecentre in Cape Town. The study used the Choice Framework as a theoretical lens. The study showed that (i) indeed the telecenters were aiding in empowering the youth living in disadvantaged communities (ii) the youth faced a number of personal, environmental and institutional challenges which limited their use and benefits from the telecenters. This research may help policymakers and project implementers on how to design and implement similar projects in future.

**Keywords:** Telecentre · Economic empowerment · Disadvantaged communities · South Africa · Youth · Choice Framework

## 1 Introduction

Economic challenges in South Africa are attributed mainly by inequality in the society [1]. Information and Communication Technology [ICT] is believed to play an important role in national development in areas such as education, health and economy [2]. ICT interventions are used to develop community ICT services in disadvantaged communities, for economic benefits, through participation in the global markets and citizens/government interaction [3]. One such intervention is the introduction of telecentres.

A telecentre is ‘a physical space that provides public access to [ICTs]’ [4, p. 73]. Telecentres have the ability to improve human skills that enable people to find jobs and consequently extend their financial capital [5]. Furthermore, telecentres may indirectly improve social capital for youth to interact and share knowledge and directly improve

capital assets. In addition, telecentres may contribute to empowerment of disadvantaged communities [6, 7].

There is a plethora of studies on the communal view of empowerment in disadvantaged communities. However, a particular concern is the level of youth unemployment and the inability of the education system to produce the skills required by the economy in sufficient numbers [8]. Existing empirical studies mostly evaluate and focus on the socio-economic influence of telecentres in disadvantaged communities as a whole. However, there is still a dearth of studies specifically focusing on the youth [6, 7, 9]. Most research on empowerment is adult-specific and does not specifically apply to youth [10]. Existing literature relates to the practical and theoretical approaches to youth empowerment that mirror adult issues, with some research relating to youth [10]. However, there are studies that refer to adolescent empowerment which demonstrate development and self-efficacy as determinants that may lead to empowerment [11].

We argue that youth living in disadvantaged communities can be economically empowered through the use of telecentres. Thus, the research questions for this study are:

- *What factors affect the usage of telecentres by the youth of disadvantaged communities in South Africa?*
- *How do telecentres contribute to economic empowerment of the youth in disadvantaged communities in South Africa?*

South Africa offers an interesting context for the study due to its level of ICT penetration relative to other African countries [12]. The country has one of the highest penetration rates in sub-Saharan Africa [12]. The study used Smart Cape and a privately-owned café. Data was collected through semi-structured interviews conducted at these telecentres. This research may help policymakers and project implementers on how to design and implement similar projects.

## 2 Literature Review

### 2.1 Disadvantaged Communities in South Africa

In the South African context, disadvantaged communities have a high level of informal settlements. The apartheid system is mainly blamed for the state of disadvantaged areas in South Africa. The apartheid system was designed to create ideological and judicial structures that ensured colour segregation amongst the people of South Africa [13]. The apartheid policy allowed only white people to live in city centre areas where most jobs were situated, whilst non-whites were forced to live in outlying areas, far from jobs [14]. Disadvantaged communities are an example of the post-apartheid effects such as poverty and unemployment which affect predominantly black people [15].

Disadvantaged areas are commonly known as townships. Townships are underdeveloped, usually [but not only] urban residential areas, which were reserved for non-whites [Africans, Coloured and Indians] who lived near or worked in areas designated for whites only during apartheid. The disadvantaged areas are identified by their low buying powers and poor quality of telecommunication infrastructure [16].

A large portion of households in the townships cannot afford technological devices such as laptops and cell phones [17].

South Africa has high crime rates, especially in major cities such as Cape Town [18]. Black townships have the highest crime rates in the country and most victims of crime in South Africa come from poor households located in townships [13].

## 2.2 Telecentres

Telecentres are physical centres that provide access to the public for communications, training and information services, using a variety of technologies including telephones, library services, phones, faxes and computers, as well as internet and email [19]. Telecentres were initially established to minimise the inaccessibility of rural and isolated locations to ICTs [20]. The aim of telecentres was to bring benefits of ICTs to support communities through economic, educational and social development [5, 16]. Telecentres were built with an aim to bridge the digital divide between urban and rural communities [5, 21].

Telecentres provide computer access to people who cannot afford their own personal computers; they have become support services for disadvantaged communities [16]. Telecentres offer several benefits such as improving human, financial, natural, physical and social capital, by enabling users to easily communicate [5]. There is abundant literature on telecentre ability to minimise the digital divide amongst rural and urban areas; for decades this has been believed to be, and is, one of the core benefits of having telecentres [5, 21]. There are many telecentres in developing countries; however, their usage is limited, especially for disadvantaged citizens [22].

## 2.3 Youth in South Africa

The term ‘youth’ means different things for different countries and organisations. It is used interchangeably with terms ‘young adults’ and ‘pre-citizens’ [10]. South Africa categorises youth as persons between the ages of 14 and 35 [11]. Of the total population of South Africa of 55.6 million, 20.1 million are classified as youth [23]. The current youth are born in a digital age and grow up using ICTs in their daily lives [24].

Youth unemployment in South Africa is high and rose drastically after 2008. Unemployment in South Africa affects youth, especially those who are classified as black, female and/or living in rural areas [25]. In an attempt to combat the shifting economic labour demand in South Africa, resources such as entrepreneurship development, computer access and training, and additional training skills are provided by organisations [25].

## 2.4 Empowerment

Empowerment is key to community development and enables individual self-confidence, self-direction, independence and self-worth [6]. There are multiple perceptions of empowerment and it is used in multiple disciplines, making it difficult to come up with a clear definition of empowerment that applies across disciplines [16]. Empowerment is the increase in an individual’s ability to make effective choices and

translate these choices into desired actions and outcomes [26]. Empowerment is also seen as a process that gives power to individuals or groups to make choices in their personal lives, communities and societies [27]. Empowerment is considered a multi-dimensional social method of enhancing the capacity of individuals or groups to make decisions and transform those choices into desired outcomes [27]. There are different dimensions of empowerment such as social, psychological, economic, cultural, information and political [28].

Economic empowerment entails:

- Improved access to markets
- Enhanced entrepreneurial skills
- Alternative sources of income
- Stronger productive sources
- Improved employment opportunities
- Improved income through [a] lower transaction costs, [b] reduced transport needs, [c] improved timeliness.

Economic empowerment is the promotion of people by giving them the right skills, competencies, resources and access to secure incomes and livelihoods [29]. Economic empowerment has a strong impact on poverty alleviation, growth and human development [30]. It may be achieved through the use of telecentres to seek employment and alternative opportunities [29]. Literature on economic empowerment is centred on four areas, namely, the promotion of assets of people, transformative forms of social protection, microfinance and skills improvement [31].

## 2.5 ICTs and Economic Empowerment

ICTs have the potential to empower by alleviating poverty and facilitating socio-economic improvements [7, 9, 32]. Use of ICTs helps people acquire skills, enabling resources and access to ensure and sustain revenue and livelihoods, to seek employment and additional opportunities [29]. Individuals with high educational resources and information are more likely to find it more easily to use the facilities to enhance their skills and gain more [26]. ICTs may provide economic empowerment by increasing the income of its community members through job creation, job opportunities, saving the community from travelling and lower transaction costs, allowing acquiring of job skills and supporting local businesses with provision of information on the markets [5].

A number of studies allude that telecentres' initial aim is to promote universal ICT usage in underserved communities and eventually empower individuals living in these communities, thus mitigating the digital divide [5, 21, 29]. There are many factors that inhibit telecentres from empowering individuals [22]. Empowerment does not only depend on the availability of telecentres but also includes components such as intrapersonal factors, interactional factors and behavioural factors to achieve a form of individual empowerment [6].

### 3 Theoretical Framework: Choice Framework

The study adopted the ‘Choice Framework’ by Klein [33]. The Choice Framework is based on the ‘Capabilities Approach’ by Sen [34]. The Choice Framework attempts to understand different elements of the development process and aims to view this process systematically [33]. The approach is defined as a process of expanding the real freedoms that people enjoy, leading the lives they have reason to value [26]. ‘Choice is both the aim and principal means of development’ [33]. The Choice Framework suggests that individuals have the ability, with the aid of their resource portfolios, to negotiate a social structure to attain, using appropriate choices, the development outcomes they wish to achieve [26]. The Choice Framework has four key components: development outcomes, degree of empowerment, agency and structure. Figure 1 illustrates the Choice Framework.

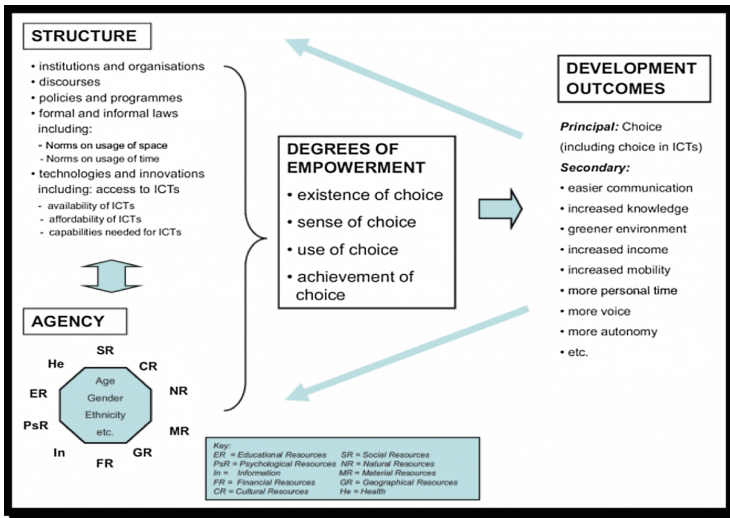


Fig. 1. The Choice Framework (Source: Klein, 2010 p. 680)

#### 3.1 Development Outcomes

The outcomes may be primary or secondary outcomes. The primary outcomes of a choice are the actual choice itself, while the secondary outcomes are considered based on an individual’s choice as to what they value in the lives they live [26]. Choice is considered to be the primary objective and depends on the kind of life an individual values.

Secondary outcomes of choice depend on an individual’s choice and the type of life they value. These outcomes include increased mobility and more voice. ICTs may prove to be a useful tool to achieve these outcomes. Other economic outcomes include ease of communication, increased knowledge and increased income.

### 3.2 Degree of Empowerment

Choice represents the degree of empowerment of an agency; this is a product of resources and structural conditions [34]. Degree of empowerment is composed of four categories: existence of choice, sense of choice, use of choice and achievement of choice. Table 1 summarises degrees of empowerment.

**Table 1.** Degrees of empowerment [Ojo, 2013]

Dimensions of choice	Description
Existence of choice	Describes whether various opportunities exist and are attainable for an individual, provided that their resources and their structural conditions allow it
Sense of choice	Entails an individual's awareness of possibilities that new technologies offer
Use of choice	Describes individual's usage of available choice
Achievement of choice	Is determined by matching of outcome and choice made

### 3.3 Agency

Agency talks about an object that has some abilities to use different resources that are inputs to achieving goals [34]. Agency has personal characteristics such as age, gender, ethnicity of an individual, in a given context, which may influence the scope and scale of resources. The resources may include educational, health, geographical, psychological, financial, natural, social, information, cultural or material resources.

To assess the degree of agency, it may be necessary to assess the resources which affect how telecentres empower the youth in disadvantaged communities. In this study, the youth may not be able to access ICTs due to geographical locations and financial resources, or due to limited education resources.

### 3.4 Structure

A structure has the ability to constrain or enable an agent in attaining their goals. The structure consists of formal and informal laws, rules, regulations, norms, customs, culture, access to technologies, policies and procedures [26, 34]. Elements within a structure have the ability to influence an individual's agency; these include dimensions such as the availability, affordability and capabilities that are needed to use the facilities effectively [26].

The framework enabled us to evaluate how different resources [agency] and structure affect the youth in their quest to achieve development outcomes. Successful economic empowerment of youth is dependent on the agency portfolio, structure and the type of choices the individual makes to attain that development outcome.

## 4 Study Context

The study used Smart Cape Access Project and Private Internet Café (PIC) telecentres. Smart Cape is a City of Cape Town initiative whilst PIC is privately owned. For ethical reasons we named the privately-owned café ‘PIC’.

The Smart Cape project was launched in 2001 with the aim of serving mainly disadvantaged communities in Cape Town. The project runs in almost all public libraries in the city [19]. Smart Cape provides free computer and internet access to individuals residing in the city [19]. To use the facilities, an individual has to register as a member of the library. Users are allowed 45 min of free access per day and a limited amount of Wi-Fi bundles per month.

The two centres used in this study are located in the townships of Khayelitsha and Mitchells Plain. Both centres are easily accessible to the public. The centres have between five and ten computers each. All computers are running on open-source operating systems.

PIC was established in 2004 and its main office is located in Cape Town. The organisation has a presence in the Western Cape, Eastern Cape and Kwa-Zulu Natal provinces. PIC has a range of services, including computer training courses, ICT support and telecentre services. The PIC centre used in this study is located in Khayelitsha Township. The center has 30 computers and all computers have proprietary operating systems and software.

## 5 Methodology

The study used a qualitative approach and adopted an interpretive philosophy. Empirical data for the study was gathered, using semi-structured interviews. The research strategy selected is the case-study approach where an in-depth inquiry into the topic within a real-life setting was made.

### 5.1 Target Population and Sample

Youth who have lived or are living in disadvantaged communities and use the telecentres were the target population. The youth age group was between 18 and 34. The youth could be unemployed, working or studying at any educational institution. We also targeted telecentre management since they could potentially provide vital information on telecentre usage and opinions on the benefits that telecentres bring. The sample of the study consisted of 18 participants. Since it is challenging to determine that an individual is financially disadvantaged, all youth who used the telecentres in the disadvantaged communities were considered. The research used purposive sampling [35].

Data was collected in June 2017 (eight respondents) and July 2018 (ten respondents). This was done to obtain a diverse data for the study.



## 5.2 Data Collection and Analysis

We adopted face-to-face semi-structured interviews. The interview questions were based on the constructs of the Choice Framework. All interviews were recorded and notes were made available to respondents for validation. The interviews took between 30 and 60 min long each. The researchers used thematic analysis to organise and analyse the data.

## 5.3 Ethical Consideration

Permission was obtained from Smart Cape and PIC. For ethical reasons, the identities of the respondents were hidden. We gave code names from one to eighteen, using prefix *Resp1* to mean respondent number one and *Man7* to mean manager number seven. ‘Man’ is a prefix we gave to a library assistant we interviewed at Smart Cape telecentre.

# 6 Findings

## 6.1 Demographics of Respondents

Table 2 summarises the demographic profile of the respondents.

**Table 2.** Profile of research participants [N = 18]

Ages	Gender	Occupation	Income level	Telecentre
18–23 - 8	Male - 12	Employed - 5	ZAR0-ZAR5000 <sup>a</sup> - 16	Smart Cape - 12
24–29 - 6	Female - 6	Unemployed - 8	ZAR5000-ZAR15000 - 2	PIC - 5
30–34 - 3		Student - 5		Both - 1
35-Above - 1				

<sup>a</sup>Income is in South African Rand (ZAR), 1 US\$ is approximately 14 ZAR

The majority of the respondents had an income below ZAR5000. This, along with the unemployment status, confirms that the majority of the respondents may be classified as disadvantaged. Frequency of the respondents visits to the telecentres varied; some visited twice a week whilst others once a week.

## 6.2 Reasons for Visiting Telecentres

Most participants had similar motives for visiting the centres. These included the short travel distance to utilise resources, entertainment, convenience provided by the centre, technical support, good advertisements, affordability and good service. Customer service was good. ‘. . . I feel safe and comfortable as well at PIC and their internet service, with assistance’ [Resp1]. However, they complained that there were too few centres and too many users. ‘Firstly, it’s convenience; there aren’t many of these telecentres around’ [Resp5]. The services at Smart Cape telecentre were free, unlike PIC where there was a charge.

The internet access provided by these telecentres enabled the users to do a variety of activities online. Mostly, they visited the telecentres to do school work, seek employment and use the resources. The environment was quiet and they were motivated to work when they saw other people also busy with their work.

### 6.3 Agency

One factor which we assessed under agency was geographical resources. The majority of the respondents lived within walking distance to the telecentres and most of them took about 10 min to reach their respective centres. Only one respondent mentioned that it was normally about a 30-min walk to the telecentre from home; however, the respondent did not consider it far.

Many respondents had access to technologies such as smartphones, laptops, TVs, DVDs, tablets and pay satellite TV. A number of participants were able to utilise different technologies in the telecentre such as computers, printing machines, accessing social media and emails, webcams and effectively made use of Universal Serial Bus (USB)'s. This contrasts earlier studies around use of public access points in Cape Town [19, 31]. The difference could be due to the focus on the youth, as young people are generally more technologically savvy [31].

A large portion of the respondents were either unemployed or were students. The income of the respondents ranged between R0-R5000 per month, implying that they did not have much income to spend on accessing ICTs, especially expensive items such as personal computers. Purchasing a computer would be out of reach for those coming from poor communities. Social resources (family and friends) assisted some respondents with funds to buy data before they found out about free internet services at the centre.

### 6.4 Structures

**Policies and Programmes:** Some policies displeased respondents at PIC. There was a non-refundable usage charge that non-account users incurred at PIC telecentre. If a user paid for 30 min and only used a service for 15 min, the user did not get a refund for the remaining time. Some respondents mentioned that downloading at the telecentres was not permitted but people downloaded anyway. *'It is not allowed for people to download videos because it is costly due to data costs'* [Man7].

Some respondents felt that the Smart Cape telecentres' 45-min free access had limitations. The allocated time was sometimes not enough for some respondents to watch all the content they wanted, especially learning material. The time was not enough for watching tutorials; downloading content would be a solution. Once the time was used up, one could not access any other library computer for that day. An alternative would be to go to a telecentre at Cape Town Central for the extra hour after 5 pm. This option was not feasible for the majority of people living in disadvantaged areas. The distance to and from the two areas to Cape Town Central library is over 31 km and a return fare would cost over ZAR30. Besides, it was not safe to travel afterhours in the townships, especially for women.

Some respondents preferred internet cafés as there was no limitation on time for usage. However, the choice to use the centre was dependent on their financial resources.

Other respondents mentioned that the telecentre users were not allowed to visit certain sites. This law was verbal and there was no automatic site blocker in place.

**Norms of Usage and Laws:** The majority of the respondents mentioned that the centres were congested at particular times and on particular days. Normally, weekends and between 1 pm and 3 pm, the centres were full. The centres were often full when school children came from school. The library assistant noted that children used the place and sometimes played games on the computers. The children's usage of the facilities sometimes caused conflict with adults.

*'There is confusion and conflict because sometimes an individual could come in and find a child busy on the computer and ask the child to move so that they can use it . . . according to them, the child isn't doing anything constructive' [Man7].*

Designated areas for adults and children would be a possible solution to this conflict. These areas would need to be monitored effectively to ensure fairness. However, the telecentres are too small and it would not be easy to demarcate spaces for different user groups.

The trading hours for the centres were 9 am to 5 pm, with exceptions of Thursdays (7 pm) and Saturdays (midday). People who were impacted by business times the most were the employed because they arrived back at the community after telecentres were closed. A later time slot '*which closes at 8 pm*' (Man7) would suit those people. A respondent noted a need for '*an extra hour, especially for people that come from work and are busy during the day*' [Resp4]. Despite fears of being attacked, respondents felt a later time slot should be considered.

**Access to Technologies:** Two main challenges that affected the availability of ICT resources at the telecentres were limited resources and failure in ICT equipment. The computers at the centres were not sufficient for the demand: this resulted in people waiting in queues. Furthermore, the respondents complained about slowness in internet connections, slowness in computers and faulty printers. The hardware was outdated and there was a need for a technician within the telecentres to look into these problems.

All respondents had a positive attitude towards the affordability of the ICTs at the centres. Resp1 of PIC believed that although the centers '*. . . are not expensive, they are very cheap*', there was still room for improvement and that there should be lower rates than the existing ones. '*. . . Smart Cape 'free' usage policy allowed users to use the facilities at no financial cost to them.*

One of the factors that require successful experience in telecentre usage is familiarity with ICTs [36]. The Smart Cape telecentres used open-source software. The software created confusion for novice users who were not used to this different software.

The different operating systems posed difficulties for users, especially those with low computer literacy. However, this was not a major problem as there were support services at the telecentres. '*. . . some find that it is an issue to print things on the*

*webpage. So I have also helped some in that regard*'. Clients appreciated the assistance at the centres.

## 6.5 Degrees of Empowerment

**Existence of Choice:** The facilities afforded different choices to the users and potential users. Different opportunities existed and were attainable to the majority of individuals using the facilities. For most respondents, location was not a barrier, since they lived close to the telecentres. Further, they were computer-literate. Further, support from the assistants at the telecentres was available for those who struggled. Although the telecentres had challenges such as slow internet connection and limited space, people still chose to use them.

**Sense of Choice:** The respondents understood the possible opportunities that technologies in the telecentre could bring them. The library assistant noted that individuals had opportunities to '*research information, [and] look for jobs*'. However, the majority needed time and effort to make use of the opportunities. When asked on the possible entrepreneurial opportunities that a telecentre provided, Resp6 said '*I can only get the information but at the end, it is up to me*'. This illustrated that he was aware that the possibilities and resources were there and it was up to him to use them to achieve his desired outcomes.

**Use of Choice:** Respondents made a choice to utilise the telecentres for a variety of reasons. Some of those reasons were in line with achieving their personal goals. Respondents were aware of the benefits telecentres provided and used them where they could.

Some respondents used the telecentre resources to apply for tertiary education and employment. They saved money when they applied online. Students downloaded school materials at the centre. Aspiring entrepreneurs used the telecentres to access information, communicate with stakeholders and promote their businesses through social media. Respondents realised that although all resources were available at the centre, it was essential for them to make the appropriate choices within a given time constraint to achieve their desired goals.

**Achievement of Choice:** Respondents were satisfied with the telecentre and the impact it had on their lives. Through appropriate choices, some respondents used the telecentres to achieve their goals, such as finding employment. However, after making choices, individuals may or may not achieve all desired outcomes they wish for. For example, some respondents applied for tertiary education, but their applications were not successful.

## 6.6 Development Outcomes

We focused on the economic empowerment and development outcome. The findings described in this section are only those related to economic empowerment.

**Primary Outcomes:** Primary outcomes occurred when the respondents made choices; in this case, about using telecentres to assist them in achieving their goals. Some respondents chose to use a free telecentre, while others chose the fee-charging café. The major attraction for the café over the Smart Cape centre was unlimited time slots. These choices, to a larger extent, depended on the respondents' economic status.

**Secondary Outcomes:** Secondary outcomes of individuals depended on the life they would value to have. By choosing to use a telecentre, individuals may value having easier communication with loved ones. Secondary goals attained by respondents included increased income, access to new knowledge, easier communication, gaining skills, more personal time and successful applications for opportunities. Respondents increased their disposable incomes through saving, job acquisitions and entrepreneurial activities.

Telecentre charges were relatively low or non-existent. The centre provided the users with opportunities to save since they did not have to purchase data. This is particularly important since the costs of data in South Africa are considered high and since people living in disadvantaged communities do not have a number of opportunities for free Wi-Fi through shopping centres.

Users saved time accessing telecentre services instead of travelling long distances to access alternatives. The users saved on costs since they did not have to go far to get things done. This is particularly important for the townships since most services are located far. Some respondents submitted job applications online instead of physically going to potential employers. Resp5 submitted his songs using the resources at the telecentre. *'I save a lot by using it financially. Imagine if I had to go all the way to Sea Point South African Broadcasting Corporation to submit a song. It's time-consuming and time is money'* [Resp5]. The distance between Sea Point and Khayelitsha is about 45 km and it takes over two hours and a return fare cost of ZAR50. Resp3 used the facilities to collaborate with her lecturer who was based in another province. Other respondents used the telecentre to communicate via emails and other social media platforms.

The library manager indicated that users were able to get employment using the telecentre resources. Resp1 noted that: *'Yes, that's how I got my current job. I used to come here at PIC, almost every day to submit my CVs online and check on emails and things like that'*.

Another benefit from using the telecentres was knowledge. The library assistant said that: *'There is a lot of information that they can find online, . . . so they can research, even find tutorials and notes. They can also meet business-minded individuals . . . online'*. Respondents also acknowledged that the telecentres made *'information much more accessible'* to people and that the telecentre made it easier than having to travel long distances.

The majority of respondents mentioned that they gained skills through the use of the facilities at the telecentre. Most skills pertained to computer literacy and some were gained through practice and interactions with people in the telecentres. The library assistant explained that computers assisted people in gaining knowledge on how to operate different computer tools. Some also improved non-technical skills such as reading skills and they developed a new perspective on things.

Initially, some people did not know how to use the facilities; however, through the assistance of staff at the centre, they gained some computer skills. *'I gained quite a few skills here and there, especially Microsoft Programs' [Resp2]*. This resulted in Resp2 being able to complete her CV using Microsoft Word. Although the majority of respondents acquired computer skills via the telecentres, some respondents had prior knowledge on how to use the computer before starting using the telecentre facilities.

Children used the facilities to entertain themselves by playing game on the computers. *'Children watch videos, play games. Some of the videos are educational based videos' [Man7]*. *'When I am bored in the hood I just come here and crack that thing on Facebook' [Resp1]*.

Resp5 mentioned that the telecentre gave him a greater reach to the population with minimal costs. He was able to promote his music via social media and was able to upload his songs on social media.

## 7 Discussion and Conclusion

The study investigated how telecentres affected the economic empowerment of the youth living in disadvantaged communities in South Africa. It also investigated factors which might limit the empowerment opportunities. The study found that the youth in disadvantaged areas in South Africa can achieve economic empowerment from using telecentres. The study noted that telecentres may help save costs, as well as facilitate generation of income, albeit in small amounts. Users who had access to laptops and mobile devices still found the telecentres to be useful.

The youth saved on data costs by utilising the facility resources to access data-intensive applications such as YouTube. They also reduced travel expenses by using the telecentres to send documents and make applications.

The youth who used the telecentre achieved economic empowerment by gaining improved income, improved employment opportunities, increased entrepreneurs skills and improved access to markets. The computer skills people attained through the telecentres made them more employable. Entrepreneurs used internet resources to promote their products on social media. The internet resource helped them to generate income. Online tutorials also assisted them in acquiring new knowledge. This finding is in agreement with literatures on how telecentres provide economic empowerment [5].

The findings of this study identified the factors that influenced economic empowerment for users of telecentres such as: individual agency portfolios, the choices users made and the telecentre structures. Individuals who lived close to the telecentre, with the right material resources, educational resources, information and geographical resources, were more likely to be empowered. With the appropriate portfolios in place, along with structure, users needed to make appropriate choices such as using their time at the centres to apply for jobs and learn new skills, instead of doing something less productive.

The youth, trying to access and benefit from the technology, faced a number of challenges. These challenges limited them from optimally achieving economic empowerment. The challenges were at personal telecentre level as well as environmental level. At personal level, some users and potential users had poor ICT skills and

therefore failed to use the facilities optimally. The high crime rate in the townships prohibited people from bringing their own laptops and phones to access the free Wi-Fi in the area and they ended up burdening the computer facilities in the centres.

The telecentres (especially the Smart Cape) had limited ICT technical assistance, insufficient ICT facilities at the centres, and experienced failure in ICT. The time limitation on the Smart Cape facilities was a great constraint. Users would want to seek assistance but, due to the limited staff, their time slot would be depleted before they had completed the task they wanted to do on the application. The challenge of the time limits at the Smart Cape points and the sister project, 'Cape Access' were noted in earlier studies [29]. The problem is much more relevant and urgent presently with an increase of online content for learning and empowerment. The opening times limited how the people used and benefited from the centres.

To better assist the youth to be economically empowered through the use of the telecentres, these challenges need to be addressed. There is a need for computer training programs to assist youth in speeding up their computer literacy. The youth in disadvantaged communities may not be able to afford to pay for ICT training. Free training, such as that offered by Cape Access [19, 29], would be valuable. The telecentres need to consider increasing the number of computers and staff, as well as sufficient space to better accommodate the high demand for ICT.

## References

1. Sulla, V., Zikhali, P.: *Overcoming poverty and inequality in South Africa : an assessment of drivers, constraints and opportunities*. Washington D.C. (2018)
2. Sein, M.K., Harindranath, G.: Conceptualizing the ICT artifact: toward understanding the role of ICT in national development. *Inf. Soc.* **20**(1), 15–24 (2004)
3. Aygerou, C.: The link between ICT and economic growth in the discourse of development. In: Korpela, M., Montealegre, R., Poulymenakou, A. (eds.) *Organizational Information Systems in the Context of Globalization*, vol. 126. Springer, Boston (2003). [https://doi.org/10.1007/978-0-387-35695-2\\_23](https://doi.org/10.1007/978-0-387-35695-2_23)
4. Harris, R.: Telecentres in rural Asia: towards a success model. In: *International Conference on Information Technology, Communications and Development*, pp. 71–111 (2001)
5. Kapondera, S., Hart, G.: The use of multipurpose community telecentres and their services in Malawi: the case of Lupaso Community Telecentre. *South Afr. J. Libr. Inf. Sci.* **82**(1), 13–25 (2016)
6. Tanner, M., Osman, M.: The influence of Telecentres on the psychological empowerment of underserved community members. In: *10th European Conference on Information Systems Management, ECISM 2016, Portugal*. Academic Conference and Publishing International Limited (2016)
7. Brown, J., Hoque, S.: Community based information services: a comparative study between Bangladesh and Philippine telecentres. In: *First International Conference on ICT for Transformation*, p. 52–57. University of Buraimi (2016)
8. Mlatsheni, C., Leibbrandt, M.: Unemployment in South Africa. In: *The Oxford Companion to the Economics of South Africa*, 1st edn. Oxford University Press, New York (2014)
9. Ibrahim, Z., Ainin, S.: The influence of Malaysian telecenters on community building. *Electron. J. eGov.* **7**(1), 77–86 (2009)

10. Russell, S., Muraco, A., Subramaniam, A., Laub, C.: Youth empowerment and high school gay-straight alliances. *J. Youth Adolesc.* **38**(7), 891–903 (2009)
11. Chinman, M., Linney, J.: Toward a model of adolescent empowerment: theoretical and empirical evidence. *J. Prim. Prev.* **18**(4), 393–413 (1998)
12. GSMA. *The Mobile Economy Sub-Saharan Africa 2017* (2017)
13. Powdthavee, N.: Unhappiness and crime: evidence from South Africa. *Economica* **72**(287), 531–547 (2005)
14. Rospabe, S., Selod, H.: Does city structure cause unemployment? The case of Cape Town. In: *Poverty and Policy in Post-apartheid South Africa*, 1st edn. Human Science Research Council Press (2006)
15. Sekatane, M., Sekhampu, T.: Correlates of poverty amongst households receiving government grants in a South African township. *Int. J. Soc. Sci. Humanit. Stud.* **6**(1), 11–21 (2014)
16. Aji, Z., Yusof, S., Osman, W.R., Yusop, N.: A conceptual model for psychological empowerment of telecentre users. *Comput. Inf. Sci.* **3**(3), 71–79 (2010)
17. Lenhart, A., Purcell, K., Smith, A., Zickuhr, K.: Social media & mobile internet use among teens and young adults. Millennials. *Pew Internet Am. Life Proj.* **01**, 1–16 (2010)
18. Lemanski, C.: A new apartheid? The spatial implications of fear of crime in Cape Town, South Africa. *Environ. Urban.* **16**(2), 101–112 (2004)
19. Chigona, W., Lekwane, O., Westcott, K., Chigona, A.: Uses, benefits and challenges of public access points in the face of growth of mobile technology. *Electron. J. Inf. Syst. Dev. Ctries.* **49**(1), 1–14 (2011)
20. Mukerji, M.: Telecentres in rural India: emergence and a typology. *Electron. J. Inf. Syst. Dev. Ctries.* **35**(1), 1–13 (2008)
21. Cheuk, S., Atang, A., Lo, M.: Community attitudes towards the telecentre in Bario, Borneo Malaysia: 14 years on. *Int. J. Innov. Manag. Technol.* **3**(6), 682–687 (2012)
22. Attwood, H., Diga, K., Braathen, E., May, J.: Telecentre functionality in South Africa: re-enabling the community ICT access environment. *J. Commun. Inform.* **9**(4), 1–24 (2013)
23. Stats, S.A.: *Quarterly Labour Force Survey, Pretoria* (2018). (Quarter 4: 2017)
24. Wilson, N., Dasho, S., Martin, A., Wallerstein, A., Wang, C., Minkler, M.: Engaging young adolescents in social action through photovoice - the youth empowerment strategies (YES!) project. *J. Early Adolesc.* **27**(2), 241–261 (2007)
25. Wilkinson, A., Pettifor, A., Rosenberg, M., Halpern, C., Thirumurthy, H., Collinson, M.: The employment environment for youth in rural South Africa: a mixed-methods study. *Dev. South Afr.* **34**(1), 17–32 (2017)
26. Kleine, D.: ICT4WHAT?—using the choice framework to operationalise the capability approach to development. *J. Int. Dev.* **22**(5), 674–692 (2010)
27. Samah, B., Badsar, M.: Factors influencing rural community empowerment to achieve telecentres' ownership. *Soc. Sci.* **8**(5), 461–465 (2013)
28. Bailur, S., Gigler, B.: Introduction: the potential for empowerment through ICTs. In: *Closing the Feedback Loop: Can Technology Bridge the Accountability Gap?*, pp. 1–16. World Bank, New York (2014)
29. Alao, A., Lwoga, T.E., Chigona, W.: Telecentres use in rural communities and women empowerment: case of Western Cape. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017. IAICT*, vol. 504, pp. 119–134. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_11](https://doi.org/10.1007/978-3-319-59111-7_11)
30. Akram, S., Shaheen, I., Kiyani, S.: Socio-economic empowerment of women through micro enterprises: a case study of AJK. *Eur. Sci. J.* **11**(22), 197–211 (2015)
31. Sulaiman, N., Muhamad, R.: Empowering the society through companies CSR agenda. In: *SHS Web of Conferences*. EDP Sciences (2017)



32. Yusop, N., Mohd, A.S., Mat Aji, Z., Ibrahim, H.H., Kasiran, M., Dahalin, Z., et al.: The influence of community characteristics towards telecentres success. *Comput. Inf. Sci.* **3**(2), 116–120 (2010)
33. Kleine, D.: *Technologies of Choice?: ICTs, Development, and the Capabilities Approach*. The MIT Press, London (2013)
34. Ojo, A., Janowski, T., Awatwi, J.: Enabling development through governance and mobile technology. *Gov. Inf. Q.* **30**(1), S32–S45 (2013)
35. Saunders, M., Lewis, P., Thornhill, A.: *Research Methods for Business Students*, 5th edn. Pearson Education, London (2009)
36. Chigona, W., Licker, P.: Using diffusion of innovations framework to explain the communal computing facilities adoption among the urban poor. *Inf. Technol. Int. Dev.* **4**(3), 57–73 (2008)



# Peer Networking and Capacity Building for Child Protection Professionals – Lessons from “ChildHub”

Sendrine Constant, Balwant Godara<sup>(✉)</sup>, Thierry Agagliate,  
Nihaalini Kumar, and Amara Amara

Terre des hommes Fondation, Lausanne, Switzerland  
bgodara1980@gmail.com

**Abstract.** Child protection systems across the global South suffer from common problems, one of the most critical among which is low number and skills of relevant professionals to deliver services. Additionally, child protection professionals are often demotivated, uncoordinated and isolated, with limited access to continuous training and support. Peer learning and capacity building networks help address these issue, and often leverage the spread and scope of information and communications technologies. We present one such network, ChildHub, initially developed and deployed in South-East Europe, a region whose child protection systems present features similar to those in Africa and Asia. The success of this platform, evinced by a continuously growing community and confirmed by an evaluation after three years of operation, provides motivation and lessons for contextualization to sub-Saharan Africa and south Asia. Thanks to its inherent modularity, ChildHub will easily be adapted to the contexts and needs of the two regions, thus building on the interest generated in Asia and Africa for such networks. The paper also presents the approach that will be taken to implement the platform for Africa and Asia.

**Keywords:** Blended (online and offline) approach · Capacity building · Child protection · Information and communications technologies · Peer networking

## 1 Introduction – Context and Landscape

### 1.1 Definition of Child Protection Systems

A child protection system is defined as [1]: “certain formal and informal structures, functions and capacities that have been assembled to prevent and respond to violence, abuse, neglect and exploitation of children. A child protection system is generally agreed to be comprised of the following components: human resources, finance, laws and policies, governance, monitoring and data collection as well as protection and response services and care management. It also includes different actors – children, families, communities, those working and subnational and national level and those working internationally. Most important are the relationships and interactions between

and among these component and these actors within the system. It is the outcomes of these interactions that comprise the system”.

## 1.2 Child Protection Systems in the Global South

“Capacities” are a core element of child protection; formal examples of these include adequate number, capacity and skills of relevant professionals [2]. The child protection systems in the Global South – including sub-Saharan Africa [3–5] and south Asia [6–8] – suffer from the same problems as concerns these capacities. More specifically:

- Social services are rarely a priority in the political agenda.
- Despite progress in the elaboration of regulatory systems, many countries show a lack of vision for quality improvement, no real preoccupation for “value for money” and no investment in the continuous development of the sector.
- The professional groups (especially social workers, caregivers and medical professionals) are often demotivated and uncoordinated, are understaffed and have limited to no access, to continuous training and peer support. Their capacity of effectively supporting children is significantly affected in the long term.
- Child protection systems are not capable of offering a continuum of care, from prevention to alternative support and reintegration.

## 1.3 Peer Learning and Capacity Building Networks in Child Protection

eLearning and Peer Networking have proven useful in addressing the following issues:

- Reducing fragmentation and inaccessibility of knowledge on specific topics;
- Reducing isolation felt by professionals, and increasing support and motivation;
- Increasing opportunities for development, through skill upgradation and recognition;
- Strengthening the link between practices and policies on the one hand, and knowledge and evidence on the other; and
- Improving synergies and coordination within and between teams.

There are some successful learning networks in the child protection space, such as the **CPC Learning Network** [9], the **RISE Learning Network** [10] and the **Alliance for Child Protection in Humanitarian Action** [11]. These initiatives have proven to be feasible, relevant and useful in bringing together professionals to discuss, design and feed back into policies and programmes. Terre des hommes (Tdh) has initiated such a network, the Child Protection Hub (**ChildHub**) in Southeast Europe. ChildHub’s architecture and success forms the basis for the current proposal.

## 1.4 Structure of This Paper and Its Relevance to the Conference

We present a peer learning and communication platform, ChildHub, initially developed for child protection professionals in Central and South Eastern Europe. Currently used by professionals in 10 countries, this platform has also been the subject of a detailed external evaluation. The results are promising, and will form the basis of improvements of the platform in Europe. The experience and evaluation of ChildHub also offers valuable lessons for its contextualization to other regions, notably South Asia and sub-Saharan Africa.

## 2 ChildHub – Context and Foundations

### 2.1 Context in Which ChildHub Was Developed

A 2015 baseline study on the child protection workforce in areas where Tdh works, led to the identification of the main gaps in Central and South Eastern Europe: (i) Gap between content of training and practical skills demanded; (ii) No systems of licensing, accreditation; (iii) Under-qualified and insufficient staff; (iv) Feelings of isolation among professionals; and (v) No recognition of work, low motivation, huge workloads.

Consequently, the sector is confronted with significant staff turnover; limited, irrelevant and uncoordinated training; and low motivation and performance. This comes at a time when the need for efficient child protection services is critical - there is a high incidence of sexual violence, bullying, domestic violence, neglect of children, and discrimination and marginalization of ethnic minorities.

At the same time, the study identified some interesting opportunities in the Region. The similarities between social protection systems in the region would make exchange of practices possible and relevant. There is an increased momentum in the child protection sector with the adoption of the Sustainable Development Goals (SDGs), and at the same time, there is a solid base of existing knowledge, promising practices, experts and organisations. These latter are willing to share experiences given the opportunity, and this sharing could be facilitated by the widespread access to digital technologies.

### 2.2 Approach, Objectives and Expected Outcomes

Following the above analysis, Tdh's Regional Office decided to initiate the Child Protection Hub for South East Europe, ChildHub in 2015 [12–15]. The founding vision, key objectives, expected outcomes and beneficiaries are given in Table 1.

**Table 1.** The foundations of the Child Protection Hub

Vision	To unlock the potentials of child protection actors by delivering innovative services, content and tools that can help them achieve positive changes for children
Purpose	By end-2017, professionals and key stakeholders have increased access to technical resources and support networks allowing them to expand, improve, and advocate for qualitative services and policies for children in need of protection and their families
Objectives	<ul style="list-style-type: none"> <li>• Create opportunity for strong networks at regional and national levels</li> <li>• Increase opportunity for upgrading knowledge and skills of professionals &amp; others</li> <li>• Equip professionals and stakeholders to advocate for better policies and practices</li> </ul>

(continued)

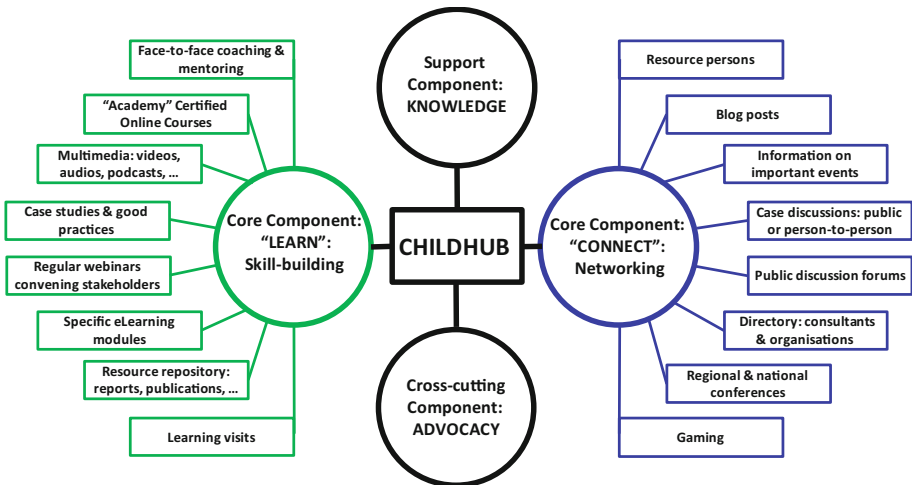
**Table 1.** (continued)

Expected outcomes	<ul style="list-style-type: none"> <li>• Professionals develop skills to implement activities in more responsive &amp; effective</li> <li>• Actors connect and cooperate, to disseminate and replicate promising practices</li> <li>• A regional community of knowledge and practices is created</li> </ul>
Beneficiaries	<ul style="list-style-type: none"> <li>• Indirect - 500,000 children at risk or victims; families who will benefit from better services and enhanced policies</li> <li>• Direct - child protection professionals – with a strong focus on social workers, but including other professions</li> </ul>

### 3 ChildHub – Components, Implementation and Performance

#### 3.1 The Four Components of ChildHub

ChildHub allows professionals to (i) Learn and explore; (ii) Connect and exchange. These two core components are supplemented by a support component (knowledge management) and a crosscutting component (advocacy). These are available in all the major regional languages (Fig. 1).



**Fig. 1.** Structure and components of ChildHub

**The Learning component** aims at providing opportunities for professionals to access resources for quick learning, such as podcasts and videos, as well as webinars, resources for trainers and materials for independent learning. ChildHub has built a significant portfolio of courses. It takes a blended approach - complementing offline with online learning. **The Networking component** proposes joint - online and face-to-face - activities such as regional conferences, national round tables, forums for

discussions/sharing of news. It contains a roster of Resource Persons, as well as game-like elements that invite actors to cooperate and synchronise their understanding of common or urgent child protection issues and relevant policy aspects

**The Knowledge Management and Resources Component** aims at making knowledge, information and data, available online, to all and in a user-friendly format. However, ChildHub is not only a collection of resources. It develops its own knowledge. The library contains a database of publications and easy-to-absorb information, extracts and summary documents, infographics, videos, toolboxes and child friendly materials. ChildHub can also be used to promote organisations' work regionally and initiate collaborations.

Under each of the three components, efforts are made to **advocate for change based on evidence collected**. The cross-cutting component aims to provide professionals with the tools, methodologies and data that would allow for improved advocacy at national or regional levels. For instance, in one country, several NGOs have submitted a position paper on the deinstitutionalization process, resulting in some of the network's demands being achieved. Several countries held roundtables with local stakeholders to increase collaboration and input. Resource persons in each country have highlighted areas for continued advocacy.

### 3.2 Scale of ChildHub

Table 2 presents the main parameters of scale of ChildHub. More details are available on the ChildHub website (<https://childhub.org/en>).

### 3.3 Evaluation of ChildHub

An independent evaluation was commissioned by Tdh and the Austrian Development Agency, and conducted by inFocus Enterprises Ltd, at the end of the third year of ChildHub. Its overall **purpose** was to assess the extent to which the project has reached its objectives, for accountability purposes towards donors, beneficiaries and stakeholders and; and draw the main lessons and generate recommendations for the next phase.

**Table 2.** Current scale of ChildHub in Europe

Component	Scale
Learning	<ul style="list-style-type: none"> <li>• 3 eLearning modules, available in 5 languages; accessed by 1'000 professionals</li> <li>• 422 persons trained in face to face meetings by the 50 trained trainers</li> <li>• 400 people attended 43 case discussions; 600 people attended 26 webinars</li> </ul>
Networking	<ul style="list-style-type: none"> <li>• 229 resource persons trained to promote continuous improvement in the field</li> <li>• 60,000 persons visited ChildHub.org; 3000 persons became members</li> <li>• More than 3000 persons participated in offline activities and events</li> </ul>
Knowledge	<ul style="list-style-type: none"> <li>• Virtual repository of 17,500 items, accessible in 6 languages</li> <li>• Key documents elaborated by the ChildHub community</li> <li>• Newsletters reaching 8,000 subscribers every fortnight</li> </ul>
Advocacy	<ul style="list-style-type: none"> <li>• 2 regional conferences brought together 120 stakeholders from 11 countries</li> <li>• 4 promising practices promoted and visited by 31 stakeholders</li> <li>• Regional observatory that produces thematic reports and papers for advocacy</li> </ul>

The evaluation methods span summative (extent to which anticipated outcomes were produced), formative (identifying improvements that could be made to future) and process (internal dynamics of how ChildHub was implemented) elements. A mixed method approach was taken for data collection, with primary and secondary data sources of both qualitative (key informant interviews and focus group discussions) and quantitative (survey based) data. With the limitations of budget and time and the availability of respondents, the evaluation focused on the primary beneficiaries of activities: a sample of the resource persons and the members of ChildHub. The evaluation encompassed visits to two sites, in two different countries. The data collection instruments are accessible publicly: Online survey questionnaire; Interview guide for Resource People; Interview guide for Coordinators, Staff and project advisors; Focus group guide.

### 3.4 Findings from the Evaluation of ChildHub

The main finding in relation to the **output targets** is that they have all been significantly over-achieved compared to original intended goals (Fig. 2). There have also been a number of early-stage outcomes, and there is an increasingly good understanding of the range of skills and capabilities required by both formal and informal actors.

However, the timeframe for **mid- to long-term changes** to occur, for example in relation to widespread practice change, as a result of ChildHub's training and networking efforts, is likely to be longer than expected, with success dependent upon the inter-section of a number of factors, some of which are out of the control of ChildHub. Some factors can be put into place to improve the likelihood of mid to longer term changes occurring in the next phase (see recommendations below).

There have also been a number of **unintended outcomes**. Networking appears to have provided a much wider set of connections for Resource People than expected. ChildHub has started to change attitudes and behaviours towards consuming information, accessing training and collaborating online, helping ensure professionals who are unfamiliar with the online world, are able to make full use of ChildHub in the future.

### 3.5 Recommendations and Plans for the Future and Contextualisation

The experience in the design, implementation and scale-up of ChildHub in Europe, as well as the findings of the formal evaluation, will help shape the future of the platform while also providing the motivation and the guidelines for its contextualization to other regions. In this section, we present the recommendations and future plans for the evolution and contextualization. ChildHub can be enhanced with the following elements:

- **Stronger advocacy at national and regional levels.** On the one hand, ChildHub has gathered evidence through research; on the other, it has a core group of influential people who can convey the messages and represent the cause. Also, ChildHub can be a platform for regional action on issues such as Children on the

SUCCESS FACTORS IDENTIFIED	CHILDHUB RATING
Clearly define the target populations for ChildHub interventions	● not being fully addressed
Ensure a diversity of cross-sector actors	● are doing well
Include representation from target population in all stages of project development and delivery	● not being addressed
Creatively engage the target population	● are doing
Avoid paying people 'directly' to engage	● sometimes addressed
Cultivate Resource People with 'system' leadership skills	● often addressed
Go to them, don't expect them just to come	● sometimes addressed
Continuous and clear communication	● communication is very regular
	● clarity of message around purpose could be improved
Ensure sufficient resources for additional 3-5 years	● doing well
Remove the financial barriers to access	● doing very well
Establish a Regional Coordination unit (Tdh Hungary) and Country Coordinating partners	● doing very well
Remove organisational barriers	● sometimes addressing
Remove language barriers	● doing well
Remove technical barriers	● not addressing
Provide valuable information and knowledge resources	● doing very well
Use a blend of online and offline training approaches	● doing very well
Use offline meetings/events to achieve complementary goals	● sometimes doing
Consider the need for post-activity support	● not addressing
Have a shared vision and agenda for change (regional and national)	● partially doing
Ensure ChildHub is integrated into Tdh National office & partner/member strategies	● partially doing
Align with or include programmatic strategies directed at children and communities	● not addressing

Fig. 2. Performance of ChildHub in terms of its main output targets

Move, as it is building a regional community and network of professionals. The advocacy pathway, in turn, should be connected with research and face-to-face meetings.

- Seek to **interface and/or collaborate with other, complementary platforms**. For instance, a concept is currently being developed for the Alliance for Child Protection in Humanitarian Action to share resources and animate a community of practitioners.
- Partnerships can also facilitate the daunting task of **collecting resources**, by establishing automatic systems of pulling regional and national information into ChildHub. This would greatly facilitate the collection of resources – especially from important reference sites like the Save the Children Resource Library.
- **Innovative activities** and services using the tools and communication/learning facilities of ChildHub. Accessibility for all represents a key innovative aspect and this aspect could be further developed. Improving the workplaces of professionals, especially in rural, isolated areas, is also a key topic for innovative projects.
- **Coaching and mentoring module** highly demanded by professionals. It requires a dedicated pool of experts as coaches or supervisors. Using distance communication,



the coaches should offer support to practitioners, especially those working in difficult, isolated areas, or those working with beneficiaries with complex needs.

- **‘Offline’ components** like the regional conferences and the country visits, have proven much more useful than initially expected. These should be strengthened, to adequately complement the intensified and diversified online activities.

The following **technical and process improvements** are relevant in view of the findings from the ChildHub evaluation:

- **Design:** Clearly define who specific ChildHub activities are targeted towards; Leverage social media; Target supervisors and senior management more directly within organisations; Continue to address and intensify translation efforts; Address IT skills issues amongst users; Establish learning goals for training activities and consider post-activity support; and Co-create new solutions with Resource Persons and partners to address the lack of adequate supervision of social workers.
- **Governance and management:** Set up steering groups for each country; Better cultivate the resource persons with ‘system’ leadership skills; participatory approaches to strategic planning; Ensure that Tdh country offices and in-country partner/member organizations align their existing plans/activities. Finally, guided by a clear strategic framework, define functional working groups (e.g. policy advocacy, M&E) and strategy working groups (e.g. juvenile justice) to drive the mutual alignment of member efforts and the implementation of ChildHub’s overall strategic plan.
- **Sustainability:** Introduce a more structured approach, best guided through the production of a common Theory of Change, which can then be used as a basis for the community developing learning questions to be further explored and guide the documentation of good practices. Adopt a Developmental Evaluation approach [16], better adapted to initiatives with multiple stakeholders, high levels of innovation, fast paced decision-making, and areas of uncertainty than the traditional forms of evaluation which work well in situations where the progression from problem to solution can be laid out in a relatively clear sequence of steps. Finally, consider a range of potential ‘end games’ or routes to sustainability as early as possible.

## 4 Contextualization of ChildHub to Africa and South Asia

As we saw in Sect. 1.2, child protection systems in South Asia and sub-Saharan Africa share the same shortcomings with those in South-Eastern Europe. Tdh currently works in four countries in South Asia – Bangladesh, India, Myanmar and Nepal – and is exploring the contextualization of ChildHub there, as a tool for Tdh delegations to connect and learn, and, more importantly still, **as an inter-agency platform for child protection professionals in the region**. Similarly, the idea of ChildHub would be as relevant for Africa, and could learn from the effort underway to contextualize it in Asia.

#### 4.1 Learnings from Europe – Scope for Contextualization

The **modularity** of ChildHub means that each pillar of the platform (learning, networking, resource center) allows for the use of a variety of methods and tools. The choice can be made at regional level and adjustments are possible regularly. The **functionalities** of each component (for example the use of blogs, forums, chat, etc.) can be expanded or limited, in line with the specificities of users, with the general use of collaborative tools in the region, with the infrastructure and applications that are chosen by the implementing consortium. Experience shows that there are some **minimum, necessary conditions for contextualization** of ChildHub: (i) a strong **regional executive team** which guarantees that the development is responsive to the local needs and interests; (ii) a **pool of resource persons** to boost the activity, and to ensure a qualitative macro picture of the policies and practices in the region; (iii) **online and face-to-face activities** from the very beginning, to increase trust, exchanges and effective collaboration; and (iv) a carefully designed **monitoring system**, including a regional baseline on the policies and practices, as well as the workforce in the child protection systems.

#### 4.2 Relevance for Asia

The need to establish a **peer network around and beyond Tdh in Asia** stems from Tdh's long presence and experience in this zone:

- There is a need for child protection actors (inc. those within Tdh and its partners) to continuously evaluate and update their skills. In-job training using a virtual platform could be feasible and effective way, causing least amount of disruption in operations.
- There are similar projects (such as the continuum of care for children and their mothers) and common approaches (such as moving from direct implementation to institutional strengthening). Peer learning on these could be extremely beneficial.
- Cross-border trafficking is a real menace, across several borders in the region. Collaboration between professionals across countries is thus a real need of the hour; a peer network between the Asian countries could help address this need.
- Effective communication between Tdh persons – and Tdh's partners – could take place over a virtual platform, to complement in-person meetings and other avenues of exchange.

The process of **contextualization is 'Southern-driven'** for several reasons. Firstly, the need for peer networking has been **expressed by several actors in south Asia, within, around and beyond Tdh**. The potential users and beneficiaries of ChildHub in Asia are key and historic actors in the sector, with a good understanding of the ground needs. Moreover, the technical expertise and content would come from local organisations and contexts. The starting point would thus be the experience of ChildHub in Europe, but adapted to the context and tailored to the needs in south Asia.

### 4.3 Outline and Avenues for Implementation of ChildHub in Asia

We saw above that there is a strong need to strengthen skills of child protection professionals and to connect them to each other; ChildHub has succeeded in doing this at the Central European region. We therefore strongly promulgate the contextualization of ChildHub to other regions, including Africa and Asia, where the challenges of the sector are essentially the same. Contextualization, rather than ‘reinventing the wheel’, would also be a good way to learn from past experiences (thus increasing chances of success) and increase resource-effectiveness (by reutilizing the technical resources).

ChildHub Europe’s experience is well documented. An internal report presents the motivation, contents, management, costs and partnership structure. The external evaluation done in February 2018 contains a set of recommendations for both the future evolution of ChildHub in Europe and its contextualization to other regions. Together, these would provide the ‘blueprint’ for contextualization to Asia.

We propose an architecture for ChildHub Asia that is similar to the existing ChildHub. We plan to learn from the experience in Europe (“Recommendations and plans for the Future and Contextualization of ChildHub” section above). ChildHub Asia would involve some **additional features**. We also propose to take into account the technical and process recommendations, notably for more effective governance structures and higher sustainability. Therefore, ChildHub Asia and Africa would have the following 10 additional features:

1. Make ChildHub Asia a platform for **strengthening collaborations in the sector**. This implies seeing ChildHub for its full potential right from the outset – as a multi-agency tool.
2. Strong **links with other regions**, to strengthen cross-region learning. Our landscape analysis on ICT4D in and for Asia showed that such cross-learning is potentially very useful and under-exploited as of now.
3. **Extend the platform to other strategic priorities – going beyond Child Protection, create a corresponding section for professionals working on maternal and child health**. This will be planned for the future phases, once ChildHub Asia is up and running, and has achieved critical mass for child protection professionals.
4. **Diversifying the information** available and the sources it is collected from; it is increasingly important to involve user-generated information to make ChildHub truly participative and complete the ‘top-down’ structure of today (resources come from experts and are consumed by practitioners) with a ‘bottom-up’ approach.
5. Complementary and fruitful **partnerships with other networking platforms**.
6. **Emphasis on** using ChildHub for **advocacy** at national and regional levels.
7. Leveraging ChildHub to **monitor the situation** of child protection services.
8. **Stronger coaching and mentoring** to accompany capacity building.
9. A **more innovation-driven** approach, including child-led social innovation.
10. **Stronger ‘offline’ components** to reinforce and complement online activities.

### 4.4 Implementation

It is important to keep in mind the ultimate ambition for ChildHub Asia, irrespective of the short-term funding. So, a phased approach to implementation would help align our

ambitions and timelines to probable funding options. Moreover, a phased approach will allow us to ensure a progressive evolution, from direct transposition to child protection, towards an inclusion of all the programmatic areas.

- Phase I (typically, 1 year): Creation of ChildHub Asia for child protection, thus allowing the use of existing resources from ChildHub Europe (theoretical bases, basic course structure, concepts, legal frameworks, international regulations, ...). This will culminate in establishment of the overall structure and start of first training and networking activities. Creation of content in one dominant regional language. Start of main networking activities like webinars and blog posts.
- Phase II (typically, 2 years):
  - Scale-up in number and variety of members;
  - Scale-across to other areas, with sections on MNCH and juvenile justice;
  - Scale-in, with creation of content in multiple languages.

The **content available to members** – both the learning and the networking – will be built in collaboration with national and regional partners, and validated by external partners. We will also ensure a certification mechanism from academic institutions for eLearning. The **Front-end** (the website) will be designed for PC and mobile devices. Moreover, we propose to have offline access to courses and evaluations, to enable members to work (build and test skills) even in absence of connectivity (Fig. 3).

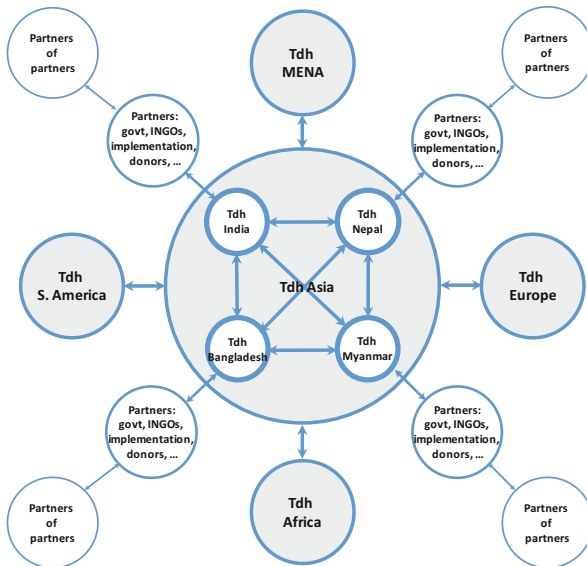


Fig. 3. ChildHub Asia (a similar model can be developed for Africa)

**Resources Required:** Since we propose to start the implementation using the same architecture as ChildHub Europe, as well as some of the same contents, this will ensure a dynamic and cost-effective start. The three-year experience in Europe has been well

documented, including a cost analysis that provides the different expense items and the costs incurred (inc. the unit cost, since the document details the scale of each activity and its costs). This will help estimate and seek sufficient funds.

#### 4.5 Results Expected

We expect ChildHub to produce the following results in South Asia and Africa:

- A more extensive and linked child protection network, between the main stakeholders working on child protection in Asia;
- A sustainable regional collaboration, with effective engagement between country delegations to share knowledge and experiences;
- A stronger workforce, thanks to access to knowledge and modern practices which could enhance the skills of the professionals by learning from their peers;
- A stronger link between professionals, and higher satisfaction and motivation;
- Ultimately, improved outcomes for children.

## 5 Conclusions

Platforms like ChildHub enhance the resilient elements of the system by supporting and valuing the actors of child protection, creating a culture of collaboration, and a strong movement that can analyse and influence the evolution of children's welfare through strong, targeted and evidence-based advocacy. Professionals who are more connected to each other, with access to knowledge and practices, are more skilled, motivated and supported to make better-informed decisions for children.

## References

1. UNICEF/UNHCR/Save the Children/World Vision, p. 3 (2013)
2. Unicef. Adopting a systems approach to child protection: key concepts and considerations. Working paper, January 2010
3. Training Resources Group and Play Therapy Africa. Strengthening Child Protection Systems in Sub-Saharan Africa. A working paper, August 2012
4. Badoe, E.: A critical review of child abuse and its management in Africa. review article. *Afr. J. Emerg. Med.* 7, S32–S35 (2017)
5. USAID: Human capacity within child welfare systems – the social work workforce in Africa (2009)
6. UNICEF: Review of Child Protection Systems in Four Countries in South Asia (2018)
7. Boateng, P.: Interventions on child labour in South Asia. Helpdesk report, May 2017
8. UNICEF: South Asia in Action: Preventing and responding to child trafficking (2008)
9. CPC Learning Network. <http://www.cpcnetwork.org/>. Accessed 3 Aug 2018
10. RISE Learning network. <https://riselearningnetwork.org/>. Accessed 3 Aug 2018
11. The Alliance for Child Protection in Humanitarian Action. <https://alliancecpha.org/>. Accessed 3 Aug 2018
12. Child Protection Hub for South East Europe. <https://childhub.org/en>. Accessed 3 Aug 2018

13. ChildHub consortium. ChildHub – child protection benefitting from new technologies. Eurochild conference, July 2016
14. ChildHub consortium. ChildHub – a creative hub for interactive learning and development. LINEA (Learning Initiative on Norms, Exploitation and Abuse) Meeting. October 2017
15. InFocus; Final Evaluation of the Child Protection Hub for South East Europe Project; An independent evaluation commissioned by Tdh Foundation and the Evaluation Unit of the Austrian Development Agency and conducted by inFocus Enterprises Ltd, February 2018
16. Patton, M.Q.: *Developmental Evaluation: Applying Complexity Concepts to Enhance Innovation and Use*, 1st edn. Guilford Press, New York (2010). ISBN: 9781606238721



# Investigating the Implementation of ICT Tool to Electoral Process in Nigeria

Aishatu Shuaibu<sup>1</sup>(✉), Salihu Dasuki<sup>2</sup>, and Muhammadou Kah<sup>1</sup>

<sup>1</sup> American University of Nigeria, Yola, Nigeria  
Aishatu.shuaibu@aun.edu.ng

<sup>2</sup> The University of Sheffield, Sheffield, UK

**Abstract.** This study is aimed at understanding the implementation of Information Communication Technology (ICT) tool to electoral process and its challenges in Nigeria using actor-network theory (ANT) as a lens. Moment of translation of ANT was applied to gain an insight of the phenomenon. Empirical data was used for the analysis in the context of social behavior between human and non-human actors following inductive research approach. Case study methodology was carried out at Independent National Electoral Commission (INEC). The methods of data collection were through interview, participant observation and reviewing organizational documents. Challenges of the Smart Card Reader (SCR) in Nigeria's electoral process are highlighted. Results of the study indicated that the challenges in implementation of the SCR emanated from the heterogeneous actors "human and non-human", which lack synchrony during the process. Apart from the success of the card reader during accreditation, there was inadequate manpower training by INEC body and insufficient ICT infrastructure that weakened the ANT process.

**Keywords:** Actor-network theory · Smart Card Reader · Independent National Electoral Commission

## 1 Introduction

Developing countries, Nigeria, in particular, is currently facing enormous challenges relating to poor governance [1] Infrastructural decay, economic mismanagement, and system collapse are some consequences of the systemic corruption that for so long permeated the system. Similarly, as with other developing nations especially in the African continent, the utility of ICT in the administration of organizations is low with a high level of suspicion and mistrust [2]. Implementation of ICT tool in Nigeria's electoral process though recorded some level of success in the 2015 general elections is still bedeviled with multifaceted challenges. As in the case of many other developing nations, the challenges range from the ICT tools failure to many other human rights violations [3, 4]. Many have argued that the implementation of ICTs to electoral process has brought about great improvement [5, 6] resulting to reducing electoral malpractice [7]. However, there is little understanding on the implementation of ICTs to electoral process [8]. The failure is envisaged to have emanated from the implementation of ICT and the relationship between human and non-human actors in the

electoral process [6]. This study is aimed at understanding the implementation of ICT tool on the electoral process and its challenges. This study contributes to the use of actor-network theory in e-government research in developing nations, Nigeria's electoral process in particular; to investigate the Smart Card Reader implementation and its challenges. It will further improve the understanding of employing ANT in information systems research, its limitation and, challenges. A qualitative research approach using the interpretive method with "intrinsic" case study approach was adopted [9, 10]. Authentication of voters using Smart Card Reader (SCR) in relation to human actors and challenges to the electoral process was the focus of the investigation. The underlying objectives lead to posing the research questions as to how do the implementation of Smart Card Reader emerged and its challenges?

## 2 Theoretical Framework

ANT is regarded as the sociology of translation [11–13]. It explains the interaction of actors towards achieving goals or objectives. ANT serves as a theoretical lens through which the underpinning reality of the implementation phenomenon under investigation is viewed. It is of the view that knowledge is the end product of a heterogeneous network of aligned interest. The theory considers the process of a heterogeneous network as pieces from technical, textual, social and conceptual which are put together and translated to produce an end product [13]. In addition, it is concerned with the relationship between human and non-human (institutions, organization, society, machines and, agent) actors. It is regarded as the "*sociology of translation*" and it is worried about the "*Mechanics of Power*" [13]. The "*Mechanics of Power*" and its relationship to organization believe that there is a Macrosocial or Macroactor, and Microsocial or Microactor in translation [13, 14]. The Macro and Micro actor is referring to human and non-human. Both human and non-human actors are not separated from each other in the translation process [11].

The translation model is described as a generalized process that includes several phases and the phases are interrelated with one another. All actors are identical and they interact with one another in the moment of translation [11]. Similarly, ANT provides an in-depth understanding of the relation between actors in the implementation of ICT tool and its challenges relevant to the objective of this study. In addition, it provides an insight into the challenges of electoral technology relevant to the non-human artifacts through the concepts of the moments of translation as a lens to building the network. The challenges can be attributed to the weaknesses of the actors in building the network as it is evident from the work of [15]. [15] traces the weaknesses of government to realize the capabilities of services in the administration. [6] explains the "failure of Thailand Smart ID Card project" that led to total abandonment of the project. This failure is attributed to the cumulative process of different actors that resulted in undesirable outcomes. [11] applied ANT as a lens to study the falling of scallop in St. Brieuc Bay. Some of the actors (Scallops and fishermen) failed to accept their roles which led to the failure of the project. With regards to this research, the ANT actors are brought together through the "Moment of Translation" so as to expose the weaknesses of the various integrated actors on the process of implementation of SCR.



Once the actors interact, the movement in the translation moment is negotiated and enclosed [11]. [11] describes the moment of translation as: Problematisation; Inter-essement, Enrolment, and Mobilization which will be discussed later.

## 2.1 Limitation of Actor-Network Theory

ANT is used through a method of telling a story [16], as it requires a long description of a story fit into a complete book [12]. This becomes difficult and lengthy for a required word count of a journal [17]. Similarly, as it relates to this research it becomes difficult to choose which actors to be included in the network, to make the description more interesting and desirable. Furthermore, the ANT has difficulty in clarity of actors who exactly have to be among the network for analysis, inability to represent actor in the network, and definition of the network by network component in a manner recursively [18]. These challenges can be overcome by applying an analytical approach [16], and further explained that the challenges need nonstop incremental action as the issues occur for successful implementation.

In addition, the technological aspect of ANT is left behind, giving more consideration on the human aspect. A persistent criticism of ANT in Information Systems (IS)-based research is that investigators using ANT fail to maintain the notion of generalized symmetry [19, 20]. Many critics pointed out that ANT in IS-based research focus more on the human actors while neglecting (intentionally or unintentionally) the technology aspect. It is argued that both the actors and network should receive equal attention in the study [19, 21].

## 3 Methodology

To apprehend the research problem under inquiry, an empirical investigation was conducted to understand the role of the network of actors in the implementation of ICT enables interventions to the electoral processes in Nigeria. The research adopted an interpretive case study approach [22] due to its ability to explain the complex socio-technical interaction process using interviews, case description, and empirical observation [23]. Qualitative data was collected between August to October in 2017 at Independent National Electoral Commission (INEC) office, Yola, Nigeria.

### 3.1 Data Collection Method

Interviews, participants Observation, and organizational documents were applied as techniques for data collection [10]. The interviews were conducted with twenty-six participants. The design of the interview questions was guided by the translation models of ANT [24]. These participants were the INEC officials both lower and upper bureaucrats and the electorates.

The interview questions were semi-structured that involved both open and closed-ended questions. This allows interviewees become flexible while answering the questions. The interviews were held in English language and an in-depth face-to-face interaction. The interaction during the interview lasted for about forty-five minutes to

one hour thirty minute each. All interviews were tape recorded with permission given to the researcher. Some of the interviews were conducted in the offices of the informants while others were on a queue for registration and replacement of Permanent Voter's Card. Curious follow-up questions were asked during the interviews on new and emerging topics. This gave the opportunity to raise any other issues considered relevant. Participants were selected based on the snowballing technique.

Participant observation and document analysis were also carried out. Participant observation assisted in carrying out the database on day-to-day activities happening at INEC. Feelings, ideas, and reactions of the participants were observed and noted for the study. Additionally, how systems work and how support is given to the systems were also observed. Besides, documents were analyzed as other sources of data collection. Document analysis gave more details of things that were not clear during observations and interviews. INEC project documents and Nigeria ICT tools for election policy documents were collected and analyzed. The aim was to understand the relationship and influences of human and non-human actors within the project network [25]. The use of various qualitative methods to collect data helped in ensuring triangulation and a rich data set to illustrate the various network of actors involved in the implementation process.

Qualitative data analyses were carried out to analyze all the data collected. Interviewed data were transcribed through examining, pinpointing and recording patterns into themes following the teachings of thematic analysis [26]. An iterative process was used for reading the transcript samples that resulted in the creation of a codebook. All related obscurity was clarified after the coding of the transcripts samples and codebook was filtered. The themes were categorized reflecting respondents feedback relating to the implementation of ICT tool and challenges. The transcripts were coded and merged into larger themes. Different themes relating to the relationship of actors on issues of the implementation and challenges were contained in the codebook. The coding followed through the movement of heterogeneous actors as it relates to the case study [27]. The main themes were obtained through playing and re-playing of recorded interviews. Also, reading and re-reading of the interviewed transcript as discussed by the participants were analyzed. Secondly, the themes were grouped in relation to the translation models of Actor-Network Theory [28]. These were done with careful consideration given to the implementation of ICT tool to electoral processes as a phenomenon for the research. Field note taken during observations were analyzed using codes that were used for interviews.

Similarly, INEC documents (the INEC temporary register book EC1A were a list of registered electorates were kept, INEC 2015 general elections report, Electoral Operations Support Center (EOSC) manual and reference were made to INEC website) was analyzed with a view to discovering the research setting, major actors for intervention and agencies involved in the project, as well as social and cultural issues that may emerge in the research settings. The interview was conducted among respondents which were 7 top bureaucrats, 8 members from the electorate and 11 lower bureaucrats.

## 4 Case Study Analysis

The Election Management Body (EMB) was the principal actor of the project responsible for taking the decision of the Smart Card Reader network formation. The project was initiated in 2013 as part of the desire to reduce Nigerian electoral malpractice and improve on the transparency to obtain a free and fair election. The smart card reader serves as the research sample and the project was implemented in 2015 during the Nigerian general election. However, as stated in the analysis of this study the project was implemented even though it encountered some challenges. Moreover, the SCR has failed to authenticate in some cases due to problems that arose in the translation processes. These problems manifested which resulted to the challenges of the SCR implementation. The findings were traced through the processes of ANT “Moment of translation” to obtain an understanding of the implementation and its challenges from the SCR into the Nigerian electoral process.

### 4.1 Problematisation

Problematisation is a stage where the focal actor defines the problem and identifies the actors. In this study, the objective of the problematisation stage starts from the moment the focal actors; Election Management Body (EMB) became indispensable by defining and identifying the role and nature of the problem to other actors. The problem identified by the EMB is to implement an ICT tool (SCR) as a solution to provide a free, fair and credible election for Nigerians. The ICT tool implementation was described by the EMB as the obligatory point of passage (OPP). Apart from the EMB, other relevant actors include stakeholders such as; political parties, politicians, civic groups, system analyst, citizens, (voters, electorates or registrants) security officials, INEC officials and national assembly officials. These actors are required for heterogeneous network formation using the technological artifacts (software and equipment) associated to the use of SCR. The OPP which serves as the objective of the project align the interest of other actors as in [11]. The EMB as the focal actor of the Smart Card Reader project network formation, establish the objective of implementation of SCR suggested ways through which the decision was to be implemented. Even though the Smart Card Reader was implemented and used, there are still challenges. It was explained by one of the INEC officials that:

*“There was a lot of complaint on transparency. Sometimes the result is being changed from the polling unit before it gets to the INEC headquarters. With the introduction of SCR tool, the election malpractices were reduced and it enhances transparency though there are some challenges associated with the SCR such as rejection of fingerprint. Clear example of the fingerprint rejection is in the case of the then President of the Federation Good Luck Ebele Jonathan. Without the introduction of ICT by the EMB transparency in result would not have been possible”*

Prior to the 2015 general election, there were issues of credibility and integrity of election result and these problems were identified through multiple registrations of the electorate during the election process in Nigeria. Some of the interviewees stated that:

*“With these problems, we decided to come up with a machine that will be able to identify a voter”*

Moreover, other INEC officials stated their views on the use of SCR as:

*“SCR serves as a technology for curbing electoral malpractice. It improves on the credibility of election leading to a free and fair election, reduces duplication of voters and improves on good record keeping”*

In addition, the INEC as a body lacks enough ICT trained staff. This resulted in adopting ad hoc staff to be included in the formation of SCR implementation network. The Head of ICT stated that:

*“We hired ad hoc staff from the National Youth Service Corps (NYSC)”*

It was also indicated that when the SCR project was initiated, there were lots of challenges:

*“Before SCR was accepted by the government and the general public the commission took it to the house of assembly seeking for permission to use it. The issue of SCR was argued at the national assembly but was fairly accepted. Also, the INEC staff insisted on meeting with the traditional rulers, the political party agent, and community elders to convince the public on SCR usage”*

## 4.2 Intersement

Intersement is a stage where negotiation takes place based on the definition by a principal actor with other actors. This negotiation took place within the stakeholders during a meeting to agree with the usage of ICT tools for the election process. Though, there were challenges from the public and the government resulting in the rejection of the SCR. The SCR was not formally approved constitutionally before 2015 general election. However, INEC as an independent body has the power to use the SCR. As expressed by an INEC staff:

*“It was not approved constitutionally before the 2015 general election. The court rejected the use of card reader because it was not approved constitutionally but, INEC has the power as a body to use it. This led to a court case. It was after the 2015 general election that the government agreed and recommended to use it constitutionally”*

The use of the old machine (infrastructure decay) and power shortage due to an insufficient fund from the government to support the implementation affected the project. Some of the electorates stated that:

*“The election process was too slow and in some cases, the SCR failed to authenticate due to power shortage”*

There was an awareness campaign through media houses which was used to reduce the challenges facing the acceptance of the SCR. One of the interviewees at INEC office explained that the SCR is a platform for improving the Nigerian election process. He stated:

*“The masses can have trust on INEC staff due to transparency because SCR will authenticate and count the number of voters accredited. Before now, most politicians thought that they can use their money to manipulate the election. There is good potential with SCR for reducing the electoral malpractices”*

With the problem defined and actors identified in problematisation phase, a restricted network of the e-electoral process was set up in the commission. This is done with the interest and dedication of the principal actors based on the technical artifact, non-technical infrastructure, and election officials. Having shown the linkage and stabilization of other actors, principal actors or owners become indispensable and force other actors to accept roles in the network formation based on their interest.

The technical artifacts were purchased. As stated by some of the interviewees:

*“It was contracted to a company in China and some of INEC staff went on training. The SCR went through pilot study and test. Software and other chips were installed in it. The machine was initially known as INEC Voters Authentication System (IVAS) but, after some checks and installation of chips and software to suit its purpose properly, it was regarded as SCR”*

This was done with the assistance of the commission’s ICT staff. The EMB encouraged the INEC officials to become acquainted with the e-electoral processes in the commission. However, the contractors (human actors) detached themselves from joining the network. The alignment of interest is consolidated by the owner after parties of interest (human and non-human) had been attracted. The EMB aligned the interest of all actors of the e-electoral process to concentrate on Obligatory Passage Point (OPP) to achieve the maximum usage of the SCR. As one of the INEC ICT staff expressed:

*“A mock election was conducted and a sample of the used technologies was carried out in the house of assembly. Both agent and political parties were trained on the use of SCR. They all look at it advantage, credibility, adaptability, flexibility and usability”*

### 4.3 Enrolment

Enrolment is a phase where all other actors accept roles defined by the focal actors to align their interest in the network. In this stage, the main actor (that is the EMB) of INEC defines roles of other actors. The features of SCR became clear and were identified as; antenna, Subscriber Identity Module (SIM) card and SIM card batteries which will last for hours. The role of other actors who accept the agreement became interrelated based on the network formation. During the electoral process, actors are engaged in their various activities for the network formation. A staff from INEC office mentioned:

*“There is the presiding officer who is in charge of the ballot at polling unit, assistant presiding officer one (1) is responsible for the operation of SCR, assistant presiding officer two (2) is in charge of the register and poll assistant is responsible for controlling the poll”*

The role of all actors is recognized and coordinated by the focal actors in which their interest will be represented in the network based on the constant agreement.

Though the enrollment stage was successful, there are little challenges of non-availability of INEC ICT trained staff. The hired ad hoc staffs were not fully devoted to the work. There was a problem of the poor power supply and infrastructural decay which weakened the process. INEC officer stated that:

*“The ad-hoc staffs were not attentive on the work. Most of them were just after the payment and these slow the process of election. Also, the SCR in some cases shut down, due to power failure. Some electorates were not authenticated, because the ad hoc staffs were not patient enough to wait for the SCR to respond”*

#### 4.4 Mobilization

This is the stage where the translation is completed. All actors have accepted their roles and were regrouped to perform certain functions. The focal actor (EMB) ensures a representative from each group that serves as a delegate. It is where the focal actors turn out to be the representative of all other actors. ICT officer from INEC mentioned:

*“During the 2015 Nigerian general election, SCR was implemented and electoral malpractice and time wastage was reduced”*

At this stage inscription becomes important. The commission speaks on behalf of other delegated actors to the success of the e-electoral process. As stated by some electorates during an interview:

*“The commission has tried and credit goes to the EMB. This is because; corrupt officers come to power through corrupt means, but with the introduction of ICT tools to electoral processes, corruption was highly minimized. Until the introduction of ICT tool by the EMB that voters were able to vote fully. Missing of ballot papers, rigging, and election violence was wiped out. Therefore, in the absence of role played by EMB, the success of the election would not have been possible”*

The success of the mobilization stage was through the emergence of EMB as the voice of all other actors. In mobilization, there is relationship strength that exists between the actors and delegates. This relationship maintained the stability of network of actors towards Obligatory Passage Point (OPP). The translation model of ANT was successful. However, the mobilization stage was faced with some challenges. The challenges manifested from the disloyalty of some actors as stated in the previous stages, and disenfranchising the disabled from voting. An officer from INEC discussed that:

*“The election processes supposed to be all-inclusive. In this case, the disabled were not carried along. A leaper cannot put his fingers on the machine to be captured and be authenticated. A brail is not provided for the blind to read the contestant and there is no tack tile (voter’s card for the blind) to cast their vote.*

In another case, the interviewee stated that:

*“A lame person using a wheelchair is not considered on setting up the polling unit. An Impaired person is not provided with who to explain to them on what is happening. Also, Network connectivity is another impediment to smooth conduct of elections. The network even within capital cities fluctuates and sometimes completely off. However, most of the officials use their phones to connect their computers”.*

## 5 Discussion

Interpreting the SCR implementation in Nigerian electoral process using ANT concepts, mainly the “Moment of Translation” process, problems were encountered from the early stage of the translation process, regarded as problematisation stage. There was difficulty of cooperation from the national assembly, traditional rulers and community elders by the EMB to be part of the network. This problem extended the SCR implementation involving into a court case. As a result, there was no full support of the

implementation from the national assembly, and other important actors which resulted in weaken of the process at the problematisation stage. Moreover, INEC does not have enough ICT staff, consequent upon which ad hoc staff from the National Youth Service Corp (NYSC) was hired. The hired actors have little knowledge of the SCR implementation and contributed more to the challenges encountered in the process. This is similar to the findings of [6]. In [6], the focal actor failed to include professional and independent organizations with knowledge in the design of ICT project, culminating into poor implementation and the Smart Card ID project failure. In the SCR case, the national assembly and NYSC staff negligence to be fully part of the SCR implementation network marks the starting point of the challenges.

Though the negotiation at the interesement process took place and the SCR was contracted to a company in China, there were still challenges and the process was not fully successful. This is attributed to poor functioning of the devices and poor infrastructure, particularly power shortage. Also, the fund released by government to the INEC for the project was not sufficient to have a successful implementation of the project. Consequently, the INEC officers could not monitor the ad hoc staff effectively to the roles assigned to them in the network. These also contributed to the challenges in the implementation of the SCR. [11] reported that disagreement between fishermen and the scallops led to the failure of the entire breeding program.

In the enrolment process it is evident from the SCR implementation that hired ad-hoc did not take full responsibility of the roles assigned to them by the EMB. Heeks & Stanforth (2015) indicated that the consultant finds it difficult to locate their office in the old colonial era in the Ministry of Finance building. As a result, it weakens the network of technology implementation. Additionally, departmental task forces responsible for the technological change implementation were not formed. These occurred in the case of SCR implementation between the hired staff and the electorate. The hired staff failed to take full responsibilities of the roles assigned to them by the EMB. Some of the electorates were not authenticated due to the weaknesses from the hired staff as well as the SCR power failure. There was no provision in the SCR to capture the disabled, and the SCR is supposed to capture all voters to maintain the rule of the election. This resulted in disenfranchising the disabled. Finally, at the mobilization stage, the disloyalty of some of the actors in the actor-network of SCR caused the challenges in the implementation.

The contextual analysis helped in understanding the formation of ANT and shows clearly the challenges of the implementation. The actors had disagreeing interests at the formation of the SCR implementation network. However, the implementation was completed and the SCR was used despite the challenges.

## 6 Conclusion

The study investigated the implementation of ICT to the electoral process in Nigeria using qualitative-inductive approach through the lens of ANT. The ANT was particularized into the Nigerian electoral processes through the four-translation model. Empirical data was used for the analysis in the context of social behavior between human and non-human actors. At the mobilization stage, there was asymmetry between the principal human actors, the national assembly, traditional rulers, community

stakeholders and the EMB. This weakened the process from inception. Insufficient trained INEC staff necessitated employing the services of ad-hoc staff with poor training in SCR further posed a major challenge.

Apart from the inadequate knowledge on the use of SCR by engaged ad-hoc INEC staff, poor power supply and insufficient funds released to INEC gave room for poor monitoring and implementation of the use of SCR. Thus, the hired ad-hoc staff did not assume the full responsibilities resulting to poor implementation of the use of SCR. Similarly, battery rundown, lack of electricity and inability of the SCR to capture persons with disability were some the other challenges at the enrolment process. Even though, challenges were encountered from all the process, the introduction of ICT (SCR) to electoral processes reduced problems associated with multiple registrations as well as authentication of electorates. Thus, implementation of ICTs to the electoral process should not focus only on the registration and authentication of electorates only, but casting of votes should also be involved. This indicates the need for more research to be conducted on issues of ICTs to electoral process identifying the role played by human and non-human actors.

In addition, election should be all-inclusive; thus, the need to provide facilities to include the people with disabilities into the electoral processes. The current INEC policies guiding the election process in Nigeria does not make provision for the disabled. As a result, electorates with disabilities were disenfranchised from the process. Therefore, INEC needs to provide legal backing and ICTs tools for the disabled electorates.

## References

1. Adegbam, A., Adepoju, B.M.: Good governance in Nigeria: a catalyst to national peace, stability and development. *Afr. Res. Rev.* **11**(4), 144 (2017). <https://doi.org/10.4314/afrrrev.v11i4.12>
2. Ejechi, E.O.: Information communication technology in academics: how far with elderly Nigerian academics? *Int. J. Humanit. Soc. Sci.* **3**(6), 5 (2013)
3. Office for Democratic Institutions and Human Rights: Election Observation Handbook, 6th ed. ODIHR, Warsaw (2010)
4. Avgerou, C.: Explaining trust in IT-mediated elections: a case study of e-voting in Brazil. *J. Assoc. Inf. Syst.* **14**(8), 420–451 (2013). <https://doi.org/10.17705/1jais.00340>
5. McGrath, K., Maiye, A.: The role of institutions in ICT innovation: learning from interventions in a Nigerian e-government initiative. *Inf. Technol. Dev.* **16**(4), 260–278 (2010). <https://doi.org/10.1080/02681102.2010.498408>
6. Gunawong, P., Gao, P.: Understanding e-government failure in the developing country context: a process-oriented study. *Inf. Technol. Dev.* **23**(1), 153–178 (2017). <https://doi.org/10.1080/02681102.2016.1269713>
7. Olusadum, N.J., Anulika, N.J.: Electronic voting and credible election in Nigeria: a study of owerri senatorial zone. *J. Manage. Strategy* **9**(3), 30 (2018). <https://doi.org/10.5430/jms.v9n3p30>
8. Adeshina, S.A., Ojo, A.: Factors for e-voting adoption - analysis of general elections in Nigeria. *Gov. Inf. Q.* (2017). <https://doi.org/10.1016/j.giq.2017.09.006>
9. Stake, R.E.: *Qualitative Research: Studying How Things Work*. Guilford Press, New York (2010)







10. Walsham, G.: Doing interpretive research. *Eur. J. Inf. Syst.* **15**(3), 320–330 (2006). <https://doi.org/10.1057/palgrave.ejis.3000589>
11. Callon, M.: Some elements of a sociology of translation: domestication of the scallops and the fishermen of St Brieuc Bay. *Sociol. Rev.* **32**(1\_suppl), 196–233 (1986). <https://doi.org/10.1111/j.1467-954X.1984.tb00113.x>
12. Latour, B.: On actor-network theory: A few clarifications, pp. 369–381 (1996)
13. Law, J.: Notes on the theory of the actor-network: ordering, strategy, and heterogeneity. *Syst. Pract.* **5**(4), 379–393 (1992). <https://doi.org/10.1007/BF01059830>
14. Callon, M., Latour, B.: Unscrewing the big Leviathan: how actors macro-structure reality and how sociologists help them to do so, vol. 17 (1981)
15. Twum-Darko, M., Noruwana, N., Sewchurran, K.: Theoretical interpretation of e-government implementation challenges in South Africa: a case study of a selected provincial government. *J. Gov. Regul.* **4**(1), 175–185 (2015). [https://doi.org/10.22495/jgr\\_v4\\_i1\\_c2\\_p2](https://doi.org/10.22495/jgr_v4_i1_c2_p2)
16. Stanforth, C.: Using actor-network theory to analyze e-government implementation in developing countries. *Inf. Technol. Int. Dev.* **3**(3), 35–60 (2007). <https://doi.org/10.1162/itid.2007.3.3.35>
17. Heeks, R., Stanforth, C.: Technological change in developing countries: opening the black box of process using actor–network theory. *Dev. Stud. Res.* **2**(1), 33–50 (2015). <https://doi.org/10.1080/21665095.2015.1026610>
18. De', R.: Electronic governance theory. In: ICEGOV International Conference on Theory and Practice of Electronic Governance, vol. 5 (2008)
19. Mwenya, J.K., Brown, I.: Actor-network theory in IS research: critique on application of the principle of generalized symmetry. In: Proceedings of the South African Institute of Computer Scientists and Information Technologists on - SAICSIT 2017, pp. 1–10. ACM Press, Thaba 'Nchu, South Africa (2017). <https://doi.org/10.1145/3129416.3129448>
20. Braga, C., Suarez, M.: Teoria Ator-Rede: novas perspectivas e contribuições para os estudos de consumo. *Cadernos EBAPE.BR* **16**(2), 218–231 (2018). <https://doi.org/10.1590/1679-395164275>
21. Vicsek, L., Király, G., Kónya, H.: Networks in the social sciences. *Corvinus J. Sociol. Soc. Policy* **7**(2), 77–102 (2016). <https://doi.org/10.14267/CJSSP.2016.02.04>
22. Klein, H.K., Myers, M.D.: A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Q.* **23**(1), 67 (1999). <https://doi.org/10.2307/249410>
23. Thapa, D.: The role of ICT actors and networks in development: the case study of a wireless project in Nepal. *Electron. J. Inf. Syst. Dev. Countries* **49**(1), 1–16 (2011). <https://doi.org/10.1002/j.1681-4835.2011.tb00345.x>
24. Nurdin, N., Stockdale, R., Scheepers, H.: Coordination and cooperation in e-government: an Indonesian local e-government case. *Electron. J. Inf. Syst. Dev. Countries* **61**(1), 1–21 (2014). <https://doi.org/10.1002/j.1681-4835.2014.tb00432.x>
25. Fenwick, T., Edwards, R.: Introduction: reclaiming and renewing actor network theory for educational research. *Educ. Philos. Theor.* **43**(sup1), 1–14 (2011). <https://doi.org/10.1111/j.1469-5812.2010.00667.x>
26. Braun, V., Clarke, V.: *Successful Qualitative Research: A Practical Guide for Beginners*. SAGE, Los Angeles (2013)
27. Wright, S.: Exploring actor-network theory and CAQDAS: provisional principles and practices for coding, connecting and describing data using ATLAS.ti. In: Institutional Repository of Technische Universität Berlin, vol. 31 (2015). <https://doi.org/10.14279/depositonce51>
28. Bengtsson, F., Lundström, J.E.: ANT-maps: visualising perspectives of business and information systems. In: Thirty Fourth International Conference on Information Systems, Milan, vol. 17 (2013)

# **Digital Platforms for Development**



# A Multi-level Perspective on Digital Platform Implementation and Impact: The Case of EasyTaxi in Colombia

Juan Erasmo Gomez-Morantes<sup>1</sup> , Richard Heeks<sup>2</sup>  ,  
and Richard Duncombe<sup>2</sup> 

<sup>1</sup> Systems Engineering Department, Pontificia Universidad Javeriana,  
Bogotá, Colombia

[je.gomezm@javeriana.edu.co](mailto:je.gomezm@javeriana.edu.co)

<sup>2</sup> Centre for Development Informatics, University of Manchester,  
Manchester, UK

[{richard.heeks, richard.duncombe}@manchester.ac.uk](mailto:{richard.heeks, richard.duncombe}@manchester.ac.uk)

**Abstract.** Growth of digital platforms in developing countries has yet to see equivalent growth in research. This paper presents one of the first conceptualised analyses of platform implementation and impact. Using the “multi-level perspective”, it analyses a successful ride-hailing platform: EasyTaxi in Bogotá, Colombia. This was originally a niche innovation but has effected a socio-technical transition to a dominant position within Bogotá’s taxi regime. Speed of transition is explained in terms of tensions within that regime and from wider demographic change, combined with specific utility of the platform to drivers and passengers who faced a prior context of exploitation, mistrust and insecurity. Though the new regime is a hybrid of platform and non-platform features, its impacts can already be seen: datafication, formalisation, and shift in power away from old taxi operating companies and towards passengers and, in particular, towards the platform itself. Alongside case-specific insights, the paper demonstrates the utility of the multi-level perspective as a means to analyse the enactment of digital platforms.

**Keywords:** Digital platform · Socio-technical transitions · Multi-level perspective · Ride-hailing

## 1 Introduction

Digital platforms – “a set of digital resources—including services and content—that enable value-creating interactions between external producers and consumers” [5: p. 381] – play a rapidly-growing role in the socio-economic life of developing countries [18]. Yet the research literature is dominated by studies focused on the global North, leaving knowledge gaps along the entire lifecycle of platforms in the South: design–implementation–adoption–impact [*ibid.*].

This paper contributes with one of the first case studies of a developing country digital platform analysing implementation and impact; selecting EasyTaxi – a ride-hailing platform first developed in Brazil, though the focus here is its role in the capital,

Bogotá, of neighbouring Colombia. First introduced in Colombia in late 2012, within less than three years EasyTaxi dominated the taxi bookings market, prompting our first research question to explain why such a rapid change took place. We secondly wish to understand the nature of this change: not just the micro-level of taxi bookings but the broader structural impacts of digital platform introduction. To help shape our analysis, we understand platform-based change as a socio-technical transition; specifically using the ‘multi-level perspective’ (MLP) as a frame [10]. Following a review of literature and methods, the paper presents MLP-structured findings, and then conclusions.

## 2 Literature Review

The rapid global spread of digital platforms is partly real because of the billions of users adopting them and partly terminological as ‘platform’ has become a label of choice attached to the likes of Google, Facebook, iTunes, Uber, etc. This rapid growth has been matched by a growth of published research on platforms, yet there has been a serious research lag such that, for example, research agenda-setting papers are only just emerging [6]. This is especially true of work on platforms in developing countries: as one indicator, in the three leading ICT4D journals<sup>1</sup> there are only six published papers with ‘platform’ in the title; all published since late 2016.

This was part of a more systematic review of 76 papers on digital platforms in developing countries<sup>2</sup>. More than half were computer science papers that focused on platform design and architecture, and the next largest group were design-oriented, analysing context or intended adoption (e.g. using the Technology Acceptance Model) in order to inform platform design. There was a group of six papers looking at broader strategy, such as best practice for platform governance or design of the wider platform ecosystem. Another group of six looked at current use of particular platform functions, mainly of e-learning and social media platforms.

Only three papers looked at the implementation of platforms, and their focus was mainly on challenges to adoption. Only one [21] drew out factors behind successful adoption. Using an actor-network theory sensitisation, it identified the need for platforms to incentivise use among multiple user groups if they are to succeed. Five papers analysed impact<sup>3</sup> in some way; of these four were positivist in approach, providing a quantitative analysis of micro-level impact e.g. on individual behaviour. One [29]

<sup>1</sup> *Information Technology for Development, Information Technologies & International Development, Electronic Journal of Information Systems in Developing Countries* [15].

<sup>2</sup> This searched three sources for “platform” in the title: the three ICT4D journals; the same search in the three leading development studies journals (*World Development, Journal of Development Studies, Development and Change*) which identified no relevant papers; and a Google Scholar search - intitle: “platform” (digital AND “developing countries” AND “information systems”). In total, this identified 76 relevant papers.

<sup>3</sup> As might be expected there was some sense of research chronology, with earlier papers focusing on design and feasibility issues, and with implementation- and impact-oriented studies only emerging later.

looked specifically at ride-hailing platforms in India and focused on driver livelihoods, with drivers reporting income and skill increases.

The review thus found no papers to date addressing the two questions – on speed of adoption, and the broad picture of impact – that inform this study. Where a conceptual framework was used to shape analysis – and often there was no such framework or concepts were induced from the analysis – then this was a patchwork of different ideas. Given this, alongside lack of theory directly addressing our questions, it was appropriate that we looked outside the platform studies literature for our conceptualisation.

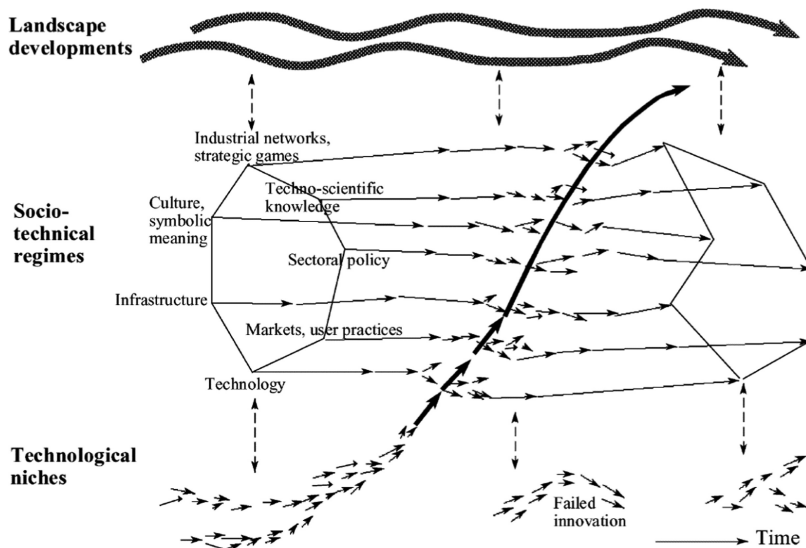


Fig. 1. The multi-level perspective on socio-technical transitions [8].

Because of our focus on change but also the need – described in the literature above – to incorporate issues such as human incentives, groups and livelihoods alongside the technology of the platform, we identified equivalence between the introduction of digital platforms and the idea of socio-technical transitions: changes from one socio-technical configuration to another [8]. In particular we saw the relevance of the conception of socio-technical transition via the multi-level perspective [*ibid.*, p. 9]. Summarising significantly (see also Fig. 1), this focuses on three elements, understood to operate at different levels:

- The broader landscape of long-term “demographical trends, political ideologies, societal values, and macro-economic patterns” [11: p. 28] that are “beyond the direct influence of actors” [9: p. 913]. This represents the wider context within which a socio-technical regime operates.
- The socio-technical regime: a configuration of linked elements including “technology, user practices and application domains (markets), symbolic meaning of technology, infrastructure, industry structure, policy and techno-scientific

knowledge” [8: p. 1262] that guide the activities of actors in some common endeavour. The definition of regime elements differs between writings on MLP and, in our analysis, we will organise these into four regime elements, drawing on Geels [12] and Scott [27]. These are: resources (physical artefacts such as technology but also intangible assets such as data), routines (standard processes and practices), relations (social connections between actors), and institutions (both formal such as regulations and informal such as discourse). These are not only seen to structure activity but also – germane to our later analysis – to constitute the key components of power within the multi-level perspective [1]. The boundary for the “common endeavour” will in our case be the taxi sector in Bogotá, within which a socio-technical transition – introduction and widespread adoption of a digital platform – occurs.

- The technological niche is a relatively protected space within which learning and innovation can occur. As indicated in Fig. 1, innovations typically make their way into contact with the existing regime. Some fail but others succeed and, in doing so, they reconfigure the regime; transitioning it from one socio-technical system to another.

Although this has not yet, to our knowledge, been applied for analysis of digital platforms, the MLP framing offers a relatively comprehensive way to understand the wider development implications of introduction of platforms: both factors that shape the transition to a platform-based regime, and the changes that occur in that transition.

### 3 Methods

We adopted a case study research strategy: not only, as our literature review indicated, has this been typical of analyses of digital platforms [see also 6] but it was also specifically relevant to the type of questions around impact and speed of platform adoption that we wished to answer [4, 31]. We selected EasyTaxi for three main reasons: the rapidity and extent of its adoption made it a platform success story: one that has sustained and has had sufficient impact to warrant analysis; it is representative of a type of platform now operating in most developing country cities, making it of general interest; and key stakeholders were willing to participate in data gathering. It can also be seen as fairly typical of digital platforms: both referring to itself as a platform and fitting the definition given above because it provides digital resources (an app, location-based mapping, rating scheme, etc.) that enable value-creating interactions (taxi bookings and journeys) between external service producers (taxi drivers) and consumers (passengers) with EasyTaxi acting as platform intermediary for this two-sided market. Though the phone-/tablet-based app is the most visible component, it is the back-end, server-based platform that holds the power of data, data analysis, and market/driver management.

Interview schedules were designed around the multi-level perspective framework (landscape, regime components, niche innovation), and 24 interviews were conducted in total: 14 with taxi drivers (both users and non-users of EasyTaxi), 4 with EasyTaxi

managers, 3 with central and city government officials, and 3 with other stakeholders (taxi owners, union officials). In addition there was a form of participant observation in being a passenger-user of EasyTaxi, and secondary documentation analysed included commercial brochures, regulatory documents, and news articles. Transcribed notes from all sources were combined and analysed using NVivo; with a first coding cycle using attribute and descriptive coding techniques then being refined and categorised based on the MLP [25].

## 4 Findings

### 4.1 The Pre-existing Regime

Travel by taxi makes up 8% of motorised journeys in Bogotá [24] and, in terms of routine practices, Bogotá's yellow cabs pick passengers either through on-street hailing or through pre-booking. Historically, pre-booking was made by phone to one of the city's taxi operating companies (TOCs) that owned memorable phone numbers (e.g. 211-1111) and also owned radio frequency licences. The booking would generally be communicated to drivers via an open radio call from the TOC despatcher with the first driver to arrive at the location getting the fare: "*They cut each other off, one of them would jump into the pavement, and they could even get into a fist fight in the street. It was terrible*" (Taxi Driver 1). During the early 2010s, a few taxis had a GPS-based screen system installed with on-screen response. Taxi owners – it was relatively rare that drivers would own their vehicle [24] – paid a monthly *rodamiento* fee to the TOCs: affiliation to a TOC was an operational requirement. The fee ranged from around US \$18 without a radio (i.e. just on-street hailing) up to c.US\$55 for affiliation with GPS installation. Drivers also had to register with a TOC, though this was often quite informal. Drivers paid the owner a flat-rate fee per shift of around US\$45 plus a deposit (c.US\$175) and daily 'savings' (c.US\$2.50) that are accrued against any accident damage to the cab; they also paid fuel costs (c.US\$20) and a daily carwash fee (c.US \$2.50).

The oligopoly power of taxi operating companies – three-quarters of taxis were affiliated to just five TOCs [16] – was based on resources and relations: the power of easy-recall phone numbers, the cost and scarcity of radio frequency licences, and contacts with national and local transport regulators. Taxi owner power but also competitive pressures arose from scarcity of taxi operating licences as a resource: capped at 50,000 since the early 1990s, the cost of buying a taxi operating licence from an existing owner had risen to more than US\$40,000 by the mid-2010s. Looking at drivers, the industry was described as a "*receptacle of poverty*" (City Official): high unemployment and poor social security pushed individuals to take up taxi driving in order to earn money, and there was strong competition for work. From a resource dependency perspective, then, TOCs and owners could readily substitute drivers, and this served to weaken the power of driver unions. Other social institutions – such as those of law enforcement – also had weaknesses which shaped the regime.

This provided some basis of stability for the regime in terms of main actors: regulatory institutions were unchanging; barriers to entry were so high for TOCs and

even for taxi owners that their structures were static; and the churn of individual taxi drivers made little difference to the regime.

However, these factors also underpinned tensions that created a backed-up pressure for change. Three resource-competitive forces intersected on drivers; from taxi owners for earnings, from other drivers competing for fares, and from the pool of unemployed who could substitute them. These led to various over-competitive practices among drivers: refusing passengers wanting low-value journeys; aggressive driving to reach a potential fare first and to complete journeys quickly; refusing to use the meter and other forms of overcharging; hacking the meter in order to extract higher earnings; complicity in robbery of passengers (see also [3, 7, 22]). TOCs had some power to address this through sacking or fining drivers: however, drivers could register from scratch – with a clean record – with a different TOC (though taking a hit on earnings when moving to one with a smaller market share). Poverty, criminality and institutional weakness within wider Colombian society led to “millionaire rides” (fake drivers and accomplices robbing passengers by taking them to one ATM after another to obtain cash) and felonious passengers robbing taxi drivers (who generally only transacted in cash). Whatever the actual prevalence of these activities, it was their widespread profile that fostered insecurity and mistrust of drivers and passengers.

Mistrust was also rife between drivers and owners/TOCs because of the perceived exploitative nature of their relationship with asymmetries of risk-bearing and value-taking. TOCs were seen as rent-seekers, monetising their resource oligopoly but not intervening in disputes between owners and drivers, not training drivers, and assuming no responsibility for the quality of the service, the working conditions of drivers, or the cars: “*the TOCs won’t help you with anything*” (Taxi Driver 2). Efforts to regularise the employment status of drivers e.g. to provide training, insurance, pensions were blocked by the TOCs. Owners bore some risk but, if they had problems with drivers e.g. around sickness or late payments, they just got rid of them. Drivers bore the main costs and risks: accidents, breakdowns, robbery, traffic tickets, lack of passengers, and being stuck in Bogotá’s congestion were all their problem. When fuel prices rose, that ate into their earnings. Owners sometimes faced increased costs e.g. if the *rodamiento* charge was increased, and sometimes faced increased earnings opportunities e.g. if city-wide fares were increased. In either case, they increased the tariff charge to drivers; passing on cost rises, capturing price rises.

## 4.2 The Landscape

If fracture lines were apparent within the regime, they were opened further by landscape pressures. As noted, the number of taxi licences had been static for >20 years; yet, during that same period, the population of Bogotá rose from 5.5 m to 8 m. Combined with GNI per capita growth from US\$1,000 to c.US\$7,000, urban mobility and demand for transportation increased significantly, making it increasingly difficult for passengers – often middle-class and politically-vocal – to get a taxi during peak hours. At the same time, the technological terrain was shifting. Colombia is only an



average digital economy performer in regional terms but the Ministry of ICT has helped create reasonable competition, pricing, portability of numbers, and service quality in the mobile broadband market [20]. Supported by a growing ecosystem of mobile/broadband service providers and phone/tablet suppliers, retailers and repairers; mobile penetration rose from 6 subscriptions per 100 people in 2000 to 120 per 100 in 2015; mobile broadband rose from 9 per 100 in 2009 to 42 per 100 in 2015 [17].

### 4.3 The Niche Innovation

Into this highly-susceptible context of internal and external pressures stepped EasyTaxi as a personal transportation digital platform. At its core is a smartphone app bringing a different routine. Passengers register their details on the platform via the app and place a journey start/end booking; the first available driver to respond gets the booking; the passenger can then see the driver location, estimated time to pick-up, driver/vehicle details, and estimated fare; the app tracks the journey, and at the end the passenger can rate the driver and other aspects of the trip. Passengers can register and pay in-app via credit card, but in practice the great majority of payments are still made by cash (drivers are less likely to accept pay-by-card bookings). While guided by the EasyTaxi estimate, fares are still calculated by taxi-meter and according to the standard tariff set by the city transport department. Once drivers are registered, they are charged a US\$0.30 per-booking fee which decreases the greater the number of bookings in a given month (a very different philosophy from the flat-fee payment drivers must make to the cab's owners). The app is just the interface for the underlying platform which captures all the data; estimated at up to 300,000 passenger/driver requests per minute across all of EasyTaxi's multi-country operations [2].

EasyTaxi's design had to provide utility to two main groups: drivers and passengers. For drivers, the promise is that they will get more bookings more easily with fairer treatment and, more powerfully and particularly as network effects take hold, there is the threat of losing business if not registered with EasyTaxi. For passengers, there is a greater sense of certainty and security that the app confirms the booking, allows them to track the taxi, and to know and check the identity of their driver.

Network effects are a major challenge for digital platforms seeking to effect a socio-technical transition: the value of the platform to users increases exponentially as more buyers and sellers join and, hence, the platform must rapidly recruit both. Thus platforms may not readily have the type of protection seen as typical for niche innovations: time free from market and other pressures of the existing regime in order to learn, build relationships, revise designs, etc. [8]. However, EasyTaxi was able to protect itself in three ways in Brazil (EasyTaxi Manager 1, see also [19, 23, 26, 28]). During 2011, the development team attended three start-up "boot camp"-type events (winning competitions in each) that enabled highly-accelerated learning, iteration and relationship building with key business, urban governance and finance stakeholders. During 2012–2013, EasyTaxi received successive rounds of substantial external finance that provided time and space for further revisions but also to build the base of users to a sufficient level. And the agile, "lean start-up" approach used by the development team greatly reduced the protection time required for innovation. For the Colombia

implementation, the original Brazil developments represent a protected niche from which a near-complete product could be transferred<sup>4</sup>.

Like all platform implementations, roll-out in Colombia faced a series of barriers but, in part due to learning from the earlier implementation in Brazil, these were relatively easily surmounted. Regulatory barriers and the social capital of existing taxi firms were sidestepped when the government accepted ET's argument that it was a communications services, falling just under the jurisdiction of the Ministry of ICT, rather than a transportation service, which would have fallen under the multiple jurisdictions of the National Transit and Transportation Ministry, the Ports and Transport Superintendency, and agencies within Bogotá City Council. Taxi drivers lacked phones – fewer than 1% had smartphones in 2012 (EasyTaxi Manager 1) – and capabilities to use them, so EasyTaxi sent its marketers to lunch or rest spots “*where drivers concentrate*” (EasyTaxi Manager 2). They lent out smartphones, ran training courses and offered free test periods during which no charge was made until they had built a critical mass of drivers and passengers. That critical mass was essential in overcoming the epistemic barrier of awareness: an advertising and promotional campaign was run but word of mouth – from drivers to other drivers, from drivers to passengers, from passengers to drivers – was key to diffusion and adoption. By the end of 2015, there were more than 55,000 driver-users in Colombia (up from 18,000 two years previously and from zero four years previously<sup>5</sup>); it was being used by the majority of drivers in Bogotá (though often in combination with other apps). EasyTaxi had a claimed 90% market share of ride-hailing apps in Colombia<sup>6</sup> and the great majority of driver bookings now came from EasyTaxi not the traditional radio/GPS system. Competition has also, at least to some extent, been addressed. TOCs tried to stop drivers using the platform, but in vain: “*What they've done is try to talk to taxi drivers, tell them “look, if you use EasyTaxi, you cannot work with us”. At the end, when EasyTaxi starts to send more bookings than [TOCs], that threat, to put it that way, loses its value*” (EasyTaxi Manager 1). Attempts by TOCs to set up their own app largely failed with only Taxis Libres surviving, and then only with small market share. Local firm Tappsi launched at around the same time. While it existed as a separate app until 2018, the firm was bought and then steadily merged into EasyTaxi's operations from late 2015. Only Uber, which launched “quietly” in 2013 has presented serious competition since around 2015. But it has faced far more aggression from traditional taxi firms, owners and drivers and from government than has EasyTaxi because it does not work with the traditional, licensed yellow taxi drivers [14, 30]. This has worked to the advantage of EasyTaxi as Uber, rather than it, has acted as the lightning rod for resistance to change in the taxi industry.

<sup>4</sup> Though a number of local customisations were still required e.g. around ways to specify passenger location; something notoriously difficult in Bogotá and other Colombian cities.

<sup>5</sup> By 2018, this was 110,000 with more than two million passenger-journeys per month [13].

<sup>6</sup> Though this includes EasyTaxi's merger with Tappsi.

#### 4.4 Regime Transition

As per the model above, we look here at four regime elements that change during the transition: routines, relations, resources and institutions. EasyTaxi inscribes into the app elements of the journey process and captures data about them for its platform; elements that were not previously formally recorded: booking, passenger and driver locations, directions to reach the passenger, reporting the passenger on board, cancellations, journey route and completion, passenger rating of driver. Data that was largely lost in the past is thus now owned by the platform, which has allowed it to undertake data-based algorithmic management. At an operational level, for example, it checks that drivers adhere to certain performance standards and intervenes if they fall short. At a more strategic level, it analyses booking demand patterns and advises drivers about prime times and locations. Notwithstanding ownership of data by the platform, some is shared: passengers get critical data they previously lacked: the visual identity and rating of their driver, type of taxi, the taxi's exact location and route; and drivers also get new data e.g. a record of their bookings and estimated fares.

The technology ownership system has changed. Memorable phone numbers are still owned by the TOCs, but their value was steadily diminishing as more bookings were made via the digital platform. Radio and GPS systems were typically owned by the TOC and rented by owners but drivers own their smartphones/tablets themselves. The multi-functionality of these devices has also been exploited by drivers: they use Waze/Google Maps to find their way to passengers and to plot journeys; they use WhatsApp to share information with other drivers about accidents, road blocks, or police operations. But one notable feature was that – while the old GPS systems had been ditched since EasyTaxi had rendered them redundant – radios were still retained in most cabs. A central feature of a taxi platform is that it disintermediates the despatcher out of the process, but drivers valued what the despatcher provided. They could ask for directions not well-covered by map apps e.g. specific buildings; and especially they sought help when there was a problem; particularly to summon help from fellow taxi drivers.

This latter was a recurrent interview theme: continuing presence and importance of driver groupings. Some of these were formal such as the unions which organised protests against Uber. Others were small, informal groups called via the radio – and rapidly responding – for example if a driver faced an aggressive or non-paying customer. These acted as a counter-balance to what would have been the 'natural' structural relations of the new regime; an atomised and automated relation just between individual drivers and the digital platform. Even EasyTaxi itself had countered this because it organised feedback channels between the company and the drivers: not just email and social media but periodical focus groups to get feedback on the app specifically and more generally on the function of the platform-based approach. Passengers similarly – who could only contact the old TOCs via the despatchers on the main phone number – were given multiple contact channels: in-app feedback, email, social media and a call centre.

Finally, if we turn to institutions, we can see a regulatory shift. The quotidian regulation of drivers used to come via owners or TOCs but it was fairly loose, informal and sometimes rather capricious. Under the new regime, registration procedures with

EasyTaxi are much stricter than those with the TOCs. Operational regulation of drivers' actions is undertaken – often algorithmically – formally and objectively by the platform. Given EasyTaxi's dominant market position, drivers no longer have the option of cleaning their records by quitting and registering with a different platform as they could do with TOCs. So driver behaviour is more tightly constrained than previously.

In terms of discourse, there has been a shift towards more positive framing: not just EasyTaxi's press releases finding their way into the media but the positive reactions of drivers and passengers towards the app, with international travellers, for example, continuously recommending use of EasyTaxi as a way to stay safe in Bogotá. However, reflecting the legacy of the old regime either in the perception or reality of relations, negative sentiments were not far from the surface: ET's senior manager describing taxi drivers as “gang bangers and very quarrelsome”; passengers complaining about continuation of poor practices such as bad driving and overcharging; and drivers concerned that EasyTaxi could be as monopolistic as the TOCs.

This last point reflects a broader issue of what does not change. Uber requires a complete change: new vehicles, new licensing, new driver selection, etc. and runs a dedicated and stand-alone service. But EasyTaxi works with and does not require change to, many of the features of the pre-existing regime. Regulatory oversight remains the same: EasyTaxi itself may be ICT Ministry-regulated, but taxis and drivers using the app remain under the jurisdiction of the same and various transport-related government agencies. Owners and drivers – allowing for exclusion of some “rotten apples” who cannot work with the new system – remain the same. And, by allowing drivers to use EasyTaxi as one of multiple booking systems, even TOCs were not head-on excluded: indeed, affiliation to a TOC remains an operational requirement for drivers and is the only explanation for their continuing existence. Just that, like the boiled frog, the TOCs are being slowly weakened and in time are likely to be superseded.

## 5 Conclusions

Growth of digital platforms in developing countries has not yet been matched by growth in research on this phenomenon; particularly conceptualised analysis of implementation and impact. A first contribution of this paper is the demonstrated relevance of understanding successful platforms as socio-technical transitions, and analysing them using the multi-level perspective.

Turning to our initial research question, the rapidity of transition from a call- to platform-based booking system for taxis in Bogotá emerges from the MLP as deriving from two main factors: the push of pressures within the landscape and the pre-existing regime that was matched by the pull of utility of the application for two key groups: drivers dissatisfied with their treatment by TOCs; passengers dissatisfied with service and security standards. But it also required enablers: landscape enablers of a necessary technological infrastructure; design enablers of incremental rather than discontinuous change; and implementation enablers in effective handling of potential barriers of technology, skills, knowledge, regulation and competition.

At the time of research, the transportation regime in Bogotá still had a hybrid format; mixing the old radio-based, TOC-dominated regime and the new app-based,

platform-dominated regime. In part, this was a hybridity of transition; moving from the old to the new. But it was also a hybridity of design: EasyTaxi, unlike Uber, working within existing regulations and processes such as metered fares. And it was a hybridity of choice shaped particularly by the context of insecurity and mistrust that has pervaded transport in Bogotá: drivers continuing rental and use of radios; continuing strength of informal driver groups; even design decisions like the provision of an EasyTaxi call centre for passengers.

Notwithstanding its hybrid nature, we can already identify three impacts associated with introduction of this platform that help address our second question. First, datafication, with the capture, storage and analysis of digital data about many aspects of personal transportation that was previously lost in the ether or at least the value of which was not being captured. Two other impacts flow from this datafication. There has been a formalisation of some processes; particularly the before, during and after of passenger journeys, and some aspects of the management of drivers. This was in part a reaction against institutional informalities that are typical of developing countries.

As a final impact, one can see some shifts in power as a result of the platform's introduction. Passengers have been empowered to some extent thanks to the new data flows which help address the previous informational uncertainty and nescience which had fed fear and insecurity about travel in Bogotá. But the key change has been some transfer of power from the old taxi operating companies to the platform. Not merely due to the declining market share of the former but also the loss of value of the resources they control. And also due to the significant value of the data the platform now owns, the transfer of responsibility for driver management to the platform's algorithms, and the more positive discourse that circulates about EasyTaxi.

One may also comment on what has not changed. Although they have been happy with the platform to date, the position of drivers has not changed much in terms of power. Through their support groups and use of the radio, they have acted to resist some potential loss of power to the platform. However, the emergence of EasyTaxi as a virtual monopoly in the app-booking market is a threat, with potential for "Meet the new boss. Same as the old boss" in terms of the power to exploit drivers that has been seen in other markets. Fortunately, Uber is around to – switching expressions – act as bad cop to EasyTaxi's good cop.





## References

1. Avelino, F., Grin, J., Pel, B., Jhagroe, S.: The politics of sustainability transitions. *J. Environ. Plan. Policy Manag.* **18**(5), 557–567 (2016)
2. AWS: About EasyTaxi. Amazon Web Services, Seattle (2015)
3. Ballen Pachon, L.F.: *La Fiebre Amarilla en Bogotá: Los Taxímetros Fuera de Control*. Universidad del Rosario, Bogotá (2012)
4. Benbasat, I., Goldstein, D.K., Mead, M.: The case research strategy in studies of information systems. *MIS Q.* **11**(3), 369–386 (1987)
5. Constantinides, P., Henfridsson, O., Parker, G.G.: Introduction—platforms and infrastructures in the digital age. *Inf. Syst. Res.* **29**(2), 381–400 (2018)

6. de Reuver, M., Sørensen, C., Basole, R.C.: The digital platform: a research agenda. *J. Inf. Technol.* **33**(2), 124–135 (2018)
7. Fink, H.A.B.F.: Corrupción en la policía de tránsito. Una primera aproximación a través de entrevistas con taxistas colombianos. *Relaciones* **32**(126), 67–85 (2011)
8. Geels, F.W.: Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study. *Res. Policy* **31**(8), 1257–1274 (2002)
9. Geels, F.W.: From sectoral systems of innovation to socio-technical systems: Insights about dynamics and change from sociology and institutional theory. *Res. Policy* **33**(6–7), 897–920 (2004)
10. Geels, F.W.: Ontologies, socio-technical transitions (to sustainability), and the multi-level perspective. *Res. Policy* **39**(4), 495–510 (2010)
11. Geels, F.W.: The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environ. Innov. Soc. Transit.* **1**(1), 24–40 (2011)
12. Geels, F.W.: Regime resistance against low-carbon transitions: introducing politics and power into the multi-level perspective. *Theory Cult. Soc.* **31**(5), 21–40 (2014)
13. Gonzalez, M.C.: Easy Taxi y Tappsi se fusionan y duplicarían su capacidad, Portafolio, 11 June 2018
14. Griffin, O.: Uber’s Colombian speed bumps. *TechCrunch*, 24 March 2016
15. Heeks, R.: An ICT4D journal ranking table. *Inf. Technol. Int. Dev.* **6**(4), 71–75 (2010)
16. Ibanez Perez, M.P.: Viabilidad Técnica y Financiera del Servicio de Taxis en el Sistema Integrado de Transporte Público. Universidad Nacional de Colombia, Bogotá (2012)
17. ITU: ICT Eye. International Telecommunication Union, Geneva (2018)
18. Koskinen, K., Bonina, C., Eaton, B.: Digital Platforms in the Global South. DIODE Paper no. 8, CDI, University of Manchester, UK (2018)
19. McConnell, K.: Brazilian entrepreneurs innovate with smartphones, US Mission Geneva, 23 November 2011
20. Meltzer, J.P., Marulanda, C.P.: Digital Colombia. Brookings Institution, Washington, DC (2016)
21. Moitra, A., Kumar, A., Seth, A.: An analysis of community mobilization strategies of a voice-based community media platform in rural India. *Inf. Technol. Int. Dev.* **14**, 116–133 (2018)
22. Muse, T.: The danger of the millionaire ride. *Newsweek*, 26 June 2013
23. Oliveira, R.: Dicas de Tallis Gomes (Ceo do EasyTaxi) sobre como criar uma startup de sucesso. *SmallData*, 8 November 2013
24. Rodriguez-Valencia, A.: Taxicab operation in Bogotá, Colombia. *Transp. Res. Rec.* **2416**(1), 92–99 (2014)
25. Saldana, J.: *The Coding Manual for Qualitative Researchers*. Sage, London (2009)
26. Scheller, F.: ‘App’ de táxi recebe aporte de R\$ 10 milhões. *Estadao*, 13 October 2012
27. Scott, W.R.: *Institutions and Organizations*, 4th edn. Sage, Los Angeles (2014)
28. Stewart, E.: Easy Taxi recibió inversión de US\$15 millones de Rocket Internet. *PulsoSocial*, 25 June 2013
29. Surie, A., Koduganti, J.: The emerging nature of work in platform economy companies in Bengaluru, India: the case of Uber and Ola Cab drivers. *E-J. Int. Comp. Labour Stud.* **5**(3) (2016)
30. Wade, J.: National taxi driver protest against Uber clogs roads across Colombia. *Finance Colombia*, 10 May 2017
31. Williams, M.D., Dwivedi, Y.K., Lal, B., Schwarz, A.: Contemporary trends and issues in IT adoption and diffusion research. *J. Inf. Technol.* **24**(1), 1–10 (2009)



# Exploring Tensions of Global Public Good Platforms for Development: The Case of DHIS2

Brian Nicholson<sup>1,2</sup>(✉) , Petter Nielsen<sup>1</sup> , Johan Saebo<sup>1</sup> ,  
and Sundeep Sahay<sup>1</sup> 

<sup>1</sup> Department of Informatics, University of Oslo,  
Gaustadalléen 23B, 0373 Oslo, Norway  
brianic@ifi.uio.no

<sup>2</sup> Alliance Manchester Business School, Manchester, UK

**Abstract.** The purpose of this paper is to explore tensions in global public goods (GPG), based on the case of digital platforms for innovation. GPG designs promise normative ideals of non-rivalry and non-exclusivity, which in practice are challenged in reality and fraught with tensions. This paper draws on theory of contradictions to illustrate some of these tensions, which confronts simplistic and linear views that implementing GPG health management platforms will translate unproblematically to efficiency gains. The paper explores field data collected by the authors in the Health Information Systems (HISP) research programme around a digital platform (DHIS2) installed in over 80 countries globally, primarily in the health sector. Episodes are taken from action research undertaken by the authors drawn from experiences of multiple implementations in various countries. This paper furthers the theoretical understanding of contradictions arising from the espoused ideals of GPGs and the realities of their implementation and use. The implications focus on the need to move away from simple deterministic visions of GPG towards acknowledging the contested nature of their outcomes.

**Keywords:** Digital platforms · Health information systems · DHIS2 · Contradictions · Tensions

## 1 Introduction

Discourses around digitalization have become central to research and practice concerning ICT for development (ICT4D). A contemporary ICT4D digitalization research agenda focuses on the notion of “development 2.0” referring to ICT for digital production and innovation offering grassroots development [8]. This paper contributes to a stream of related literature that focuses on exploring the significance of digital platforms in relation to socio-economic development [10].

Digital platforms are broadly defined as multi-sided markets based on value-creating interactions between external producers and consumers, with the platform core serving as a mediator between the multiple sides of the market. Much of the extant literature on digital platforms has emerged from studies of commercial and public

sector platforms situated in the regulative institutions of the global North [6, 7, 12] and the potential for “translation” of these platforms for the global South and the development impact remains understudied. The potential for open digital innovation platform designs to facilitate the ideals of global public good (GPG) such as non-rivalry and non-exclusivity remain understudied.

Our aim is twofold: firstly to improve the current understanding of global public good digital innovation platforms in the context of strengthening health information systems in the global South. Secondly, to contribute to accelerating inclusive innovation through participation of people in the countries themselves. However, we argue that the ideals of GPG are challenged in practice. This paper is guided by the following research question:

“How can global public good platforms facilitate inclusive innovations by enabling effective participation in strengthening health information systems?”

The empirical basis is the case of the University of Oslo Health Information System Programme (HISP) and the open source platform District Health Information Software (DHIS2). We examine this platform through the lens of an organizational tensions framework [11]. This framework recognizes organizations as conflicted sites of activity and takes as its starting point the ‘dilemmatic’ nature of organizing arising from the paradoxes, contradictions and ironies. The paper is organized as follows: in the next section literature on digital platforms is reviewed and the conceptual framework presented. The next section presents the methodology and case description. The findings and analysis is divided into four vignettes that illustrate the tensions of GPG platforms. The paper concludes with some implications.

## 2 Relevant Literature

This section is divided into two parts. In the first, we present our conceptualization of digital platforms relevant to DHIS2 and the notion of digital innovation platforms as global public goods. In the second section, the notion of tensions and paradoxes is presented as the analytical framework.

### 2.1 Digital Platforms

Koskinen et al. [10] broadly identify two types of digital platforms: transactional and innovation. The first category relates to platforms where the main purpose is to facilitate transactions between different organisations and individuals, such as buyers of accommodation with sellers (Airbnb), drivers with passengers (Uber), news, videos and updates (Facebook) etc. Our focus in this paper is on digital innovation platforms that produce content, products or services developed by one or more parties, and which serves as the foundation upon which a larger number of actors can build further complementary innovations. This potentially generates self-reinforcing network effects [4, 6, 7]. An example of a digital innovation platform is the Google mobile operating system ‘Android’ that facilitates third party developers to build applications. Similarly, open source Linux allows for creation of applications across various different devices.



This example of open architecture corresponds to DHIS2 which allows Apps to be developed freely and linked to the core platform architecture. Two main interconnected discourses relating to digital platforms are relevant: innovation studies and ICT for development. There is evidence that digital technologies are taking on platform features of “build once and use multiple times,” creating innovation opportunities that are more socially inclusive. This promises the possibilities for developing country organizations to participate directly in software feature development and direct the use of the platform to address locally relevant problems. However, materializing these innovations in practice across heterogeneous settings is a non-trivial task, involving technological as well as institutional and social innovations. Strategies for this materialization necessarily need to be different from that involved in commercial platforms because of a very different context. Understanding these differences is significant because most extant research addresses software platforms in the commercial sector, with an emphasis on markets in the global North [e.g. 4, 6, 7, 12]. Research in this domain has contributed primarily to the academic and practitioner literatures on design, drivers, business models and regulation of commercial platforms. This focus is unsurprising given the overwhelming dominance of major global platforms such as Apple, Amazon, Facebook, Google and Microsoft [15]. However, even the focus on the specificities of public sector organisations has focused on the global North [2, 5].

Kaul, Grunberg and Stern [9] identify two main characteristics of global public goods. First, is the characteristic of non-rivalry and non-exclusivity. Second, the benefits are quasi universal across groups of people, social groups, geographies, and generations. Considering open digital innovation platforms, licenses allow users to freely run the program for any purpose, modify it as they want, and to freely distribute copies of either the original or their own modified version. However, to date the notion of GPG applied to digital innovation platforms remains under researched.

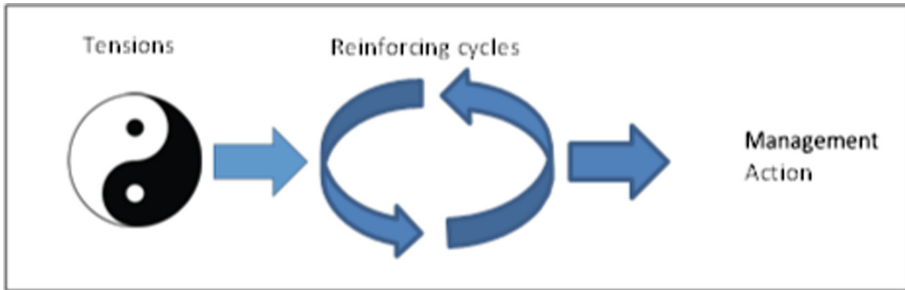
## 2.2 Analytical Framework: Organizational Tensions

A growing body of literature focuses on articulating contradictions and tensions in various organizational settings [16]. This literature contrasts with a view of organizations as stable, consensus driven and rational in favour of a recognition that dualities, ambiguity and contradiction are inevitable normal facets of organizations [13]. An organisational tensions framework recognizes organizations as conflicted sites of activity and takes as its starting point the ‘dilemmatic’ nature of organizing arising from the paradoxes, contradictions and ironies which naturally exist in organizations [18]. There is limited consensus on whether tensions are positive or negative. Wendt [17] for instance argued that tension is detrimental to organizational productivity but more recently Tracy [16] posits that the impact of tensions (whether positive or negative) rests on the way it is managed. However, in many cases, contradictions come with an underlying potential for change.

A contradiction involves an either–or choice between two opposing alternatives; a paradox is a dilemma that demands impossible choices between non-existent or mutually exclusive options. Related to the discourse on contradiction and paradox is the dialectical view, which allows for the merging of opposites by embracing both poles as ‘both–and’ options [13]. Here, dualities are seen as bi-polar opposites that

often work against each other; rather than being simple alternatives between mutually exclusive options, the choice to focus on one pole or the other elicits tensions. Putnam and Boys [13] describe dialectics as interdependent opposites aligned with forces that push-pull on each other like a rubber band and exist in an ongoing dynamic interplay as the poles implicate each other.

To explore contradictions, paradoxes and their resolution (or not, as the case may be) in our field data, we draw on Lewis' framework [11] summarized in Fig. 1 below.



**Fig. 1.** Paradox framework [11]

In this framework, the tensions are expressed using the Taoist notion of yin and yang, implying that the masculine and feminine can co-exist and paradoxically conflict. Cycles of reinforcing repercussions act to embed the opposition. The third component of the frame is management action that may take place to resolve the tension.

### 3 Methodology

In this section, we present the research method firstly by providing description of the case followed by the approach to data collection and analysis.

#### 3.1 Case Description

This research was carried out under the aegis of the global Health Information System Program (HISP), a network of North-South-South collaboration where the University of Oslo, Norway (HISP UiO) has a key role in coordinating the network. This project comprises people working in the health informatics domain with the ambition to strengthen health information systems in developing countries [1].

Technically, anyone can at any time download the most recent version of DHIS2, the source code, and all required libraries and needed third party products (such as Chrome or Firefox browsers). DHIS2 also comes with a set of bundled apps, developed by UiO or through their partners in the South (such as HISP Tanzania for example). Thus, DHIS2 fits well the criteria of being a GPG as downloading the software does not hinder or reduce the possibility for others to do so (non-rivalrous), it is not possible to prevent anyone from downloading it (non-excludable) and it is available more-or- less

worldwide. The DHIS2 platform is used in 65 countries worldwide, 4500 participants have been trained at DHIS2 academies and approximately 2.3 billion people are covered by DHIS2, roughly equal to Facebook users in 2018 ([statista.com](https://www.statista.com)).

### **3.2 Data Collection and Analysis**

The data collection emerged from the authors' individual analyses and collective discussions and reflections concerning paradoxes and tensions across different DHIS2 implementation settings. The case study is interpretive [19, 20] and data was collected during participant observation in implementations and training workshops. We present four vignettes from these combined experiences from respective implementation sites and user groups. The commonality is the use of the same software DHIS2 platforms across sites and over times. These experiences are articulated as vignettes, each reflecting particular tensions, and the efforts involved of the implementation teams in trying to address these tensions. Creating these vignettes has also involved studying existing HISP research papers and PhD theses and reinterpreting them using the lens of tensions.

## **4 Case Study and Analysis**

The case study and analysis are presented below in the form of four main tensions that were experienced in the field. The tensions are identified and an analysis presented of how these contradictions play out and efforts towards their resolution.

### **4.1 Tension: Serving Those that Can Pay for Functionality vs. Those that Cannot**

Software platforms such as DHIS2 are not static but continuously evolving to keep up with the development of technology as well as ever-changing user needs. While any released version of the DHIS2 meets the characteristics of a GPG, the roadmap and the priority regarding the path of the future development of DHIS2 is managed and decided by UiO. The roadmap is balanced against available resources, and who pays what into the core development. Given this uneven nature of financial commitments, the core team cannot accommodate all requests equally and at the same time. Initially, DHIS2 was developed to serve the needs of ministries in a few developing countries and the software development activity carried out primarily by PhD and Masters students with funding from the Norwegian Research Council, Norad and the University of Oslo. Prioritization of functionality was based on whether a requirement was generic, relevant across countries and use cases. Today, DHIS2 is used by numerous ministries of health in addition to donors and NGOs with different use cases.

The tension is evident in the development of the DHIS2 software that unfolds through projects directly funded by donors and NGOs paying for particular functionality to be implemented. Other actors such as ministries of health or their representatives do not have the same financial "muscle" to influence the roadmap. Thus, while the product is broadly a GPG, the process of deciding the roadmap is both rivalrous and

excludable as the roadmap and the next release can only provide a limited number of new functionalities. This is already seen in the development process.

Reinforcing cycles are evident in the processes for suggesting new features or the path of development. Firstly, the core team of developers are responsible for deciding the priorities by balancing changes according to perceived benefits of various user groups, ease of implementation, and, crucially, availability of funding. The funding does not only relate to direct investments in developer time, but also enables access to developers often involving travel to interact with the core team in Oslo. This concurs with Roland et al. who write: “International NGOs with relatively deep pockets are able to travel and sit down with the core software developers in Oslo, and therefore have the opportunity to invest in more face time to make sure their requirements are well understood and recognised in future development of the software” [14, p. 22]. Secondly, countries investing in implementing DHIS2 have few incentives to contribute to the future development of the global good and this is also the case if global donors are the basis for the investment. In a similar way, when a global organization wants to contribute to platform development, they typically prioritize what they need for their own organization, which does not necessarily coincide with the needs of other countries.

To manage this tension, the developers seek to incorporate in the core such functionalities which can be considered generic and thus can be made relevant for other users. Further, there is also the effort of the core team to access funding for larger projects to also include resources to support the general DHIS2 platform. Initiatives like the DHIS2 Roadmap Country Advisory Team (RCAT) were created to increase the likelihood of requirements from the ministries of health being prioritized on the roadmap. Further, Norad is still an important funder of the core developer team and there are ongoing negotiations concerning the establishment of funding mechanisms from the donors that would fund the DHIS2 core development directly rather than channel funding to the country level.

Despite this challenge of prioritization, there is still a strong impetus to keep the global core generic, and which can support the development of apps as independent commodities without influencing the core. Increasingly, resourceful actors such as Populations Services International (PSI) develop their own apps for specific needs, but how much these Apps also retain the GPG characteristics remains uncertain. One way to compensate for the lack of incentives is to add a percentage fee for consultancies/technical assistance that goes to GPG development of the core. The tension highlighted here is in their efforts to enhance the generic nature of the platform set against new independent developments which may not share GPG ideals.

#### **4.2 Tension: DHIS2 as a Flexible and Generic Software vs. an “Appliance”**

DHIS2 is designed with the flexibility to be locally adaptable, i.e. to accommodate variations across different user groups and use cases. The philosophy of local user adaptation has been a key development priority from the start of its development process in 2004–05. With global scaling, the generification process has added much more functionality to be able to cater for the increasing number of use cases (from aggregate to case-based, for instance), and made this functionality generic enough to

cater for variations in use cases (from tracking “beneficiaries” earlier to currently track any “entity”). This arguably seeks to technically develop DHIS2 as a GPG.

The benefit of generification and resultant flexibility is dependent on, and sometimes offset by, an increased level of skills needed to properly take advantage of it. The result in the case of DHIS2 is that it is not an “appliance” meaning it is not ready to use for all cases. It is often described as a flexible “empty shell” which requires significant resources and expertise to set up and become operational. Thus, start-up costs are high because there is a need to source skilled technicians for customization and specialists to train staff. It is also a normal requirement for users to attend DHIS2 Academies to invest in capacity building while at the same time remaining dependent on external technical assistance.

Reinforcing cycles are shown in several user groups developing their own apps because the bundled apps are not sufficient to their specific needs. Secondly, only a few of the HISP nodes are relatively competent and self-reliant in terms of managing DHIS2 (South Africa, India, and Tanzania for example) but the lack of compatible skills between these “intermediaries” and the ministries of health reinforces the tension. Ministries typically do not have the necessary skills and resources to fully take ownership of the application and this continues a dependence on the intermediary. So while the product DHIS2 seeks to become a GPG, the expertise needed is not GPG due to the software’s generic nature, which increasingly requires more expertise, infrastructure and resources to get it running.

The DHIS2 core team has tried to counter this challenge of creating more and more generic functionalities, but this keeps the need to build capacity and guidelines of use as a moving target, constantly requiring work and more resources. To help address this challenge, an online academy on DHIS2 fundamentals has been set up, which meets the characteristics of a GPG in terms of being open and free of cost, but so far only available in English (work is underway for French and other languages). More work is thus required to make it freely and non-exclusively available.

One episode exemplifying several of the tensions brought up in this paper is from Uganda, as reported by Roland et al. [14]. A new feature of DHIS2 was under development, and input from several countries were sought to make this as generic as possible. At the same time, this input was of course rooted in some particular demands in the various countries. In Uganda this led to a tension between solving something locally, quick, and building a generic product over time. The local project staff in Uganda revealed that “It is frustrating to have to wait for a new ‘global release’ every time a requirement or change has been suggested.” [14, p. 19]. So while the developers thought they were accommodating the request by making a generic feature for the use case in Uganda, the local staff felt that their specific and immediate needs were sacrificed.

### **4.3 Tension: Supporting the Platform Core vs. Supporting Innovation in the Fringes**

The substantial investments in the DHIS2 software including the apps derived from it are directed towards and largely consumed by the UiO core activities. While the DHIS2 platform is an open platform and provides its own open access app store, it does not appear as a particularly generative platform in terms of spurring innovation by a broad

range of contributors outside UiO. While the attributes of the platform may be conducive for innovation, its broader socio-technical generativity in terms of incentives, human capacity, access to innovation networks where new attributions of technology can develop, are weak and untapped across developing countries. While there may be incentives to develop apps that solve local needs, there are few if any incentives to develop these into more generic apps. The route towards convincing the UiO developers to make locally developed apps or changes in the open source code as a part of the core is long.

This tension is reinforced by DHIS2 being developed independently from UiO into systems for other domains such as road accident reporting in Tanzania and civil registration in Tajikistan. These forks are developed based on substantial changes in the core and tailored for one country or use case. There are few if any resources available to invest in making the system generic for wider application.

Managing this tension, or rather to actively promote fringe innovation, is the very idea of the platform architecture of DHIS2. A relatively stable core and boundary resources are, in theory, supposed to make it easier for third party developers to build on it. A few resourceful NGOs are in fact actively exploiting this to create their own custom apps, but governmental actors have been slow to utilize this potential. App development academies have been held, building this capacity in several countries. Still, a trade-off remains for ministries between adapting something that is free but not perfect, and finding resources to venture into app development.

#### **4.4 Tension: Global vs. Local Accountability**

The license of DHIS2 (based on BSD) in summary states that use is at your own risk and responsibility. It can be downloaded, reconfigured and re-programmed by anyone and for anything. Apps developed can be made with varying quality and for a wide range of purposes, some of which may be malicious. While UiO is accountable to the projects they are directly involved in, it is debatable whether they also are accountable to the various implementations of DHIS2. For example, how much should the UiO team strive to ensure secure and ethical use of DHIS2? This relates to making the software itself secure, but also its various server configurations as well as standard operating procedures ensuring that local customization is following security by design. There are cases of countries losing their data in DHIS2 because of poor management and there is a considerable risk that DHIS2 is used in poor implementations.

Platforms are commonly considered as underlying infrastructure that facilitate the implementation of applications. Platform owners typically are not accountable for the applications because they have not constructed them and because they do not control them. In the case of a platform as a GPG used within public health in developing countries, accountability of platform owners and developers for implementation and ethical use is undefined. The accountability of the global product related to the local development is unclear. There are also legal questions about which jurisdictions this falls within, and the means by which a global community provides support. The first point relates to reinforcing cycles related to server space, which is a challenging problem for most adopters of DHIS2. With limited capacity locally, a cloud based solution is generally adopted with an overseas provider (e.g. Amazon). Although the

legal implications such as sovereignty may not be the GPG platform owner responsibility to engage in there is a role for advice to perform informed decisions. The latter concerns the various channels of communication for the user and implementer community. What is the responsibility for being an editor in these channels for the developers of the GPG, when they also host the various email lists etc.? A recurrent theme in country implementation can be to collect data on various user groups, such as key populations related to certain diseases (sex workers, for HIV for instance), or for any social program use. For instance, while in Norway it would be illegal to collect data about patients not directly related to health care, there have been instances where such data is collected in other countries. Examples can be religion, caste, or in general any minority. Such data has the potential to be misused.

The approach to this tension is perhaps the least mature, driven partly by ignorance or lack of interest by actors (funders, implementers, users), partly by UiO drawing a line of responsibility through the software license. However, some guidelines have been created ad-hoc for various countries, and a server academy has been developed to mitigate the worst examples of server and back-up management.

## 5 Discussion and Conclusion

The analysis offers a focus on tensions in GPG digital innovation platforms. To summarize on how can GPG platforms facilitate inclusive innovations, we present the table below (Table 1).

This paper offers new insights into the particular design considerations of a GPG digital innovation platform going beyond the prescriptions of the mainly commercial platforms literature from the global North [3, 4, 6, 7, 12]. The main difference is in tension 1 - the recognition that some users have limited capacity to pay for the service so it is downloaded for free and there is lack of any explicit desire to monetize the platform by the owners. Thus the network effects between the participants display some unique characteristics in a GPG where the incentives of the platform “owner” are socio economic development rather than the “platform monetization” discussed in Parker et al. [12]. It remains an ongoing effort in the sense that building incentives to share among platform users is sometimes problematic. Cultivating a GPG mindset in the users as well as platform owners is necessary which may imply a cultural change. Regarding tension 2 there are some similarities with the commercial literature. For example, commercial digital innovation platforms such as SAP face the same problems of generification and localization as DHIS2 but in the case of SAP this is traded off with willingness of clients with deep pockets to pay for unique customisation. The attempts to manage tension 2 and 3 by offering free documents, UiO run academies demonstrate that the DHIS2 knowledge is in itself not a GPG. However, the DHIS2 digital innovation platform fulfils many of the characteristics of a GPG but the total cost of ownership is not zero This DHIS2 knowledge remains very specialist and a source of commodity livelihoods that is sold in the marketplace by consultants, app developers, trainers etc.

**Table 1.** Summary of Tensions, Reinforcing Cycles and Management “Countermeasures” in the DHIS2 Case

Tension	Short description	Reinforcing cycles	Countermeasures adopted
Between serving those that can pay for functionality and those that cannot	DHIS2 meeting criteria of non-exclusive and non-rivalrous development	Process for developing new features	Generification of specific requirements. Convincing donors of the GPG argument for generic development Community participation
Between DHIS2 as a generic software and an appliance	Generic software increases start-up costs, related to technical assistance which does not meet the criteria of GPG	Need for configuration met by non GPG providers	Public goods such as free documentation, guidelines, online academy, training material
Between supporting the platform core and supporting innovation in the fringes	Centralizing investments in the GPG comes at an expense of neglecting developing “fringe” capacity to innovate on top of it	Incentives for local vs global priorities	Open API, outsource some app development. App dev academies, seed money
Between global and local accountability	Where does the responsibility of developers of GPG end?	3 <sup>rd</sup> party provision such as cloud computing	Server academy, some guidelines but far from enough

This paper also builds on the existing literature on DHIS2 such as Roland et al. [14]. Roland et al. have identified some of the tensions of participation but did not explicitly identify tensions of GPG. The tension 4 in particular has been given limited attention regarding the ethical considerations of maintaining a GPG digital innovation platform.

**References**

1. Braa, J., Hedberg, C.: The struggle for district-based health information systems in South Africa. *Inf. Soc.* **18**(2), 113–127 (2002)
2. Brown, A., Fishenden, J., Thompson, M., Venters, W.: Appraising the impact and role of platform models and government as a Platform (GaaP) in UK Government public service reform: towards a platform assessment framework (PAF). *Gov. Inf. Q.* **34**(2), 167–182 (2017)
3. Constantinides, P., Henfridsson, O., Parker, G.: Introduction—platforms and infrastructures in the digital age. *Inf. Syst. Res.* **29**(2), 381–400 (2018)
4. de Reuver, M., Sørensen, C., Basole, R.C.: The digital platform: a research agenda. *J. Inf. Technol.* **33**(2), 124–135 (2017)



5. Fishenden, J., Thompson, M.: Digital government, open architecture, and innovation: why public sector IT will never be the same again. *J. Publ. Adm. Res. Theor.* **23**(4), 977–1004 (2013)
6. Gawer, A., Cusumano, M.A.: Industry platforms and ecosystem innovation. *J. Prod. Innov. Manag.* **31**(3), 417–433 (2014)
7. Ghazawneh, A., Henfridsson, O.: Balancing platform control and external contribution in third-party development: the boundary resources model. *Inf. Syst. J.* **23**(2), 173–192 (2013)
8. Heeks, R.: ICT4D 20: the next phase of applying ICT for international development. *Computer* **41**(6), 26–33 (2008)
9. Kaul, I., Grunberg, I., Stern, M.A.: Global public goods. In: Kaul, I., Grunberg, I., Stern, M. (eds.) *Global public goods*, pp. 450–498. Oxford University Press, Oxford (1999)
10. Koskinen, K., Bonina, C., Eaton, B.: Digital platforms in the global south: foundations and research agenda. In: University of Manchester Centre for Development Informatics Working Paper (2018). <https://diodeweb.files.wordpress.com/2018/09/digital-platforms-diode-paper.pdf>. Accessed 25 Sept 2018
11. Lewis, M.W.: Exploring paradox: toward a more comprehensive guide. *Acad. Manag. Rev.* **25**(4), 760–776 (2000)
12. Parker, G.G., Van Alstyne, M.W., Choudary, S.P.: *Platform Revolution: How Networked Markets are Transforming the Economy and How to Make Them Work for You*. W. W. Norton, Incorporated, New York (2016)
13. Putnam, L.L., Boys, S.: Revisiting metaphors of organizational communication. In: Clegg, S., Hardy, C., Nord, W. (eds.) *Handbook of Organizational Studies*, 2nd edn, pp. 541–576. SAGE, London (2006)
14. Roland, L., Sanner, T., Sæbø, J.: Platform architectures of large-scale participatory design. *Scand. J. Inf. Syst.* **29**(2), 3–34 (2017)
15. Taplin, J.: *Move Fast and Break Things*. Macmillan, London (2017)
16. Tracy, S.J.: Dialectic, contradiction, or double bind? Analyzing and theorizing employee reactions to organizational tensions. *J. Appl. Commun. Res.* **32**, 119–146 (2004)
17. Tretheway, A., Ashcraft, K.L.: Special issue introduction. Practicing disorganization: the development of applied perspectives on living with tension. *J. Appl. Commun. Res.* **32**, 81–88 (2004)
18. Wendt, R.F.: The sound of one hand clapping: counterintuitive lessons extracted from paradoxes and double binds in a participative organization. *Manag. Commun. Q.* **11**, 232–255 (1998)
19. Walsham, G.: The emergence of interpretivism in IS research. *Inf. Syst. Res.* **6**(4), 376–394 (1995)
20. Walsham, G.: Doing interpretive research. *Eur. J. Inf. Syst.* **15**(3), 320–330 (2006)



# Software Platforms for Inclusive Innovation

Terje Aksel Sanner<sup>(✉)</sup> and Petter Nielsen

Department of Informatics, University of Oslo, Oslo, Norway

terjeasa@ifi.uio.no

**Abstract.** Software platforms present novel opportunities for innovation across heterogeneous settings, users and areas of use. We report from the case of the Health Information System Programme (HISP) that started out in post-apartheid South Africa more than two decades ago. The programme centres on the development of an open source software – called DHIS2 – primarily for decentralized public health management. Today, DHIS2 is a software platform with a significant global footprint. We contribute to literature on innovation for development, by identifying and examining processes of inclusive innovation pertaining to the longitudinal development of DHIS2. We find that a combination of long-term capacity building and knowledge sharing, consensus-based decision-making, and a modular platform architecture facilitates inclusive innovation. However, short term and project-oriented funding limits the sharing and scale-up of local innovations while the size of the venture and the heterogeneity of actors moderates inclusion in the development of core components of the platform.

**Keywords:** Inclusive innovation · Software platform · Development · ICT4D

## 1 Introduction

Digital services, applications and content can be reused and recombined and increase in breadth and value with the number of people involved in their innovation and consumption [1, 2]. Commercial platforms, such as Apple iOS, Android, Baidu and Alibaba have demonstrated an unprecedented capacity for innovation. These platforms mediate between two or more distinct groups of actors, such as app developers, content producers and consumers; or advertisers, buyers and sellers [3]. In relation to software platforms, what matters is not only technology [4], but also an ecosystem of platform stakeholders [3] and associated value creation mechanisms [5]. Yet, the platform architecture is key to a software platform's capacity to innovate. The separation of reusable generic components (platform core) from particularized services, applications and content (platform extensions) through stable interfaces facilitates distributed innovation at minimal coordination and transaction costs [3].

The rise of commercial platform ecosystems poses important questions for ICT4D research. How, if at all, can similar dynamics be cultivated around platforms for global public good? And how does the emergence of platform ecosystems shape intermediation between users and producers of innovations for development [6, 7]? Heeks et al. argue that it is currently unclear how different stakeholder relationships should best be

aligned for innovation sharing and inclusive innovation in development [8]. Inclusive innovation refers to inclusion in terms of both processes and outcomes. Innovations can be inclusive in their intended outcomes, such as improving the livelihood of the poorest of the poor, and in the participatory process of reaching those outcomes. Intermediation challenges arise with inclusive innovation at a large scale, which has recently been highlighted as an ICT4D research priority [7, 9]. In this paper, we explore inclusive innovation primarily as a process and at a large scale by asking, *how can inclusive innovation be facilitated by a software platform for global public good?*

We begin to answer this question through a longitudinal case study of software platform innovation in the Health Information System Programme (HISP). HISP is a global health information systems strengthening initiative coordinated from the Department of Informatics at the University of Oslo (UiO) in Norway. HISP aims to overcome barriers to equitable, data-driven and decentralized public health administration in developing countries. Historically, development activities in the context of health information systems strengthening have favoured short bursts of funding and technical assistance to implement standardized solutions along vertical silo structures such as HIV/AIDS, Tuberculosis and malaria rather than cross-fertilization and sharing of innovations between programmes [10, 11]. To mitigate challenges to scale up of local innovations, HISP engages in the cultivation of an international knowledge and experience-sharing network in tandem with the participatory development, implementation and use of the open source District Health Information Software (DHIS2) [12].

In the following two sections, we review relevant research on inclusive innovation and software platforms respectively. This motivates our discussion on software platforms for inclusive innovation. In section four, methods, we present the case background and our approach to data collection and analysis, which is followed by our case description in section five. Section six, provides the discussion part of the paper, while section seven reflects on the papers contributions and implications for further research.

## 2 Related Research: Inclusive Innovation

Innovation for development has been studied in terms of its intended purpose, process and impact under labels such as inclusive, frugal, grassroots, pro-poor and bottom-of-the-pyramid innovation. Here, we use the term ‘inclusive innovation’, which appears to have been coined by TheWorld Bank to describe “knowledge creation and absorption efforts most relevant to the needs of the poor” [13]. Recently, ICT4D scholars have highlighted that inclusive innovations need to be inclusive not only in outcome, by satisfying the basic needs of the underserved, but also in process, through participatory production of the innovative means to reach those outcomes [14, 15]. The participatory dimension of inclusive innovation aims to bridge traditional dichotomies between users and producers [6, 7], the supply side and the demand side [8] and align top-down standardization with local innovation [7, 9]. As highlighted by [15], inclusion in innovation is also a matter of degree, with inclusivity ranging from inclusion in consumption and use of innovations; to inclusion in innovation development processes; to inclusion in defining and shaping the very structures through which innovations are produced.

Despite the recent interest in inclusive innovation in development research in general and ICT4D in particular, the potential for software platforms to facilitate inclusive innovation at a large scale has received scant attention. Braund and Schwittay provide an exception through their study of how Kiva, a web-based micro loan service, was able to scale inclusive innovation by complementing standardization with diversification and local customization throughout its multinational network [16]. However, the Kiva study also highlights that increasing scale challenges governance of distributed innovation processes to meet idiosyncratic needs. Attempts to grapple with such challenges include absorption of local sites of learning and innovation into the core of the network and the cultivation of intermediaries who can actively support innovations [7].

A key interest in recent studies of inclusive innovation has been the role of “innovation intermediaries”, for instance in diffusing and scaling innovations [15]. The role of innovation intermediaries is particularly important in large-scale and complex innovation networks involving heterogeneous settings, users and areas of use. In such networks, intermediaries enable innovation not just through knowledge brokering between those who can redesign technology and those who understand how the technology needs to be used [7, 8], but also through direct involvement in technology appropriation and customization [17].

### 3 Innovation in Software Platform Ecosystems

Tiwana defines a *software platform* as a “software-based product or service that serves as a foundation on which outside parties can build complementary products or services” [3]. However, a *software platform ecosystem* constitutes not only software modules and the interfaces between them [4], but also different groups of stakeholders that come together to generative and derive value from the platform [3]. Hence, a software platform ecosystem can be understood as a particular type of innovation network. For instance, Android and Apple iOS facilitate innovation by enabling interaction between consumers and third party application developers. Both the technical software platform architecture and the platform ecosystem needs to be carefully governed to facilitate innovation and create value [5].

Technically, software platforms comprise three key elements: core components with low variability (e.g., data storage and data access), complementary components with high variability, and stable interfaces/boundary resources between them [18]. A key aspect with a software platform is to facilitate an economy of scale of the lean and reusable core, while further development of services, content and applications can be performed by distributed third party developers with the help of boundary resources [19], such as standardised Application Programming Interfaces (APIs), Software Development Kits (SDKs), documentation and software licenses. The boundary resources allow software platforms to be open for innovation across heterogeneous settings, users and areas of use [19, 20]. Local innovation and tailoring can take place at a large scale, at the “app level”, without intimate knowledge of the inner workings of the reusable platform core (valuable ignorance) and without direct involvement from the platform core developers. If the functionality of a platform extension, such as an

app, is used extensively across settings, it can potentially be absorbed into the platform core so that everyone using the platform can reuse and enjoy it.

## 4 Method

We report from an interpretive qualitative case study [21, 22] that builds on both authors' decade long participation in software implementation, project management, evaluation and capacity building associated with the District Health Information Software 2 (DHIS2). Observation notes and interview transcripts generated through our participation in the HISP network are our primary sources of data. The first author has been closely involved with implementation research on mobile phone-based reporting of public health data from health facilities from 2009–2015 [10], while the second author has coordinated initiatives to democratize requirements gathering and feature selection in the global software development process. The second author has also contributed to initiatives to use DHIS2 in new domains and contexts such logistics management in Kenya and Uganda and civil registration and vital statistics in Tajikistan [23].

The data analysis builds on both authors' re-examination of previously collected case study material. We jointly processed the empirical data through the development of data displays, including timelines and conceptual drawings. This allowed us to group volumes of data in relation to major shifts in user involvement in DHIS2 development, implementation and capacity building. We then identified candidate narratives that met three criteria. First, the authors had access to detailed and longitudinal data to support the narrative. Second, the narrative illustrated changes to participation in innovation processes pertaining to software development, implementation and capacity building. Third, the narrative illustrated the relationship between the emergent software platform architecture and large-scale participation in innovation. Out of the candidate narratives identified, we chose to include two narrative vignettes in this paper as they illustrate the relationship between the software platform architecture and inclusive innovation. Vignette one, about DHIS2 Academies; illustrate how different modes of inclusive innovation are deeply intertwined with capacity building activities in the HISP network. Vignette two, describes RCAT, an initiative to democratize DHIS2 platform development across a large and diverse community of stakeholders.

## 5 DHIS2, from Software Product to Software Platform Ecosystem

The DHIS software started out as an MS Access-based desktop application to support tasks of public health management in three pilot districts in Cape Town, South Africa, in 1994, after the fall of apartheid. Emancipation was a central political theme, both in terms of equitable health service provision to all, irrespective of background and 'race', and in terms of empowering local health authorities to provide health services in the ways they saw most appropriate. Early versions of DHIS evolved through participatory prototyping with local district staffs [24]. Over the next few years, DHIS saw a relative

success in South Africa and emerged as the national health management information system. DHIS slowly gained a foothold in other countries along with the cultivation of a network of stakeholders including universities, ministries of health, global regulatory agencies like WHO, international development funders, and the establishment of regional implementation organizations such as HISP South Africa and HISP India [12].

In 2004, due to growing computer literacy and increasing access to the Internet by many potential DHIS end users, work started on the open source and web-based DHIS version 2 (DHIS2). In the remainder of the paper, we focus on the years after the launch of DHIS2 in 2006, as this is when the traditional participatory software development techniques, based on prototyping and close personal interaction between developers and users, met with challenges of scale in terms of the number and distribution of heterogeneous settings, users and uses. Currently, ministries of health, NGOs and donors in more than 80 countries use DHIS2 as a health management information system. There are currently more than 30.000 end users of DHIS2 in Bangladesh alone.

DHIS2 has application programming interfaces (APIs) and a number of configurable modules (bundled apps), which enables customization across domains. Through the APIs, the core functionality of the platform can be extend by custom apps that meet specific needs. Dedicated DHIS2 app stores exist for distribution of both web applications and Android applications. Although a cadre of DHIS2 experts are located throughout Africa and Asia, they primarily work with short-term assignments in large donor funded implementations of the software. Few incentives are available for local DHIS2 experts to explore directions not directly relevant to the international donors. There are examples where DHIS2 is appropriated and used in other domains than health such as road safety in Tanzania, the new year accident reporting system in Vietnam [25] and the civil registration and vital statistics system in Tajikistan [23]. While these innovations successfully support local needs, they remain isolated branches of DHIS2 that are not taken up elsewhere in the HISP network.

The global HISP network comprises national and/or regional organizations, many of which have been established by the more than 40 information systems PhDs that have graduated with the HISP UiO research programme. The national and regional HISP organizations provide day-to-day support to national ministries and engage in local DHIS2 capacity building through DHIS2 Academies. To date, more than 90 DHIS2 Academies have been conducted with more than 4500 trainees on DHIS2 analytics, system configuration and app development. For example, a DHIS2 web applications development academy was held in Dar es Salaam, Tanzania in November 2017.

### ***Vignette 1: DHIS2 Academies, 2010-Present***

This vignette concerns the DHIS2 Academies and illustrates synergies between large-scale representation of users in software requirements gathering and top down standardization through capacity building. Since 2010, national and regional DHIS2 organizations, with coordination from HISP UiO, have arranged a number of workshops, called DHIS2 Academies. Academies are held regularly in Africa, Asia and Latin America, and have diversified to cater for training needs of software implementers and customizers at different experience levels. The Academies mainly consist of training sessions, but they also provide an arena for national and regional DHIS2

implementers to keep up to date with recent software features, share experiences, discuss technical challenges, build professional relations, and give feedback to core developers directly.

During a DHIS2 Academy in Mombasa, Kenya in 2012, a group of 12 specialists from different countries in east Africa discussed requirements for mobile phone-oriented features in DHIS2 for three hours. Regarding a feature that had been difficult to implement across multiple contexts, a DHIS2 developer shared his positive sentiment.

To create new functionality, we really need a proper use case, a real one, so we can communicate. We cannot just [gesture showing something coming out of the air]. We have been thinking about this [feature] for the longest time, from the very beginning, but we never found good examples of what would be beneficial for the health worker, as we have discussed today.

In particular, generic functions that have local variations in workflow have been difficult to develop without discussions about specific examples of use, with one example being integrated disease surveillance and response (IDSR). IDSR is the process for discovering and responding to disease outbreaks. IDSR has a number of WHO guidelines, but effective disease identification and response still requires local adaptation of ‘best practices’. During another Academy session in Mombasa, a discussion on usage of SMS alerts to IDSR response teams opened the requirement scope to include many other non-IDSR functions that could benefit from SMS alerts, such as SMS reminders to health workers to improve routine health data reporting. One of the DHIS2 Academy coordinators thanked the group by saying:

This is very good. We have been thinking about some of these cases, but very narrow. It is clear that it is a whole area with different [...] it has more than one use case.

The academy discussions mentioned above helped to clarify design features that despite international standards and guidelines had local variations and idiosyncrasies. During the same session, a coordinator tried to uncover local variations by saying:

I am wondering about IDSR. When there is an outbreak, to which extent is the process based on these structures processes versus people picking up the phone, coordinating on the phone, and breaking out of the protocol.

A long discussion followed, where participants shared their views on the organizing of IDSR in their respective countries. In addition to providing valuable input to the DHIS2 development team, participants commented that it was useful to discuss use across nations. Interestingly, despite the consensus during the session on a number of DHIS2 software requirements to support IDSR, these features were not implemented in the software until 2014, when a large international NGO paid for their development as part of its DHIS2 adoption. This highlights the challenge of balancing (bottom-up) inclusive innovation with the prioritisation of software requirements in a large venture.

At an Expert Academy in Oslo in 2015, with more than 80 participants from ministries of health, international NGOs, independent DHIS2 consultants, and experienced country implementation representatives, a session was held on the DHIS2 software development process and how various stakeholders could participate in it. Although the DHIS2 development team at HISP UiO would continue to make final decisions about standard release features, the software development coordinator listed

three ways for DHIS2 community members to propose new features: (1) write on the developer mailing list, (2) participate at DHIS2 Academies or (3) write and upload complete requirement specifications on an issue-tracking platform (i.e., Jira). These three modes of participation are not equally accessible to all users and organizations that rely on DHIS2 in their daily activities. Furthermore, the lead developer presented six qualitative criteria employed to prioritize functionality requests: perceived usefulness to the wider DHIS2 community, perceived software development workload, perceived benefit beyond what is already possible with the software, interdependencies with other functions and modules (risk), expected level of participation and feedback from the requesting party, and availability of earmarked funding. Based on these criteria, it is not surprising that well-funded late adopters of the software such as international NGOs have become increasingly influential in shaping the DHIS2 software development roadmap.

International NGOs are able to invest in time with core developers and project managers at HISP UiO to make sure their requirements are realistic, well understood and correctly formatted. Furthermore, these stakeholders can hire independent DHIS2 consultants to implement their specific in-house requirements directly.

A recent trend has been the development of third-party apps by international NGOs, who use DHIS2 as an internal management information system. Many of these apps could be useful to other organisations such as ministries of health. However, the broader HISP network has not taken up most such custom apps and many of them are not shared on the DHIS2 app stores. In part, this is because sharing generates additional responsibilities and costs associated with making app functionality generic and maintaining them over time beyond the single organization's needs. These and other challenges to large-scale inclusive innovation informed HISP UiO to implement an explicitly democratic requirement specification process, albeit with a limited number of country representatives, which we describe in the second vignette.

***Vignette 2: RCAT – Democratizing Requirements Selection (2017 - Present)***

Every new release (quarterly) of DHIS2 centres on extending the platform core and the bundled apps with generic functionality relevant across different implementation sites and organizations. However, HISP UiO has increasingly committed to contractual obligations to meet software requirements directly funded by international NGOs and donors. In 2017, HISP UiO established an initiative to deal with a concern that requirements from NGOs and donors were prioritized over early adopters of DHIS2 such as ministries of health with limited technical capacity and funds. On behalf of ministries of health in less developed economies, national and regional HISP-groups mediate DHIS2 software requirements based on active involvement in implementation and customization projects. While the HISP-groups have technical expertise, maintain strong relations with HISP UiO and legitimately represent ministries of health in the countries they are working, they have repeatedly expressed concerns that their software requirements are neglected. This was the starting point for establishing the DHIS2 Roadmap Country Advisory Team (RCAT).

The second author initiated RCAT based on three key concerns raised and reiterated by the HISP-groups over several years. First, there is a lack of transparency in the process of defining the DHIS2 software development roadmap and prioritizing



requirements. Second, requirements prioritized in the roadmap are often postponed just before a new release without any discussion. Third, the impression among the HISP-groups was that HISP UiO had made a promise to involve them more actively into the roadmap process and commit to their particular needs. A reflection document summarized these concerns and suggested the aim of RCAT to “assure that country requirements are considered for the DHIS2 roadmap”, and proposed that “representatives (1–2 people) from each HISP group will offer advice on priorities before the work starts on release 2.28”.

The virtual RCAT team was initiated with a Skype meeting with representatives from HISP-groups in Nigeria, India, Vietnam, Rwanda, Uganda, West Africa, South Africa and Bangladesh. Several issues were raised during the first meeting. First, the mandate of RCAT was discussed with a particular focus on what kind of commitment HISP UiO would give to prioritized requirements. Second, questions were asked whether this process also would involve the delegation of certain software development tasks to the different regional/national HISP-groups. Third, the representatives from the HISP-groups raised the issue of requirements specified in Jira commonly being postponed and the lack of an overview over the origin of prioritized requirements (i.e., NGOs, donors or ministries of health).

Based on the initial meeting and the RCAT coordinator (second author) discussing with the HISP UiO team, RCAT decided to organize work around requirements described in Jira. Based on one-to-one discussions with RCAT team members and email conversations with the whole team, a seven-step process of defining a prioritized list of requirements was outlined: (1) New requirements are shared and vetted on the DHIS2 user mailing list before suggested as improvements in Jira. (2) Each RCAT member group provide a list of relevant issues from Jira for the next release. (3) The coordinator compiles a common list of issues with all relevant issues. (4) Each RCAT member group give each issues on the common list a priority from zero (lowest) to three (highest). (5) The HISP UiO software developer team scrutinize the prioritized list with a focus on software dependencies and resource demand and provide change suggestions. (6) Based on the developers’ feedback, RCAT compiles a final prioritized list of requirements. (7) HISP UiO considers the final list and decides which issues to put on the roadmap.

In practice, the member groups entered their prioritized requirements in a dedicated template (stage 2). The requirements had a short textual summary and a reference to Jira (Jira Issue Key). The number of requirements entered by each RCAT member group ranged from zero to 31. Some requirements were new, but the majority already existed in Jira. Some of the new requirements were sketchy and not properly described. When compiled, the list consisted of 69 requirements. The RCAT member groups then prioritized the 69 requirements on a scale from zero to three. Only two of the HISP-groups returned a prioritized list. One of them prioritized three requirement, while the other prioritized 33 as top priority (3), 27 as priority level 2 and 4 as priority level 1. The RCAT coordinator did not find this ranking very useful because 60 requirements were highly ranked based on input primarily from one group. The HISP UiO developers could not prioritize all 60 requirements. More importantly, the requirements did not fairly represent the needs of the different member countries.

To produce a shorter and a more representative list of requirements, the RCAT coordinator asked the groups to rank their top five requirements (1–5). Seven groups engaged in this ranking. Four groups prioritized five requirements; one prioritized two and one prioritized six. The most active group prioritized 23 requirements related to the four different countries they were currently working in. In total, 28 requirements were ranked, but only four requirements were ranked more than once. When the developer team at HISP UiO were presented with the 28 ranked requirements and an explanation of the process, they opted to look into the long list of 69 requirements. They marked one as not a requirement, 4 as already solved, and 28 as having incomplete specification in Jira. Finally, 35 requirements were completely specified. The developer team did not commit to address any of the requirements beyond promising to do their best.

The version 2.28 of DHIS2 was released in October 2017. Out of the 69 requirements, 10 were implemented. While RCAT established a mechanism for the member groups to communicate and prioritize requirements on behalf of ministries of health and their end users, its effects were limited. First, the initiative did not bring much transparency to the way in which the developer team prioritize requirements from different user groups. Second, the issue voiced by the national and regional HISP-groups that the developers at HISP UiO fails to deliver on ‘promised’ functionality persisted. RCAT made this accountability challenge visible as requirements remained unresolved.

The RCAT process was in itself challenging. Some of the member groups remained passive, a few contributed with their priorities and one were extremely active. This imbalance in participation could in part be a result of the different experiences and competencies of the individual representatives. The lack of overlap between the priorities from the different groups also made it easy for HISP UiO developers to downplay their overall importance. The lack of overlap can both be due to a lack of willingness to make compromises or simply that the needs of the countries were too divergent. The RCAT initiative continues, but the establishment of several DHIS2 product manager roles has recently been established to supplement it. The product managers are responsible for engaging with different DHIS2 thematically oriented communities – to reflect the diversity of interests and needs – and to help translate specific community needs into software requirements.

## 6 Discussion

DHIS2 brings together different groups of stakeholders, such as Ministries of Health, local NGOs, international donors, consultants and software developers. Stakeholders interact with the platform differently and have different needs and motives, albeit with the majority of interests geared towards public health administration. Innovations extending the software platform are often inclusive in outcome, as they facilitate data driven decision making towards equitable health service provisioning. For instance, with access to timely and accurate statistics on the utilization of essential health services, such as child immunization and antenatal care, service providers can design interventions to reach the underserved. The DHIS2 software development has a long history of being inclusive also in terms of process through user involvement in solution

design. With the rapid growth of the venture, HISP and the DHIS2 software platform serves as a fruitful arena to problematize large scale inclusive innovation [14, 15].

In principle, the logistical challenges to large scale inclusive innovation [7, 9] may be mitigated by a software platform architecture as it allows idiosyncratic solutions to emerge at the platform fringes through app development [26]. Inclusive innovation can be more open ended at the platform fringes, where standardisation and generic features are less of a concern and both technical and organizational dependencies are fewer. Local needs associated with a growing number of heterogeneous users and uses can be met at different levels of the platform architecture through either custom apps (specific), bundled apps (configurable) or core software development (generic).

In practice, innovation in the DHIS2 ecosystem often constitute idiosyncratic local customization, rather than development of generic core functionality or configurable apps that can be bundled with the software releases and adapted across settings and programs. While actors at the fringes of the DHIS2 platform ecosystem have access to the increasingly ubiquitous Internet, digital devices, services, and content, they remain somewhat disconnected from the core of the HISP network where innovative ideas and features are likely to attract the resources and capacities required to scale innovations across settings [17]. For instance, the yearly DHIS2 Expert Academy in Oslo is an important venue for sharing innovations with the wider community and influencing the overall direction of the venture. Yet, with increasing scale, inclusion through representation in the development of the core software platform features becomes further and further removed from specific local needs and requirements.

In contrast, the level of inclusion in innovation processes are profound at the early stages of conceptualization of new features in new domains such as IDSR described in the first vignette. Depending on their perceived importance by stakeholders close to the core of the HISP network, such efforts can involve articulation of the software requirements by experienced DHIS2 core software developers. In other cases, a local software implementer or customizer, associated with one of the HISP groups, can spearhead an initiative to accommodate particular local needs. In either case, boundary resources such as APIs, SDKs, issue tracking software and requirement synthetization efforts such as RCAT both enable and constraints the work of innovation intermediaries.

Innovation intermediaries, such as the HISP UiO software developers who travelled extensively to engage in workshops and conduct in-country DHIS2 Academies in the early days of DHIS2, play a crucial role in maintaining a balance between processes of top down standardization (i.e., software appropriation and customisation) and the diffusion and scaling of bottom up innovations. With the increasing scale and scope of the venture, it is no longer feasible for the core software developers primarily situated in Oslo to participate in the majority of DHIS2 Academies and engage in discussions about the details of particular local needs. Consequently, the role of mediating requirements into the software development roadmap and the organizing of DHIS2 Academies has transferred to the national and regional HISP groups. Professionals associated with the HISP groups can either engage in software customization and app development directly or mediate requirements towards the centre of the network when technical flexibility or their capacity to approach the problem through local innovation is exhausted.

In relation to development of the generic core and bundled apps, mobilization of community representatives in the platform ecosystem is important to ensure representation of different user groups and organisations and to facilitate transparent negotiations of requirements. As our case study illustrates, with the sheer size and diversity of the HISP network, this can be challenging to facilitate in a democratic way even when the venture has a long tradition for participation in solution design. A global public good software platform for inclusive innovation, as we see it, depends on a modular software platform architecture, stable and well-defined boundary resources in addition to meticulous capacity building efforts, including training on software customization and app development, to empower innovation intermediaries in the platform ecosystem. The DHIS2 platform, the DHIS2 app store, the DHIS2 Academies, RCAT and other venues for innovation intermediation have evolved in tandem and helps balance top down standardization with bottom up innovation.

## 7 Conclusion

Making software platform innovations generic and available across contexts (i.e. scale-up) is often not perceived as a winning strategy within the confines of the current donor-driven and project-oriented funding structures that dominate global health. The strong compartmentalization of funding and activities into vertical health programs and silo structures (e.g., HVI/AIDS, TB, malaria) further solidify these dynamics. In short, the structures and time frames that encapsulate information system projects in global health often constrain local project managers and project participants' flexibility to innovate (see e.g. [27, 28]). Interestingly, our experiences from global health echoes, at least partly, the experiences around the web-based micro loan service Kiva, where local partner institutions faced challenges in terms of obtaining adequate local capacities and knowledge to comply with technological standardization initiatives aimed at efficiency and economies of scale in the multinational network [16].

International NGOs and donors provide short bursts of technical assistance or hire consultants to solve particular problems based on programmatic solutions. Such processes are often inclusive in outcome, but not in process. Furthermore, initiatives often fail to facilitate sharing and scale-up of innovations in the broader network of stakeholders and across settings with variable resources and capacities. This hampers the cultivation of a sufficiently strong cadre of innovation intermediaries that can resolve tensions between generic features and local issues and requirements. There is a need to identify ways to cultivate networks of innovation intermediaries around global public good software platforms, such as DHIS2 to facilitate inclusive innovation at a large scale within the confines of extant development industry value creation mechanisms.

## References

1. Yoo, Y., Boland Jr., R.J., Lyytinen, K., Majchrzak, A.: Organizing for innovation in the digitized world. *Organ. Sci.* **23**, 1398–1408 (2012)
2. Nambisan, S., Lyytinen, K., Majchrzak, A., Song, M.: Digital innovation management: reinventing innovation management research in a digital world. *MIS Q.* **41**, 233–238 (2017)
3. Tiwana, A.: *Platform Ecosystems: Aligning Architecture, Governance, and Strategy*. Newnes, Oxford (2013)
4. Van Schewick, B.: *Internet Architecture and Innovation*. MIT Press, Cambridge (2012)
5. Autio, E., Thomas, L.: Innovation ecosystems. In: *The Oxford Handbook of Innovation Management*, pp. 204–288 (2014)
6. Chataway, J., Hanlin, R., Kaplinsky, R.: Inclusive innovation: an architecture for policy development. *Innov. Dev.* **4**, 33–54 (2014)
7. Foster, C., Heeks, R.: Nurturing user–producer interaction: inclusive innovation flows in a low-income mobile phone market. *Innov. Dev.* **4**, 221–237 (2014)
8. Foster, C., Heeks, R.: Conceptualising inclusive innovation: modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers. *Eur. J. Dev. Res.* **25**, 333–355 (2013)
9. Heeks, R., Foster, C., Nugroho, Y.: New models of inclusive innovation for development. *Innov. Dev.* **4**, 175–185 (2014)
10. Sanner, T.A., Manda, T.D., Nielsen, P.: Grafting: balancing control and cultivation in information infrastructure innovation. *J. Assoc. Inf. Syst.* **15**, 220–243 (2014)
11. Mudaly, T., Moodley, D., Pillay, A., Seebregts, C.J.: Architectural frameworks for developing national health information systems in low and middle income countries. In: *Enterprise Systems Conference (ES)*, pp. 1–9. IEEE (2013)
12. Braa, J., Monteiro, E., Sahay, S.: Networks of action: sustainable health information systems across developing countries. *MIS Q.* **28**, 337–362 (2004)
13. Dutz, M.: *Unleashing India’s Innovation: Toward Sustainable and Inclusive Growth*. The World Bank, Washington, D.C. (2007)
14. Papaioannou, T.: How inclusive can innovation and development be in the twenty-first century? *Innov. Dev.* **4**, 187–202 (2014)
15. Heeks, R., Amalia, M., Kintu, R., Shah, N.: Inclusive innovation: definition, conceptualisation and future research priorities. In: *IDPM Development Informatics Working Papers* (2013)
16. Braund, P., Schwittay, A.: Scaling inclusive digital innovation successfully: the case of crowdfunding social enterprises. *Innov. Dev.* **6**, 15–29 (2016)
17. Roland, L.K., Sanner, T., Sæbø, J.I., Monteiro, E.: P for platform. *Architectures of large-scale participatory design*. *Scand. J. Inf. Syst.* **29**, 3–34 (2017)
18. Baldwin, C.Y., Woodard, C.J.: The architecture of platforms: a unified view. In: *Harvard Business School Finance Working Paper* (2008)
19. Ghazawneh, A., Henfridsson, O.: Balancing platform control and external contribution in third-party development: the boundary resources model. *Inf. Syst. J.* **23**, 173–192 (2013)
20. Gawer, A.: Platform dynamics and strategies: from products to services. *Platf. Mark. Innov.* **45**, 57 (2009)
21. Walsham, G.: The emergence of interpretivism in IS research. *Inf. Syst. Res.* **6**, 376–394 (1995)
22. Walsham, G.: Doing interpretive research. *Eur. J. Inf. Syst.* **15**, 320–330 (2006)
23. Sahay, S., Nielsen, P., Latifov, M.: Grand challenges of public health: how can health information systems support facing them? *Health Policy Technol.* **7**, 81–87 (2018)

24. Braa, J., Hedberg, C.: The struggle for district-based health information systems in South Africa. *Inf. Soc.* **18**, 113–127 (2002)
25. Nguyen, T.N., Nielsen, P.: From routine to revolt: improving routine health data quality and relevance by making them public. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017. IAICT*, vol. 504, pp. 548–558. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_45](https://doi.org/10.1007/978-3-319-59111-7_45)
26. Olleros, X.: The lean core in digital platforms. *Technovation* **28**, 266–276 (2008)
27. Winschiers-Theophilus, H., Zaman, T., Yeo, A.: Reducing white elephant ICT4D projects: a community-researcher engagement. In: *Proceedings of the 7th International Conference on Communities and Technologies*, pp. 99–107. ACM (2015)
28. Sanner, T.A., Sæbø, J.I.: Paying per diems for ICT4D project participation: a sustainability challenge. *Inf. Technol. Int. Dev.* **10**, pp–33 (2014)



# The Role of Digital Platforms in Disrupting Agricultural Value Chains in Developing Countries

Bookie Ezeomah  and Richard Duncombe 

The University of Manchester, Manchester M13 9PL, UK  
richard.duncombe@manchester.ac.uk

**Abstract.** Mobile devices and the platforms they support are increasingly being mainstreamed into agricultural value chains. While the extant literature on the use of mobile devices for agriculture has focused on their use for the provision of m-services through short messaging services (SMS), unstructured supplementary service data (USSD) and voice calls, there is growing evidence of the adoption and use of a new wave of digital platforms (mobile apps, web apps and online databases) in agricultural value chains in developing regions. As debates on the disruptive potential of digital platforms in agriculture are still at a nascent stage, this scoping review investigates the current research landscape on the use of digital platforms in agricultural value chains in developing regions. An assessment of the 26 digital platforms identified through the review show their potential to cause change in a number of value chain processes. However, the review reveals certain methodological shortcomings and a dearth of empirical evidence to support claims of significant disruptive impact.

**Keywords:** Digital platforms · Disruption · Agricultural value chains · Agricultural development

## 1 Introduction

Digital platforms are currently re-shaping business and socio-economic structures globally (de Reuver et al. 2017) giving rise to debates on the digital economy and decent work; data rights and privacy; the emergence of innovation platform ecosystems in resource constrained environments; frugal innovations and digital entrepreneurship (Heeks 2008; Mann 2018). Digital platforms provide affordance (both enabling and constraining) which has the potential to change, re-structure or even destruct systems into which they are introduced, due to inherent characteristics which make them differ from their non-digital alternatives (Kazan et al. 2014; Koskinen et al. 2018). Moreover, the governance of these platforms goes a long way in determining their openness, accessibility and degree to which they are inclusive which has broader implications for development.

The GSMA (2017) reports that agriculture in developing countries is experiencing an extended use of mobile devices beyond conventional voice and short message service (SMS) functions. Mobile devices, especially smartphones, provide functionalities that

enable users to access digital platforms (mobile and web applications) which facilitate a variety of economic activities in agricultural value chains (see: Fig. 1). In addition, innovators and platform users in developing regions have become key participants in the innovation ecosystem, engaging more actively with the platform economy as opposed to being passive recipients of innovation (Yoo et al. 2012; Sedera et al. 2016; Graham et al. 2017).

This review seeks to investigate the current use of digital platforms, beyond the conventional SMS and voice services, to understand the influence of these emerging digital platforms on agricultural value chains in developing regions. The remaining sections of this review is structured as follows: Sect. 2 describes the methodology adopted for the scoping review; Sect. 3 provides a conceptual background on digital platforms, disruptive innovation and agricultural value chains; Sect. 4 is a summary of key findings and thematic analysis of the literature surveyed; Sect. 5 discusses the empirical evidence; and Sect. 6 concludes the review with suggested areas for future research.

## 2 Review Methodology

Systematic and scoping literature reviews are underpinned by a step-wise methodology which entails detailed planning; justification of literature search and selection criteria; and a thorough documentation of the review process (Okoli and Schabram 2010; Arksey and O'Malley 2005). However, a scoping review differs as it adopts an iterative methodology which allows redefinition of the literature search criteria as the researcher becomes more conversant with the extant literature (Arksey and O'Malley 2005; Levac et al. 2010). Consequently, this review adopts a scoping review methodology as it is less restrictive and permits the researcher to engage with a wider breath of literature on the subject area. The five-step scoping methodology framework developed by Arksey and O'Malley (2005) and the Preferred Reporting of Items for Systematic Review and Meta-Analysis (PRISMA) methodology (Liberati et al. 2009) served as guides to structure this review process.

### 2.1 Step 1: Identifying the Research Question

Specifically, our overarching research question is: *what is known from existing literature about the current use of digital platforms (beyond voice and SMS) on agricultural value chains in developing regions? And how can we understand the (potential) disruptiveness of these digital platforms on agricultural value chains in developing countries?* The review also seeks to: (a) identify digital platforms which are mainstreamed into agricultural processes and map out aspects of the agricultural value chain where these digital platforms are being applied; (b) identify methodologies used for research on digital platforms on agricultural value chains; (c) summarise and analyse findings from research on digital platforms in agricultural value chains; (d) identify future research questions.



## 2.2 Step 2: Identifying Relevant Studies

To ensure we comprehensively capture publications relating to our research query, an iterative methodology was adopted by cross-referencing keywords related to the review topic - agri\* digital\* innovation\* platform\* app\* ICT\*, smartphone\*, m-agri\*, e-agri\*, m-service\*. Keyword search was performed using the following bibliographic databases: Scopus, JSTOR, Science Direct and Google scholar. Purposive handsearching for grey literature was also carried out by cross-referencing keywords using Google search engine to identify relevant practitioner reports.

## 2.3 Step 3: Study Selection

Search results from databases and search engines were further narrowed down to studies relevant to our research query. The review adopted an exclusion and inclusion criteria to screen articles based on title, sector, geographic coverage, language, duration, scope and content. The criteria are outlined in Table 1.

**Table 1.** Inclusion and exclusion criteria

Criteria	Include	Exclude
Title	Articles with titles that included keywords outlined in step 2	Titles with ‘SMS’ and/or Voice and/or USSD
Sector	Digital platforms used in agriculture	Digital platforms used in other non-agriculture SME’s
Geographic coverage	Developing regions	Developed regions
Timeframe	2008–2018 <sup>a</sup>	Before 2008
Language	English publications	Non-English publications
Scope	Open access peer reviewed articles, book chapters and grey literature (practitioner reports, blogs, new articles were also included)	Publications which is not open access
Content	Must discuss at least one digital platform currently being adopted in one or more value chain activity outlined (Fig. 1)	Digital platforms in development (prototype) stage not yet tested or used; platforms used for agricultural education

Source: Author’s compilation

<sup>a</sup> We assume that papers before 2008 will focus on voice and SMS platforms

Based on the inclusion and exclusion criteria outlined above, the Preferred Reporting of Items for Systematic Review and Meta-Analysis (PRISMA) methodology proposed by Liberati et al. (2009) was used in selecting the 20 publications used for this review.

## 2.4 Step 4: Charting the Data

Using the ‘reference function’ of the NVivo data analysis software, data was extracted from each publication to map the research landscape. Data extracted includes: author, year; keywords; name of digital platform discussed; type of platform (Trading Platforms, Finance Platforms, Information Repositories, Social Networking Platforms, Farm Management Platforms, Crowdsourcing Platforms); value chain function used (based on Fig. 1); description; platform owner; launch year, country, research methodology; and key findings.

## 2.5 Step 5: Collating, Summarising and Reporting

Using data extracted through the charting process in step 4 a thematic analysis of articles was carried out based on a framework for identifying potential disruptive innovation proposed by Nagy et al. (2016), discussed in the following section of this review. To iterate, these thematic categories are:

- (a) Identification of value chain segments where digital platforms are being applied.
- (b) Identification of the digital platforms and their characteristics based in their functionality, technicality and ownership.

# 3 Conceptual Background

## 3.1 Agricultural Value Chains

In developing country agriculture, the use of ICTs, such as mobile platforms, has been largely driven by inefficiencies in agricultural value chains, relating to high transaction cost and information asymmetries (Aker 2011; Deichmann et al. 2016; Baumüller 2018). A value chain represents the full range of activities and actors required to bring a product or service from inception to final consumption (Porter 1990). The value chain, as an analytical framework, allows for the systematic mapping of chain actors, their functions and activities (Kaplinsky and Morris 2001) and comprises a series of stages or ‘links’ which are made up of a broad range of (primary and secondary) actors, functions and activities which add value to an agricultural commodity as it moves along the chain (Gereffi et al. 2005; Trienekens 2011). This systematic mapping could serve as a useful approach in identifying who, where and how digital platforms are being mainstreamed into value chain activities and also provide a starting point for understanding the disruptive potential of digital platforms on value chain actors and processes.

## 3.2 Digital Platforms

The term ‘platform’ is commonly conceptualised from two different disciplinary positions: first, the engineering and economics perspective. In engineering, platforms are defined as ‘*technological architectures*’ (Gawer 2014) which serve as a foundation for the development of other innovations. For instance, Google’s android and Apple’s

iOS are digital platforms that support the development of mobile applications (apps) and other web platforms. Second, economists conceptualise platforms as ‘two-sided markets’ or ‘multi-sided markets’ that facilitate interactions between two or more group of users (Gawer 2014). Evans and Gawer (2016) describe these two platform perspectives (typologies) as *innovation platforms* and *transaction platforms* respectively. Uniting both perspectives, a platform can be conceptualised as a foundation that supports further innovation and facilitates interactions between two or more users with common interests (Gawer 2014; Tiwana 2014; Deichmann et al. 2016; Evans and Gawer 2016; Parker et al. 2016).

In developing countries where digital platforms have been adopted, transaction platforms (mobile and web applications) constitute the most widely adopted typology of platforms while innovation platforms are increasingly being adopted by resource-constrained innovators as the basis for further innovation (GSMA 2017; Koskinen et al. 2018). These transaction platforms fall into the following sub-groups:

- (1) *Digital finance platforms* which facilitate financial transactions such as input purchase and agricultural product sales, for instance, Safaricom’s MPesa (Jack and Suri 2011) and PayStack<sup>1</sup>.
- (2) *Online Trading Platforms* which bring buyers and sellers of agricultural commodities together reducing both spatial and temporal barriers to trade as well as transaction costs. For instance, the Indian Tobacco Company’s (ITC) e-choupal which brings coffee farmers and buyers together giving farmers better bargaining power as a result of the elimination of middle men (Chen et al. 2013).
- (3) *Digital social networking platforms* such as WhatsApp and Facebook are increasingly being used as a channel to advertise products and connect with users that share similar interests (Irungu et al. 2015).
- (4) *Digital crowdsourcing platforms* such as ‘ushaurilimo’ which is used to gather agricultural information from a variety of experts to address the poor extension service delivery in Tanzania (Sanga et al. 2016).
- (5) *Digital information repositories* such as the Plantwise Knowledge Bank, although not transaction platforms *per se*, are platforms used by extension agents to provide scientifically informed recommendations to farmers (Leach and Hobbs 2013).

### 3.3 Disruption Due to Digital Platforms

Digital platforms have been described as ‘*disruptive information technology (IT) artefacts that erode conventional business logic associated with traditional market structures*’ (Kazan et al. 2014). As with all other innovations, the potential or likelihood for a digital platform to transform (disrupt) agricultural value chains depends on innovation characteristics and the nature of the market or system where the innovation is being introduced (Rogers 1995; Nagy et al. 2016). As a result, de Reuver et al. (2018) suggest that studying digital platforms (and their potential to disrupt) should be tailored to a specific academic discipline or industries to provide deeper conceptual clarity.

<sup>1</sup> PayStack is an online third party payment platform used in Africa. See: <https://paystack.com/>.

In discussing disruption within the context of developing country agriculture, there is yet to be a robust understanding of what constitutes a disrupted agricultural market or value chain or how a disruptive innovation interacts with pre-existing actors and functions within these traditional markets. Disruption has mainly focused on western industrialised markets, such as Kazan et al. (2014) who point out that despite their increased adoption in all economic sectors, there is a dearth of studies which describe how digital platform disruption occurs and its implication to existing market players. The most concerted effort to propose a framework for identifying potentially disruptive innovation along a value chain was done by Nagy et al. (2016) who describe disruptive innovation as ‘*an innovation with radical functionality, discontinuous technical standards, and/or new forms of ownership that redefines marketplace expectations*’. They argue that a potentially disruptive innovation is one which provides better *functionalities, technical standards and ownership models*, comparing the (potentially) disruptive innovation with incumbent innovations currently used for the same functions on the value chain. As a starting point, this review adopts Nagy’s criteria which are used to assess the digital platforms identified in the review: according to

- (a) *Functionality* - which enables users to perform new tasks or results in behaviour changes that were previously impossible with the use of other innovations, and whether the disruption is to primary functions (such as production) or secondary (such as supporting services for the value chain) (Nagy et al. 2016).
- (b) *Technicality* - in terms of the level of complexity of the disruptive innovation and its compatibility with users existing technical knowledge. Disruptiveness suggests innovation characteristics which are *complex* if they possess new technical standards that pose knowledge barriers for users (Attewell 1992).
- (c) *Ownership* - which influences how the innovation interacts with the market, how it is priced, and how it is perceived by users (Merges and Reynolds 2000), who controls the innovation and how it is developed (Joyce and Patterson 2003).

Digital platform disruption in agriculture is a nascent debate, and the thematic review is a starting point for an on-going analysis. Our review focuses on digital transaction platforms, as digital innovation platforms (technological architectures) are beyond the remit of this paper. Therefore, the following Sect. 4 is limited to platform disruptions due to functionality, technicality and ownership, but we appreciate that a broader analysis is also required relating to disruption of existing production networks and the livelihoods of value chain actors, as well as changes in the way that agricultural development initiatives are implemented, and whether there have been agricultural intervention policy changes that reflect these developments. These broader disruptions are not the focus of this paper, but are elaborated upon in the discussion Sect. 5 with regard to what was evidenced in the sample of papers reviewed.

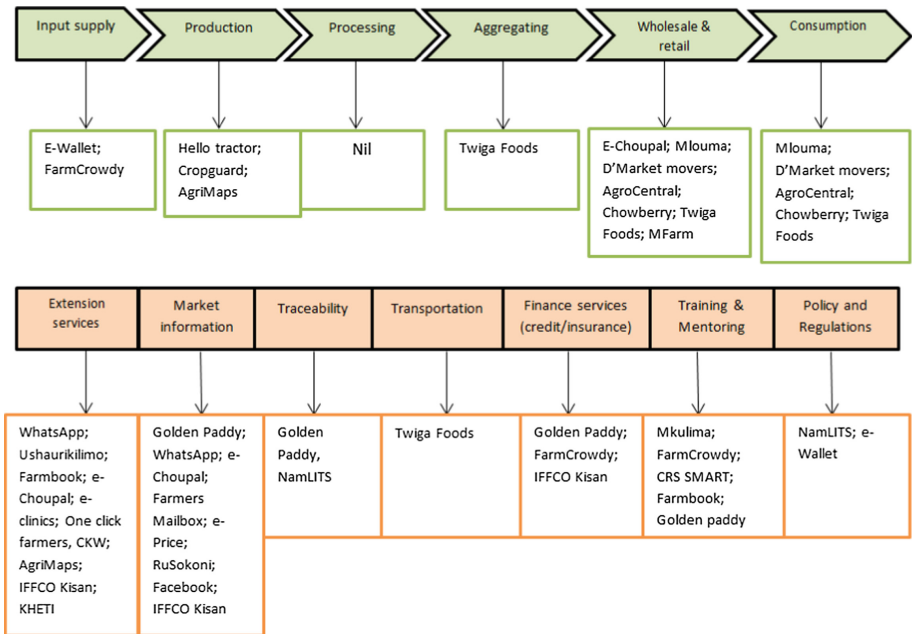
## 4 Thematic Review

The thematic analysis entails identification of the digital platforms and their characteristics based on value chain mapping, functionality, technicality and ownership models. From the publications included in this review, 26 digital platforms are

identified (including: mobile apps, web apps and databases). These include; mobile apps (10); web platforms (12) and databases (4). It should be noted that some of these digital platforms have both mobile apps and web platforms (e.g., Farmcrowdy); databases and mobile apps (e.g., e-clinics) and mobile apps supported by SMS functions (e.g., Agrocentral; Tiwga foods).

### 4.1 Value Chain Mapping

The review reveals that the digital platforms identified support secondary value chain activities such as extension service delivery (9); market information (7); financial services (4) and training/mentoring (5). While for primary value chain activities trading platforms which support wholesale/ retail (7) and consumption functions (6) account for the larger share of digital platforms adopted. Some platforms are used on more than one link in the chain to facilitate both primary and secondary activities (for instance: e-Choupal; FarmCrowdy; IFFCO Kisan; Tiwga foods); three platforms provide bespoke support on a single link (Hello tractor, Crop guard and Agrimaps); and no platform supporting processing activities was identified (see: Fig. 1).



**Fig. 1.** Identified digital platforms adopted on agricultural value chains in developing countries. Source: Author’s compilation

## 4.2 Functionality of Digital Platforms

Based on their functionality, the review identifies four types of digital platform used in agricultural value chains. These are:

- (a) *Crowdsourcing platforms*: These platforms are used in place of one-on-one fund raising and information sourcing providing a platform to obtain funds and information from larger numbers of individual investors. Examples identified include *Farmcrowdy* for crowdfunding (Ajadi et al. 2018), *RuSokoni* for crowdsourcing market price information (Rahman and Fong 2016) and *Ushaurikilimo* for crowdsourcing responses to farmers questions (Sanga et al. 2016).
- (b) *Trading platforms*: This category brings together sellers and buyers of agricultural commodities to interact in a virtual marketplace, and are used as platforms to support trading activities through providing price information and product advertisement. These include *e-Choupal* (Banker et al. 2011; Ali and Kumar 2011; Jain 2016); *IFFCO Kisan* (Darabian 2016); *AgroCentral*, *TiwgaFoods*, *Mlouma*, *Chowberry* and *D'Market Movers* (Rahman and Fong 2016); and *MFarm* (Baumüller 2015); In addition, the *e-Price* app (Zhang et al. 2016); *Facebook* (Rahman and Fong 2016; Irungu et al. 2015) and *WhatsApp* (Thakur and Chander 2016; Naruka et al. 2017).
- (c) *Extension advisory platforms*: Digital platforms for extension services (e-extension) are identified as providing two forms of functionality. First, digital platform used by *farmers* to remotely connect with extension agents (e-extension). For example, *Ushaurikilimo* (Sanga et al. 2016); and *one click farmers' service* (Zhang et al. 2016). These e-extension platforms are adopted in place of physical contact between farmers and extension personnel and have become especially useful in regions with poor transportation networks which tend to limit extension service delivery (Aker 2011). Second, digital platforms used by extension agents to facilitate extension service delivery: These include the *Plantwise Knowledge Bank* (Wright et al. 2016); the *Community Knowledge Worker (CKW) mobile platform* (Nakato et al. 2016); *KHETI* (Fu and Aker 2011); and *Farmbook* (Tata and McNamara 2018). These platforms usually support extension service delivery by providing information, training and data collection which help extension agents make more informed recommendations to farmers.
- (d) *Farm management platforms*: These are digital platforms that enable farmers make more informed farm management decisions such as *Hello tractor*, *Crop guard* (Rahman and Fong 2016); *AgriMap* (Jordan et al. 2016); *IFFCO Kisan* (Darabian 2016) and *E-wallet* (Godson-Ibeji et al. 2016; Demenongu et al. 2018). These platforms have functionalities that provide tailored information based on the site-specific realities including location, soil type and the type of farm enterprise (Jordan et al. 2016; Darabian 2016).

## 4.3 Technicality of Digital Platforms

The evidence suggests that the degree of disruptiveness is influenced by technicality. To illustrate, as a result of the complexity of the *AgriMap* mobile app, Jordan et al. (2016) report that there has been a low level of adoption and use of the app in Trinidad

and Tobago. They add that its low adoption is also due to the aging farmer population who engage in agriculture, most of whom still use feature phones (Jordan et al. 2016). Darabian (2016) explains that the slower rate of adoption of the IFFCO's mobile app, compared to their previous 'green SIM' SMS and voice model, is because most new users find it difficult to navigate the preliminary stages of registration and profile creation after the app was downloaded. As a result, users who could not overcome the challenging registration stage were unlikely to adopt mobile app (Darabian 2016).

In contrast, among Nigerian farmers, the *e-wallet* platform has been widely adopted due to its relatively low-level of complexity and its compatibility with both smart and feature phones. However, its adoption and use is constrained by poor Internet connectivity and poor electricity supply in rural Nigeria which has resulted in untimely receipt of e-vouchers and slow disbursement of agricultural inputs (Godson-Ibeji et al. 2016; Demenongu et al. 2018). Zhang et al. (2016) reveals that the wide spread Internet coverage coupled with the high level smartphone usage among old and young farmers have driven the rapid adoption and usage of the *one click farmer service* platform, *farmers mailbox* and *E-Price app* in rural Zhengjiang and Shanghai, China. They describe farmers in this region as 'tech savvy' and willing to adopt new digital platforms. As a result of farmer's behaviour towards digital innovations in these regions, more local government support has been provided in developing and maintaining these platforms (Zhang et al. 2016).

Besides technical issues relating to digital platform navigation, the complexity of the content hosted or sourced through these platforms tends to serve as an impediment to their wide spread adoption. Digital platforms such as *AgriMap* and *CropGuard* described by Jordan et al. (2016) and Rahman and Fong (2016) require medium to high level specialist knowledge in Geographic Information System (GIS), and knowledge on pest and disease identification for users to be able to make meaningful inferences from information derived through these platforms. Furthermore, the user research carried out on the *IFFCO mobile app* reveals that the new pull service model which requires users to understand what exactly to search for and interpret this information for themselves is also a challenge to uneducated users who tend to prefer the previous (green SIM) push model of receiving simple daily short messages (Darabian 2016).

Finally, in terms of ease-of-use and multi-functionality, Rahman and Fong (2016) and Irungu et al. (2015) describe the use of *Facebook* by the Mkuima Youth group in Kenya as a platform for engaging with several agricultural value chains, information sourcing and peer-to-peer mentorship. Thakur and Chander (2016) and Naruka et al. (2017) also provide evidence of *WhatsApp* usage by farmer groups in India for information sharing and trading. They posit that the relatively low level of technicality; multi-functional use of these platforms for both non-agricultural and agricultural purposes; and more specifically, the group chat functionality of both social networking platforms provide a space for crowdsourcing of information from a wide audience and peer-to-peer problem solving.

#### 4.4 Ownership Models of Digital Platforms

Our review identifies a preliminary model of ownership of digital platforms introduced to developing country agricultural value chains: These are as follows.

- (a) *Sole-ownership models*: Private business start-ups account for the largest share of solely-owned digital platforms. Although they are privately owned and should be mainly profit-driven, the nine start-up agro-digital platforms identified have either benefitted from international funding and business incubation programmes such as provided by GSM Association (GSMA) and Technical Centre for Agriculture and Rural Cooperation (CTA) (Rahman and Fong 2016; Ajadi et al. 2018). Consequently, these start-ups tend to also function as social enterprises whereby their platforms are used for agricultural development purposes as they extend information, financial and agricultural marketing support to marginalised groups (farmers) on the value chain.
- (b) *Jointly owned (partnerships)*: The three NGO-owned digital platforms identified were developed to achieve programme goals of agricultural development initiatives. These platforms are: the e-clinic platform by CABI in Kenya; FarmBook by CRS in Uganda; CKW mobile platform by Grameen foundation in Uganda; and KHETI in India funded by the EPSRC, are digital platforms developed to support the extension of agricultural advisory services as part of the goals of agricultural development programmes initiated by international organisations. As a result, the use, functionality and access to these platforms are shaped by programme goals and requirements of funding agencies.
- (c) *Government-owned*: As well as the partnership model, two exclusively government-owned digital platforms were identified, developed to support the implementation of national policy. For example, the E-wallet platform in Nigeria was developed under the Growth Enhancement Support (GES) scheme, a policy implemented by the Federal Ministry of Agriculture and Rural Development aimed at improving farmer's access to subsidised agricultural inputs (Godson-Ibeji et al. 2016; Demenongu et al. 2018). Zhang et al. (2016) observed through their review on government-owned digital platforms such as Farmers mailbox that although these platforms tend to be managed using a top-down approach, their introduction into agricultural value chains tend to be incentive-based and at no cost to adopters thereby driving their wide spread adoption.
- (d) *Communal ownership*: Digital platforms owned by cooperatives enterprise also include platforms developed by cooperatives such IFFCO Kisan (Darabian 2016).

## 5 Research Findings and Discussion

### 5.1 Disruptiveness Along Value Chains

The quantitative approach adopted by Demenongu et al. (2018) used descriptive statistics and chi square to evaluate the effectiveness of the *e-wallet* platform in supporting the provision of timely inputs to 120 purposively selected e-wallet users. They found that 75% of e-wallet users were satisfied with the improved access to fertilizers provided through the platform while 25% did not trust that the system was transparent in its operation. Redemption code mismatch between registered farmers and input suppliers was also a major challenge to timely input acquisition. Godson-Ibeji et al. (2016) also sampled 180 *e-wallet* users and found that poor mobile network coupled



with low numbers of certified agro-dealers within rural communities resulted in poor and untimely access to inputs through the *e-wallet* platform. In both studies, respondents indicated lack of trust in agro-dealers input disbursement through the platform.

In assessing the impact of the *e-Choupal* platform for decision making along the agricultural value chain in India, Ali and Kunal (2011) comparatively analysed data from 152 users and 151 non-users (the control group) of the platform. Using structured questionnaires, they investigated the usage of the *e-Choupal* platform for decision making in three segments of the value chain: (i) production planning; (ii) cultivation practices; and (iii) post-harvest management and marketing; and analyse results using Analysis of Variance (ANOVA) technique. They find that both users and non-users with some form of education, generally made better decisions than uneducated users and non-users on the three stages of the value chain investigated. Other factors such as social class, income and farm ownership model (owned or rented) influenced the ability of both users and non-users to make better decisions on the value chain. They also observe that the use of *e-Choupal* is more likely to result in individual user's behaviour change in farming practices such as crop rotation; use of certified seeds; sorting and grading techniques; and market engagement. Jain (2016) also analysed the usefulness of the *e-Choupal* platform in making informed decision by comparing users and non-users of the platform. Using 160 women and 160 men users and 40 women and 40 men non-users of *e-Choupal*, the research finds that users of the platform make more informed decisions than non-users. It however does not show how these decisions translate to increase income or improved livelihoods of users.

Banker et al. (2011) however compared transactional (price) data from three coffee trading platforms: ITC's *e-Choupal* platform; physical auctions managed by the Indian Coffee Traders Association (ICTA<sup>2</sup>); and farm gate transactions, to determine which of these platforms provides higher prices for farmers - for various coffee grades. They find that generally, the advantage of the digital trading platform over physical auction was the lower transactions cost. However, coffee grades with higher price volatility tend to be cheaper on digital platforms meaning farmers sold at lower prices than at physical auctions where physical inspection by buyers meant farmers could earn more for a similar grade sold on the digital platform.

## 5.2 Digital Platforms in Resource Poor Environments

The three NGO-owned digital platforms identified were developed to achieve the programme goals of agricultural development initiatives. These platforms are: the *e-clinic* platform by CABI in Kenya; *FarmBook* by CRS in Uganda; *CKW mobile platform* by Grameen foundation in Uganda; and *KHETI* in India funded by the EPSRC, digital platforms developed to support the extension of agricultural advisory services. As a result, the use, functionality and access to these platforms are shaped by programme goals and requirements of funding agencies. Three studies adopted experimental designs to evaluate digital platforms used for extension service delivery. These studies were part of the monitoring and evaluation of development initiatives

<sup>2</sup> ICTA holds a coffee auction every Thursday in Bangalore (Banker et al. 2011).

implemented through: the *Plantwise programme*; *SMART skills* and *Farmbook ICT tool*; and the *CKW mobile platform*. The experimental research approach adopted by Wright et al. (2016) to test the suitability of transitioning from paper-based plant clinic service delivery to digital-based (*e-clinic*) service delivery, entailed a step-wise incremental implementation design which was iterative and allowed for the adaptation of the research design as the experiment progressed. The research was carried out in two stages (March 2014–May 2014 and May 2014 to March 2015) to give room to identify behaviour change over time. By triangulating survey data, with physical observation of extension agents during training; and platform usage analytics obtained through the Plantwise Online Management System<sup>3</sup> (POMS), the research found significant behaviour change among the 60 extension agents who took part in the experimental trial and farmers who visited plant clinics. These behaviour changes included: better quality of recommendations provided to farmers; timeliness and confidence in diagnosis; and increased trust between farmers and extension workers.

Nakura et al. (2017) adopted an experimental research approach to investigate the suitability of using WhatsApp as a platform for extension advisory service delivery. An experimental WhatsApp group was created with 90 farmers; and information on crop management practices were provided to the group in written and video formats. The research results indicate behavioural changes in farmer's practices relating to selection of agrochemicals (81.1%) and adoption of seed treatment practices (51.1%). However, no control group was included in the experimental design and the experiment duration was not specified. The study relied on only farmer's perception and no panel data to support claims of user engagement over time. Thakur and Chander (2016) also conducted an experimental study on *WhatsApp* usage, for farmer-to-farmer information sharing. Within 6-months, they observed 137 posts on animal husbandry (including photos) and found that the use of *WhatsApp* in animal husbandry was gaining popularity especially because it supports photo sharing, a functionality not supported by the conventional SMS platform.

Nakato et al. (2016) carried out an experiment to assess the usefulness of the digital survey data collection platform, over paper-based survey, for the management and surveillance of banana disease in Uganda through the *CKW mobile platform*. In the first month of the experiment, the number of digital versus paper surveys collected was 812 and 856 respectively and in the second month 942 and 846. In comparing the digital and paper-based survey, it was found that most of the paper-based surveys were torn, incomplete and failed to capture exact locations of disease incident. The digital platform on the other hand used GPS to collect site-specific information which helped programme staff provide farmers with tailored information on disease prevalence and spread in two districts in Uganda which would have been relatively difficult to map using paper based surveys. Similarly, Tata and McNamara (2018) adopted randomised survey data collected between 2013 and 2015 in three phases to assess the impact of the *SMART skills* and *Farmbook ICT tool* in extension service delivery (Tata and

<sup>3</sup> POMS is an online database which contains records of farmers visits to plant clinics (name, date, village, plant problem etc.) and records of the diagnosis and recommendations provided by plant doctors (Wright et al. 2016).

McNamara 2018). Results from the 60 extension agents used for the research were compared with a control group and revealed that extension agents using the digital platforms were able to work with higher numbers of farmers than the control group.

## 6 Conclusion and Future Research Questions

Digital technologies are creating *disruptive crossovers* in almost all economic sectors through digital platforms (de Reuver et al. 2017). Therefore, it is important that information systems research should broaden its scope to understand the developmental impacts and implications of digital platforms especially in the developing countries (Donner 2018; Koskinen et al. 2018). From the review, we see that there is potential for digital platforms to disrupt agricultural value chains especially through re-structuring individual production networks, national level agricultural development initiatives and policy-level initiatives.

The review also finds that technical issues posed by some platforms (e.g., Agri-Maps and IFFCO Kisan app) have resulted in the emergence of a passive model of platform engagement where less ‘tech-savvy’ actors engage with digital platforms through intermediaries. This model of platform usage is increasingly pioneered by new-entrant agri-tech digital platforms commonly termed ‘start-ups’ (Ajadi et al. 2018) such as *TiwgaFoods*, *AgroCentral*, *FarmCrowdy*, *Mlouma*, *D’Market Movers* and *RuSokoni* (Rahman and Fong 2016; Ajadi et al. 2018). Through these platforms, agents acting as intermediaries perform technically complex activities on behalf of less ‘tech savvy’ actors (such as farmers) which include registration, profile creation, commodity advertising and facilitating financial transactions. Some of these digital platform models still adopt the SMS and voice platform to support their platform service delivery such as: sending e-receipts (e.g., *TiwgaFoods*) to farmers and vendors; sending notifications of order confirmation services (e.g., *AgroCentral*) and to deliver e-vouchers to users who do not have smartphones.

The review also maps the methodological landscape of research studies on digital platforms on agricultural value chains. The papers reviewed reveal a dearth of evidence on the impact of these platforms on agricultural value chains which buttresses ongoing debates on methodological challenges associated with assessing the impact of ICTs in agricultural and rural development. In charting the data for this review we observe that most digital platforms used in agricultural value chains beyond SMS, USSD and voice are discussed in practitioner reports such as the GSMA and CTA. These reports tend to adopt anecdotal methodology which is based on success stories which do not provide concrete empirical data to support reported statistics of usage and impact. Particularly, we observe this in publications on agri-tech start-ups by Ajadi et al. (2018) and Rahman and Fong (2016). From these anecdotal studies, the limited data provided is mostly aggregated and does not capture demographic, socio-economic and the gender profile of users, as with the case of Ajadi et al. (2018) who report that *Tiwga Foods* has 3500 registered farmers from whom they source 245 tonnes of bananas each week and deliver to 3500 vendors. These figures do not provide any evidence to support claims reported that through the platform farmers are able to obtain higher prices for their produce.

The review finds that methodological approaches adopted by most academic research on digital platforms does not provide evidence of the actual impact of the platform relative to specific (isolated) usage patterns - which could provide more insight as to disruptiveness for the platform. This is also observed by Baumüller (2018) who identifies that shortcomings in research on m-services (both in agriculture and other disciplines) stems from a lack of rigor in methodological designs which tend to rely more on farmer's perception of an m-service, rather than panel data collected over time. For instance research carried out by Demenongu et al. (2018) and Godson-Ibeji on the e-Wallet system in Nigeria; and Ali and Kumar (2011) on e-Choupal would have benefitted from triangulating results with panel data on platform usage and transaction patterns to identify other bottlenecks to service delivery as opposed to relying on only farmer's perception through surveys as done by Banker et al. (2011).

Due to the sparse empirical evidence on the (disruptive) impact of digital platforms on agricultural value chains, the review posits that future research on ICT4D relating to digital platforms on agricultural value chains should address the following questions:

- What measures should be used to understand the disruptiveness of digital platforms on agricultural value chains?
- How has the mainstreaming of digital platforms on agricultural value chains influenced how and where value is captured on the chain?
- How can the magnitude of benefits that accrue to users from the use of digital platforms on agricultural value chains be measured empirically?
- Who or what groups govern the distribution of benefits from the use of digital platforms?
- What typologies of agricultural commodities are best supported and transacted using digital platforms, and why?
- What is the role of the private sector in digital platform ownership, control and governance?

## References

- Ajadi, S., Bayen, M., Ndichu, P., Tricarico, D.: Start-ups and mobile in emerging markets: insights from the GSMA Ecosystem Accelerator. GSM Association (2018). <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2018/03/Start-ups-and-Mobile-in-Emerging-Markets-Issue-2.pdf>. Accessed 16 May 2018
- Aker, J.C.: Dial "A" for agriculture: a review of information and communication technologies for agricultural extension in developing countries. *Agric. Econ.* **42**(6), 631–647 (2011)
- Ali, J., Kumar, S.: Information and communication technologies (ICTs) and farmers' decision-making across the agricultural supply chain. *Int. J. Inf. Manag.* **31**(2), 149–159 (2011)
- Arksey, H., O'Malley, L.: Scoping studies: towards a methodological framework. *Int. J. Soc. Res. Methodol.* **8**(1), 19–32 (2005)
- Attewell, P.: Technology diffusion and organizational learning: the case of business computing. *Organ. Sci.* **3**(1), 1–19 (1992)
- Banker, R.D., Mitra, S., Sambamurthy, V., Mitra, S.: The effects of digital trading platforms on commodity prices in agricultural supply chains. *MIS Q.* **35**(3), 599–611 (2011)

- Baumüller, H.: Enhancing smallholder market participation through mobile phone-enabled services: the case of m-farm in Kenya. *Electron. J. Inf. Syst. Dev. Ctries.* **68**(6), 1–16 (2015)
- Baumüller, H.: The little we know: an exploratory literature review on the utility of mobile phone-enabled services for smallholder farmers. *J. Int. Dev.* **30**(1), 134–154 (2018)
- Brugger, F.: Mobile applications in agriculture. Syngenta Foundation, 1–38 (2011)
- Chen, Y.J.J., George, S., Zuo-Jun Max, S.: Training, production, and channel separation in ITC's e-Choupal network. *Prod. Oper. Manag.* **22**(2), 348–364 (2013)
- Danneels, E.: Disruptive technology reconsidered: a critique and research agenda. *J. Prod. Innov. Manag.* **21**(4), 246–258 (2004)
- Darabian, N.: IFFCO Kisan Agricultural App: Evolution to Data Driven Services in Agriculture, GSMA (2016). <https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2016/10/IFFCO-Kisan-Agricultural-App.pdf>. Accessed 8 May 2018
- de Reuver, M., Sørensen, C., Basole, R.C.: The digital platform: a research agenda. *J. Inf. Technol.* **33**, 1–12 (2017)
- Deichmann, U., Goyal, A., Mishra, D.: Will digital technologies transform agriculture in developing countries? *Agric. Econ.* **47**(S1), 21–33 (2016)
- Demenongu, T.S., Yahaya, M., Jiriko, R.: Assessment of farm inputs distribution under the e-wallet scheme in Benue State, Nigeria. *Int. J. Agric. Food Res.* **6**(2), 20–25 (2018)
- Donner, J.: On 'Platforms' and 'Development' Presentation at the 3rd DIODE Workshop, Cape Town (2018). [https://diodeweb.files.wordpress.com/2018/02/donner\\_platforms\\_uct\\_diode.pdf](https://diodeweb.files.wordpress.com/2018/02/donner_platforms_uct_diode.pdf). Accessed 27 July 2018
- Duncombe, R.: Mobile phones for agricultural and rural development: a literature review and suggestions for future research. *Eur. J. Dev. Res.* **28**(2), 213–235 (2016)
- Evans, P., Gawer, A.: The rise of the platform enterprise: a global survey (Report). The Center for Global Enterprise (2016). <http://epubs.surrey.ac.uk/811201/>. Accessed 31 Jan 2019
- Fu, X., Acker, S.: Impact of mobile telephone on the quality and speed of agricultural extension services delivery: Evidence from the rural e-services project in India. In: Proceedings of International Association of Agricultural Economists (IAAE) 2012-Triennial Conference, pp. 18–24 (2011)
- Gawer, A.: Bridging differing perspectives on technological platforms: toward an integrative framework. *Res. Policy* **43**(7), 1239–1249 (2014)
- Gereffi, G., Humphrey, J., Sturgeon, T.: The governance of global value chains. *Rev. Int. Polit. Econ.* **12**(1), 78–104 (2005)
- Godson-Ibeji, C.C., Chikaire, J.U., Anyaoha, N.: Assessing the effects of e-wallet scheme in farm inputs distribution to rural farmers in Imo State, Nigeria. *J. Agric. Res. Dev.* **6**(2), 034–041 (2016)
- Graham, M., Hjorth, I., Lehdonvirta, V.: Digital labour and development: impacts of global digital labour platforms and the gig economy on worker livelihoods. *Transf.: Eur. Rev. Labour Res.* **23**(2), 135–162 (2017)
- GSMA: The Mobile Economy 2017 (2017). <https://www.gsmaintelligence.com/research/?file=9e927fd6896724e7b26f33f61db5b9d5&download>. Accessed 26 Jan 2018
- Heeks, R.: ICT4D 2.0: The next phase of applying ICT for international development. *Computer* **41**(6), 26–33 (2008)
- Irungu, K.R.G., Mbugua, D., Muia, J.: Information and communication technologies (ICTs) attract youth into profitable agriculture in Kenya. *East Afr. Agric. For. J.* **81**(1), 24–33 (2015)
- Jain, S.: Impact of e-Choupal on information empowerment of rural people of Rajasthan. *Indian Res. J. Ext. Educ.* **13**(1), 88–95 (2016)
- Jack, W., Suri, T.: Mobile money: The economics of M-PESA (No. w16721), National Bureau of Economic Research, Working paper No. 16721 (2011)

- Jordan, R., Eudoxie, G., Maharaj, K., Belfon, R., Bernard, M.: 'AgriMaps: improving site-specific land management through mobile maps. *Comput. Electron. Agric.* **123**, 292–296 (2016)
- Joyce, C., Patterson, L.: 'Copyright in 1791: an essay concerning the founders' view of the copyright power granted to congress in article I, section 8, clause 8 of the US constitution. *Emory Lj* **52**, 909 (2003)
- Kaplinsky, R., Morris, M.: *A Handbook for Value Chain Research*, vol. 113. IDRC, Ottawa (2001)
- Kazan, E., Tan, C.W., Lim, E.T.: Towards a framework of digital platform disruption: a comparative study of centralized & decentralized digital payment providers. In: 25th Australasian Conference on Information Systems, 8–10 December 2014, Auckland NZ (2014). <https://pdfs.semanticscholar.org/b3b5/cacb73f522ff60142663319baa7cac8ae09a.pdf>. Accessed 31 Jan 2019
- Koskinen, K., Bonina, C., Eaton, B.: Digital platforms in the global south: foundations and research agenda, Diode Paper No 8, University of Manchester (2018). <https://diodeweb.files.wordpress.com/2018/10/digital-platforms-diode-paper.pdf>. Accessed 30 Jan 2019
- Leach, M.C., Hobbs, S.L.: Plantwise knowledge bank: delivering plant health information to developing country users. *Learn. Publ.* **26**(3), 180–185 (2013)
- Levac, D., Colquhoun, H., O'Brien, K.K.: Scoping studies: advancing the methodology. *Implement. Sci.* **5**(1), 69 (2010)
- Liberati, A., Altman, D.G., Tetzlaff, J., Mulrow, C., Gøtzsche, P.C., Ioannidis, J.P.A., Clarke, M., Devereaux, P.J., Kleijnen, J., Moher, D.: The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration'. *J. Clin. Epidemiol.* **62**(10), 1–34 (2009)
- Mann, L.: Left to other peoples' devices? A political economy perspective on the big data revolution in development. *Dev. Chang.* **49**(1), 3–36 (2018)
- Merges, R.P., Reynolds, G.H.: Proper scope of the copyright and patent power. *Harv. J. Legis.* **37**, 45 (2000)
- Nagy, D., Schuessler, J., Dubinsky, A.: Defining and identifying disruptive innovations. *Ind. Mark. Manag.* **57**, 119–126 (2016)
- Nakato, G.V., Beed, F., Bouwmeester, H., Ramathani, I., Mpiira, S., Kubiriba, J., Nanavati, S.: Building agricultural networks of farmers and scientists via mobile phones: case study of banana disease surveillance in Uganda. *Can. J. Plant Pathol.* **38**(3), 307–316 (2016)
- Naruka, P.S., Verma, S., Sarangdevot, S.S., Pachauri, C.P., Kerketta, S., Singh, J.P.: A study on role of WhatsApp in agriculture value chains. *Asian J. Agric. Ext. Econ. Sociol.* **20**(1), 1–11 (2017)
- Okoli, C., Schabram, K.: A guide to conducting a systematic literature review of information systems research. *Sprouts: Work. Pap. Inf. Syst.* **10**(26), 1–51 (2010)
- Parker, G.G., Van Alstyne, M.W., Choudary, S.P.: *Platform Revolution: How Networked Markets are Transforming the Economy and How to Make Them Work for You*. WW Norton & Company, New York (2016)
- Pongnumkul, S., Chaovalit, P., Surasvadi, N.: Applications of smartphone-based sensors in agriculture: a systematic review of research. *J. Sens.* **2015**, 1–18 (2015)
- Porter, M.E.: *The Competitive Advantage of Nations*. Simon & Schuster, New York (1990)
- Qiang, C.Z., Kuek, S.C., Dymond, A., Esselaar, S.: *Mobile Applications for Agriculture and Rural Development*. The World Bank, Washington, D.C. (2012)
- Rahman, R., Fong, J.: Innovate for agriculture: young ICT entrepreneurs overcoming challenges and transforming agriculture, CTA (2016). [https://cgspace.cgiar.org/bitstream/handle/10568/91708/1924\\_PDF.pdf?sequence=3&isAllowed=y](https://cgspace.cgiar.org/bitstream/handle/10568/91708/1924_PDF.pdf?sequence=3&isAllowed=y). Accessed 16 May 2018
- Rogers, E.M.: *Diffusion of Innovations*. The New York Free Press, New York (1995)

- Sanga, C.A., Phillip, J., Mlozi, M.R., Haug, R., Tumbo, S.D.: Crowdsourcing platform 'Ushaurikilimo' enabling questions answering between farmers, extension agents and researchers. *Int. J. Instr. Technol. Distance Learn.* **10**(13), 19–28 (2016)
- Sedera, D., Lokuge, S., Grover, V., Sarker, S., Sarker, S.: Innovating with enterprise systems and digital platforms: a contingent resource-based theory view. *Inf. Manag.* **53**(3), 366–379 (2016)
- Tata, J.S., McNamara, P.E.: Impact of ICT on agricultural extension services delivery: evidence from the Catholic Relief Services SMART skills and Farmbook project in Kenya. *J. Agric. Educ. Ext.* **24**(1), 89–110 (2018)
- Thakur, D., Chander, M.: Sharing livestock related information through WhatsApp among livestock owners: an appraisal. *Young* **16**(36), 56 (2016)
- Tiwana, A.: *Platform Ecosystems: Aligning Architecture, Governance, and Strategy*. Morgan Kaufmann, Burlington (2014)
- Trienekens, J.H.: Agricultural value chains in developing countries: a framework for analysis. *Int. Food Agribus. Manag. Rev.* **14**(2), 51–82 (2011)
- Wright, H.J., et al.: Using ICT to strengthen agricultural extension systems for plant health. *J. Agric. Food Inf.* **17**(1), 23–36 (2016)
- Yoo, Y., Boland, R.J., Lyytinen, K., Majchrzak, A.: Organizing for innovation in the digitized world. *Organ. Sci.* **23**(5), 1398–1408 (2012)
- Zhang, Y., Wang, L., Duan, Y.: Agricultural information dissemination using ICTs: a review and analysis of information dissemination models in China. *Inf. Process. Agric.* **3**(1), 17–29 (2016)



# Sharing Economy Digital Platforms and Social Inclusion/Exclusion: A Research Study of Uber and Careem in Pakistan

Fareesa Malik<sup>(✉)</sup>  and Zujaja Wahaj

NUST Business School, National University of Sciences and Technology,  
Islamabad, Pakistan

{fareesa.malik, zujaja.wahaj}@nbs.nust.edu.pk

**Abstract.** The sharing economy business models enabled by digital platforms are shifting the landscape of economic growth and nature of employment globally. This study focuses on digital travel industry of Pakistan and aims to explore the social and economic implications of sharing economy platforms. Drawing on the concepts of social inclusion/exclusion from ICT and IS literature, we examine the potential participation of digital platforms in social inclusion/exclusion of the society. We adopted an interpretive and qualitative research design. The data was collected through informal talks, observations and semi-structured interviews. For our research study, we selected two online ride-hailing companies operational in Pakistan, Uber and Careem. The study shows social impacts of sharing economy digital-platforms to enhance culture of trust, family confidence and women empowerment. It highlights the inclusion of unemployed groups through self-entrepreneurship that improve economic activities in the society. The study also identifies few contradictions and potential challenges that support social exclusion due to technology, such as biased gendered contribution in economic activities, generation/age constraints in usability and accessibility issues based on geographic locations.

**Keywords:** Sharing economy · Digital platforms · Uber/Careem · Social inclusion/exclusion · ICT4D

## 1 Introduction

The recent decade witnesses a massive emergence of digital platform based businesses that have become household names in short span of time, such as Uber, Airbnb, Lyft, YouTube and Upwork. These platform based digital businesses are rooted in the concept of collaborative consumption enabled by “activities of sharing, exchanging and rental of resources without owning the goods” [26, p. 143]. In management literature, different labels exist for the phenomenon of using and sharing of product and services (e.g. gig economy, collaborative consumption, peer-to-peer economy, sharing economy). The term “sharing economy”, coined in 2008, captures the whole ecosystem including economic and market arrangements related to this collaborative consumption phenomenon [26, 34, 37]. The sharing economy is defined as collaborative economy and collaborative consumption to exchange underused or unwanted assets for income



generation [5]. The phenomenon of resource sharing is not new to our society. Humans are accustomed to sharing extra resources, such as room, time, vehicles, and other consumable goods with people they know (e.g. relatives, friends, and neighbours). However, the business model of “sharing economy” extends the resource sharing to strangers to generate income. The resource sharing perspective does not only optimise the use of resources by utilising the idle resources but also enhances social and economic activities in the society, particularly in developing countries, where resources are not easily accessible and affordable to everyone. This study explores the potential social and economic implications of sharing economy in developing countries. It also examines how online digital platforms affect social inclusion/exclusion in the society.

Unlike traditional markets that are based on owing goods, sharing economy emphasises on social value in parallel with financial value to build stronger communities through resource sharing. It has emerged from niches to profitable markets and attracted millions of users and business investment [30]. The sharing economy sector is estimated to generate revenue of approximately \$335 billion by 2025 [35]. This tremendous growth potential of sharing economy sector may pose a serious threat to traditional industries, especially retail, hospitality, technology, media, entertainment, and travel [20].

Sharing economy has already attracted management scholars’ attention. However, because of an emerging domain, the research is still in infancy. Responding to the research need to strengthen the theoretical understanding of this emerging research area, we study a sharing economy phenomenon in travel industry of Pakistan. In this article, we aim to explore:

- 1 How online ride-hailing companies are transforming the existing social and economic structures? and
- 2 How can sharing economy contribute in social inclusion/exclusion in the society?

To find answers to these research questions, we conducted an interpretive and qualitative field study in Pakistan from February to September, 2018. For data collection, we selected two online ride-hailing platform based companies operational in Pakistan: Uber and Careem. We consulted ICT and information systems literature of social inclusion/exclusion that guided our research enquiry [48–50]. The article identifies that technology-enabled sharing economy platforms may act as catalyst to change the social and economic dynamics of the society by supporting social inclusion of the disadvantaged groups e.g. unemployed, women, low income group and socially isolated. It also explores the other side of the coin and provides counter arguments to highlight barriers that sharing economy may bring to increase social exclusion based on gender, age, and geographic location [3].

## 2 Literature Review

### 2.1 Sharing Economy and Its Societal Implications

Along with enormous potential to transform traditional industries, sharing economy provides social and economic benefits to individuals and societies through its advanced digital technologies, convenience model, cost saving, environmental sustainability,

new consumption patterns and social interaction [18, 24]. It enables higher levels of economic activities by creating markets that support exchange of goods and services and open opportunities for maximum utilization of assets and skills [4]. The sharing economy supports crowd-based networks that encourage supply of labour from decentralized individuals' crowd rather than corporations [37, 46]. The sharing of resources is enabled via community based online platforms that facilitate the interaction between producers and consumers. These online platforms also provide trust mechanisms that are enabled through screening of individuals, feedback loops and secure payment options [5, 12, 17]. The platforms define polices and governance rules; thus, act as regulatory bodies to ensure smooth transaction of exchange through the platform. In return, these digital platforms keep slice of the financial transaction of each successful exchange [33].

The existing research studies attempt to explore the opportunities and challenges that sharing economy offer to the society [16]. The economic impacts of sharing economies have been discussed in literature as cost saving through utility maximization behaviour by providing short-term access to resources that stand idle otherwise [17, 25, 31]. The sharing economy platforms attract users' participation by providing lower price services as compared to their traditional counterpart. The studies discuss the relationship between economic advantage and number of users on the platform [17]. The significant reasons of users' participation in sharing economy are availability, convenience, monetary savings and expanded mobility [4, 17]. The literature has been classified into two streams: individual level studies that identify the intrinsic and extrinsic benefits of the users' participation; and organizational level studies related to reduced transaction costs [18]. However, there is a paucity of research at societal level [11]. The limited societal level studies claimed that sharing economy has become necessity for society as it allows community interaction, diverse choices and social connections [19, 29].

The social impacts of sharing economy are under explored in the existing literature. The literature calls for future research in this field [24]. Scholars are interested in examining innovations and entrepreneurial aspects of sharing economy leading to sustainable environment [9, 22, 45]. The sharing economy has potential to empower the society through micro-entrepreneurs. It has blurred the boundary of full-time employment and casual labour. The flexible work hours for suppliers, and detachment with a single organization is considered healthier for the society by letting the individuals to opt for multiple options of work according to their preference [21, 28]. However, these arrangements cannot offer employment benefits such as pension and health insurance. Absence of employment benefits and employees' rights lead to a major criticism of exploitation on sharing economy [36]. The non-provision of minimum wages is another concern of the sharing economy critics [14]. Although the scholars have highlighted the potential risks that may come with innovation of sharing economy, the available limited studies emphasise that gains/opportunities are greater than the potential drawbacks [27]. Further studies are still required to examine the social and economic implications of sharing economy digital platforms. This is because the sharing economy trend is though burgeoning; the research is in the early stages of research. The literature is limited and fragmented, which points the need of further research studies for theory building [7].

## 2.2 Information Systems and Social Inclusion/Exclusion

Social inclusion is a concept related to reducing inequalities and deprivation between the disadvantage groups and rest of the society by providing support and services to close the opportunity gap. It operates at multiple levels including, individual, groups, communities, organizations and society [1, 15, 48]. Social inclusion and exclusions are multidimensional and complex concepts. The general understanding consider social inclusion as good and exclusion as bad thing [44]. The concepts have been developing from multiple academic disciplines and professional practices such as, sociology, political science, economics, social justices, psychology, law, and rehabilitation. It is a multifaceted concept and its assessment is mostly subjective and context dependent [48, 53]. The social structures where actors exist should also be considered while exploring social inclusion. The initial concept of social exclusion was associated with poverty and lack of income that cause economic inequality in the society. However, the continuous theoretical development has expanded the concept by incorporating multiple capability perspectives such as, economic, social, cultural and political [38, 39]. Thus, the term social exclusion includes an absence of any of the wide range of social, economic, cultural, symbolic, and personal capital [32].

The process of social inclusion/exclusion shifts different trajectory over time and is dependent on education, business practices, social prejudice, policies and geographic characteristics. Information technology plays its part to improve social inclusion of the disadvantage communities, where people can be engaged with the help of technology to address social exclusion [10, 50, 51]. However, many IS scholars criticize the idea that ICT helps in social inclusion and argue that in developing countries ICT contributes to further social marginalization and exclusion [3, 47]. The studies highlight new aspects of social exclusion that have emerged due to access to the technology, lack of skills, fear to use the technology and absence of personal motivation/interest [8, 23].

Few studies point out the existence of gender and generation differences while using technologies. Adams and Fitch [1] identify the possibilities of slight bias in using mobile technologies for female and old generation. It has been discussed in the literature that provision of technology is not solely sufficient to achieve the social inclusion through ICT [53]. Although the inclusion activities are more prominent in technology dominated societies, there is a need for more studies to examine social inclusion in conventional societies as the institutional change may be observed in traditional treatment of gender. The challenges of demographic and geographic disparities are also discussed in ICT research. The large population living in rural areas may not be able to access the technology that results in digital exclusion. The IS research is focused on two extremes: ICT is either portrayed as a tool of great social inclusion or exacerbating digital exclusion [48, 50].

## 3 Methodology

We adopted a qualitative case study approach to examine the sharing economy digital platforms of travel industry in Pakistan [42]. The qualitative research methods are suitable for in-depth investigation of the phenomenon and to explore the answers of

'how' questions for theory building [13]. We selected two platform-based ride hailing companies operating in Pakistan, 'Uber' and 'Careem', for our data collection. Both Uber and Careem are sharing economy business that use on-line booking platform to connect passengers to local drivers using their personal, non-commercial vehicles [2, 52]. Uber was officially launched in Pakistan in early 2016, whereas Careem started its operations in early 2015. Careem had captured the market share in Pakistan before Uber came. While Careem is trying to maintain its image as a reliable and quality transport service provider, Uber focuses on cost leadership by lowering its fare to the minimal.

The data was collected through informal chats, observation and semi-structured interviews with cab drivers, customers and employees of both companies [6]. To obtain the holistic understating of ground realities, the informal conversations of various lengths were initiated by project team with random drivers during numerous rides taken in routine over a period of more than six months (February to September 2018). We also consulted secondary data, available on internet, in the form of newspaper articles and press releases. Altogether 34 semi-structured interviews were conducted from company employees (4 interviews – 1 female and three males), customers (14 – 8 females and 6 males) and drivers (16 interviews – all males). Except three interviews, all interviews were conducted in Urdu language, which were later transcribed and translated into English. The transcripts were read multiple times for thematic analysis [40]. The concepts of ICT and social inclusion/exclusions helped us to make sense of the data. The themes were finalized after extensive discussions within the project team.

## 4 Findings

In the sections to follow we present the results and analysis of our field data grouped in relation to the focus of this article, which is to explore the social and economic implications of sharing economy digital platforms in Pakistan.

### 4.1 Social Implications: Culture of Trust, Family Confidence and Women Empowerment

Pakistan has a collectivist culture. Family has a central place in the Pakistani society. The men are expected to be in the breadwinning role, and women are the homemakers. The social fabric is built and sustained around the notions of honour and *izzat*. The women are considered to be the *izzat* of the family on whom the male honor depends. Generally, the women were not allowed to traverse the public sphere alone. Though, this notion has changed in the cities and a burgeoning number of women are working in the public sphere as well. However, the public transport has remained a huge problem. The bus system in Pakistan was not very safe, comfortable and efficient until recently. The local cabs have always been considered unsafe for the women and especially young girls to travel alone.

In the present project from which this article has emerged, a substantial number of respondents explained the presence of ride-hailing digital platforms in Pakistan as a 'blessing in disguise'. With the emergence of sharing economy in the travel sector, the

development of *culture of trust* along the gendered lines has paved way for business platforms to flourish. As explained by the respondents: *'it was not acceptable for families to allow girls to travel alone. But now the families trust the Careem and Uber and they have accepted these for usage by women of the family.'* (R 17, Student)

A number of factors, however, contributed towards this development of trust culture by the families. Firstly, there are instances in which a male family member experienced these services and developed trust after establishing a positive experience. Secondly, subsequent to this, for example, trust was developed when recommendation for a particular service was made by a female relative: *'I was never comfortable to travel alone on public transport. About few months back I was to go at a place where I could not drive. So me and my sister were contemplating as to what to do? We discussed this situation with a cousin who shared her positive experiences of travelling through Careem. So we decided to go for it. We ordered Careem and afterwards felt happy about our decision: it was both time and money efficient unlike the local cab. The local cab drivers would always tell a higher fare to women, and try to do small talk on the way. Careem was free of all these hassles.'* (R 1, professional)

Thirdly, the apps of these services have also helped in developing trust: *'There is a share tracker option in the app. With it, the family feels relaxed. What happens is I activate my account on my brothers mobile. All the time I am travelling, my journey appears in his mobile. With traditional cabs this was not an option'* (R 2, student)

The culture of trust was found to be working parallel with the confidence of the family in these services. The confidence of the family revolved around the Careem and Uber drivers as *different* from the local taxi drivers. This difference was articulated in two contexts (a) personal virtues like educational status, polite demeanour, and non-argumentative nature, and (b) the degree of professionalism, such as, time efficiency: *'The Careem drivers are educated. When you sit in the car, you only need to say: 'set the journey in the map' and then the entire journey is spent peacefully. They don't talk unnecessarily as it happens with traditional cab drivers.'* (R 19, professional)

Consequently, women empowerment emerged as a major key theme. First, the respondents explained exercising control by making informed decisions in terms of the choices made about the type of service and the kind of vehicle they wished to travel in. Coupled with it was the degree of control over their money, which made them feel more empowered: *'I have used both Uber and Careem. One is money efficient and the other is time efficient. If I am to go for shopping, I choose Uber and if I have time deadline, I prefer Careem. Now I am making independent decisions, which makes me feel more confident.'* (R 13, professional)

Last, but not the least, the women empowerment appeared in the context of women's increased mobility. According to the respondents, their families' would now feel relaxed in letting them travel alone at distant locations from their own homes.

Overall, in the cities, where these services are functioning; a cultural acceptance for women travelling by themselves is created. This culture of trust and confidence, yielding to the positive social implications, itself has created a demand for business platform in the Pakistani market. We will now elaborate this in the next section in the context of economic implications of shared economy in Pakistan.

## 4.2 Economic Implications: Self-entrepreneurship, Employment and the Social Location

Pakistan is a developing country in the South Asian region. With a population over 200 million, and the ever escalating unemployment, the platform business within the local travel sector has offered huge opportunities for self-entrepreneurship: *'I am an educated man. I was unemployed. With Careem and Uber an opportunity for self-employment came to me.'* (R23, Careem driver)

Thus, the unemployed youth, who otherwise would experience economic marginalization, are brought forward by platform businesses as productive members of the society. Their economic inclusion makes them socially inclusive as well. For instance, they take pride in their work by describing themselves as someone who is *doing handsome earnings*. Moreover, the inherent incentives offered to the captains' offer a sense of satisfaction and work loyalty in this industry. In addition, the social environment of Pakistan is constructed in a manner that it motivates them to remain employed in this sector in particular.

In this research, the gender was found to be a starkly intertwined factor with the economic implications for these business platforms. The captains who were attached to these platforms for more than two years articulated this: *'Between 5:00 pm to 6:00 pm, if you work as captain, you earn a lot. This is office closing time. Generally, women are the clients, as they are seeking for safe journey.'* (R18, Careem driver)

Another important pull described by the captains is the vast geographical distance within the city: *'What happen is that certain areas are lucrative if we reach their early morning. If I am at Bahria early in the morning, the passenger generally goes to Blue Area, where all the offices are situated. From there, whoever goes out will ask to take them to an office located in another part of the city. There is shortage of supply before the office timings. So I always make my supply there'* (R20, Careem driver)

Respondents also spoke about the wider employment opportunities in platform business. Firstly, those who do not have their own vehicle can also be employed: *'Those people who are unemployed can go to Careem office to acquire the list of people giving their cars to Careem. Once a mutual agreement between the car owner and potential captain is settled, you are employed on a monthly salary.'* (R8, Careem driver)

Secondly, the people who are part of platform business in Pakistan are optimistic about future possible economic opportunities through expansion in the base of ride-hailing travel sector. According to few of the respondents, they envisage a demand for travel business platform from the customers end. This, in turn, would compel a continued supply of hiring more captains and creating more employment opportunities.

Thirdly, the expansion of business platform in Pakistan is explained by respondents in the context of diversified businesses: *'Careem is about to launch CareemFood and CareemPay in Pakistan. Both of these domains will work like JazzCash for example. That is not earning through the core business 'transport'.* (R11, Careem driver)

As noted in these quotes, the existing business platforms are viewed as having a huge potential in the Pakistani market. It is pertinent to mention that the economics alone is not the sufficient reason for illustrating these dynamics. In addition, the social location emerged as a major key theme central to the daily experiences of people

associated with business platforms. Social location, in the context of this study was described mainly at the end of business platform self-entrepreneurs. Their explanation was rooted within their experiences of heightened social status, education, the class affiliation of their clients, and the geographical location at which they felt privileged to work. The heightened social status was described in the context of captains' becoming part of the global service sector. They viewed themselves as 'vendors' and not as local cab drivers, who according to them belonged to lower strata of the society, and mostly did not have their own vehicles: '*You see we are not ordinary cab drivers, who misbehave, smoke cigarettes while at work. We are professionals working as 'vendors' in the international market.*' (R10, Careem driver)

Education was further described as another personal trait to describe their social status. The respondents, who were captains used their educated status to establish a point of departure from the local taxi drivers: '*I am educated, and so are the others, who are working in this industry. Our way of talking on phone with the client or when he/she is in the car is different from the local taxi driver, whose dressing, speech, mannerism; everything is like an illiterate menial worker.*' (R11, Careem driver)

Another respondent also articulated this: '*I am a computer technician. I wanted to buy a new car. But the lease was high. It's from there that the idea came to my mind that working through apps would not be difficult, so let's try Uber.*' (R19, Careem driver)

The personal circumstances coupled with education are the key factor in describing their social location as *distinct and different* from the local taxi drivers. This was further articulated by respondents in conjunction with the class affiliation of their clients: '*Our clients respect us. They are educated people. They also know that like them we are also educated and this work is only to earn additional money.*' (R16, Uber driver)

### 4.3 Contradictions and Exclusions

Social and economic implications in the form of inclusionary practices were not the only contexts in which respondents described their experiences of the shared economy in Pakistan. Echoing Frederic et al (2009) genuine concern of the information technologies bringing challenges, the exclusionary impulses and the shifting realities, were also voiced by the respondents in this study [8, 23]. Contrast to the prestige, social status and economic benefits that are reflected above, the respondents also pointed certain contradictions. First, they showed concerns about - *social acceptance* by the society. Back home in the villages from where they hailed to the cities, they did not want the word about them working as 'captains' to float: '*My immediate family knows that I am an Uber captain. They feel proud to see my good earnings. But we have not disclosed it to our relatives in the village. You see, they see me as a relative doing office job which is my day-time work. If they find out about this Uber work, they would gossip. They would not understand that I am part of the global services sector and also a professional in this field.*' (R4, Uber driver)

Secondly, the contradictions were also expressed in relation to tampering with the client supportive mechanisms. One such mechanism was the inherent feature of giving stars to the captain, which also served the function of ensuring that the captain would not misbehave. However what if he does so? An exception to the all-parsing scenarios

was: *'As captains we depend upon stars to receive additional bonus. I know drivers, who misbehaved, and their Uber contract got cancelled. But were on road again as they registered with another SIM.'* (R7, Uber driver)

Exclusions turned out to be another key sub-theme. The marginalized populations, such as the elderly, the illiterate and rural populations are found to be excluded: *'My elderly parents don't know how to use mobile phone. They depend on me to book a ride for them'* (R3, student)

*'I have been a taxi driver all my life. People say uncle go for Uber, you will earn good. But I am illiterate and cannot use mobile phone.'* (R24, Local cab driver)

*'In cities, it's fine to use Careem. But in my village, people would not accept for a single girl to be sitting in a car with a stranger.'* (R13, professional)

## 5 Discussion and Conclusion

This study contributes to the emerging literature of sharing economy [24]. It explores the interaction of different users group (producers and consumers) and examine the impacts of sharing economy digital businesses at societal level [19, 29].

The answer to the first question – “How are digital ride-hailing companies transforming the existing social and economic structures?” – lies particularly in the context of changing the social and economic landscape of cities in Pakistan. The two ride-hailing travel businesses that are part of sharing economy include Careem and Uber. At the societal front, with the advent of these services, a cultural shift in the form of allowing young women to travel by themselves has emerged. This has become possible through the emergence of changing dynamics: culture of trust and family confidence in business platforms has developed due to their inherent feature of offering travel services that reduce harassment, availability at doorstep, and visibility of travel vehicle throughout the journey. This in turn has resulted in the women empowerment at two levels. First, the women in Pakistan are experiencing making their own decisions about opting for a particular service. Second, the women's mobility has increased as they are able to traverse multiple spaces in a day. However, considering different incidents of harassment during travel reported in media both in developed and developing countries, there is a dire need to the examine other side of the coin.

In addressing the second question – “How can sharing economy contribute in social inclusion/exclusion in the society.” – We found there were a number of inclusionary steps that these platform businesses made possible to happen in Pakistan. Firstly, Pakistan has a huge issue of unemployed population. The ride-hailing service sector has offered these people to be employed either full-time or part-time. This has converted them into productive members of the society. Thus, the innovations and entrepreneurial aspects of sharing economy are required to be explored further for sustainable development [22, 45].

Secondly, the economic stability has given them social stability as well. They are able to move in the society as a hardworking person, who is able to support himself and his family well. There are a number of challenges as well such as the key fact of excluding certain marginalized populations. The elderly, young girls living in the rural areas and illiterate people are unable to become part of this global service sector, and



therefore are at the cross roads of being further pushed to the periphery. The nascent literature highlights some experiences where platforms may promote inequality and unhealthy labour conditions [37]. Our findings also report that the absence of regulations and control mechanisms may lead to the possibilities of inequality in the society [41]. The critics of sharing economy call it as a rentier capitalism promoting consumerism for wealthy people who possess the assets [43]. With all these contradictions, exclusions and challenging encounters, the key point still remains, that is shared economy digital platforms have become a pertinent and prominent part of Pakistan's economy and culture. The wheels of growth are spinning in the travel industry of platform businesses. Now there is an increasing need to not only focus on positive experiences, but also handling the negative consequences of it in society.

In this article, we try to bring IS scholars' attention toward exploring social, organisational and technological dimensions of sharing economy business models and digital platforms. It is a right time to shift the focus from economic benefits of sharing economy to societal and organisational aspects [28]. This initial level research also identifies the need of future research on digital platforms from other industries in different research context.

## References

1. Adams, C., Fitch, T.: Social inclusion and the shifting role of technology: is age the new gender in mobile access? In: Trauth, E.M., Howcroft, D., Butler, T., Fitzgerald, B., DeGross, J.I. (eds.) *Social Inclusion: Societal and Organizational Implications for Information Systems*. IIFIP, vol. 208, pp. 203–215. Springer, Boston, MA (2006). [https://doi.org/10.1007/0-387-34588-4\\_14](https://doi.org/10.1007/0-387-34588-4_14)
2. Amit, R., Han, X.: Value creation through novel resource configurations in a digitally enabled world. *Strat. Entrep. J.* **11**, 228–242 (2017)
3. Armstrong, D.J., Riemenschneider, C.K., Giddens, L.G.: The advancement and persistence of women in the information technology profession: an extension of Ahuja's gendered theory of IT career stages. *Inf. Syst. J.* **28**, 1082–1124 (2018)
4. Ballús-Armet, I., Shaheen, S.A., Clonts, K., Weinzimmer, D.: Peer-to-peer carsharing: exploring public perception and market characteristics in the San Francisco Bay area, California. *Transp. Res. Rec.* **2416**, 27–36 (2014)
5. Botsman, R., Rogers, R.: *What's mine is yours: how collaborative consumption is changing the way we live* (2011)
6. Cassell, C., Symon, G.: *Essential guide to qualitative methods in organizational research*. Sage Publications Ltd., Thousand Oaks (2004)
7. Cheng, M.: Sharing economy: a review and agenda for future research. *Int. J. Hosp. Manag.* **57**, 60–70 (2016)
8. Choudrie, J., Ghinea, G., Songonuga, V.N.: Silver surfers, e-government and the digital divide: an exploratory study of UK local authority websites and older citizens. *Interact. Comput.* **25**, 417–442 (2013)
9. Cohen, B., Kietzmann, J.: Ride on! Mobility business models for the sharing economy. *Organ. Environ.* **27**, 279–296 (2014)
10. Cushman, M., McLean, R.: Exclusion, inclusion and changing the face of information systems research. *Inf. Technol. People* **21**, 213–221 (2008)

11. Dreyer, B., Lüdeke-Freund, F., Hamann, R., Faccar, K.: Upsides and downsides of the sharing economy: Collaborative consumption business models' stakeholder value impacts and their relationship to context. *Technol. Forecast. Soc. Change* **125**, 87–104 (2017)
12. The Economist: The rise of the sharing economy. *The Economist*, 9 (2013)
13. Eisenhardt, K.M.: Building theories from case study research. *Acad. Manag. Rev.* **14**, 532–550 (1989)
14. Gobble, M.M.: Regulating innovation in the new economy. *Res.-Technol. Manag.* **58**, 62–67 (2015)
15. Gurstein, M.: Community informatics: enabling community uses of information and communications technology. In: *Community Informatics: Enabling Communities with Information and Communications Technologies*, pp. 1–30. IGI Global (2000)
16. Guttentag, D.: Airbnb: disruptive innovation and the rise of an informal tourism accommodation sector. *Curr. Issues Tour.* **18**, 1192–1217 (2015)
17. Hamari, J., Sjöklint, M., Ukkonen, A.: The sharing economy: why people participate in collaborative consumption. *J. Assoc. Inf. Sci. Technol.* **67**, 2047–2059 (2016)
18. Hansen Henten, A., Maria Windekilde, I.: Transaction costs and the sharing economy. *info* **18**, 1–15 (2016)
19. Hwang, J., Griffiths, M.A.: Share more, drive less: Millennials value perception and behavioral intent in using collaborative consumption services. *J. Consum. Mark.* **34**, 132–146 (2017)
20. Kathan, W., Matzler, K., Veider, V.: The sharing economy: your business model's friend or foe? *Bus. Horiz.* **59**, 663–672 (2016)
21. Kessler, A.: Brian Chesky: The 'sharing economy' and its enemies. *The Wall Street Journal* (2014)
22. Kostakis, V., Bauwens, M.: *Network Society and Future Scenarios for a Collaborative Economy*. Palgrave Macmillan UK, London (2014). <https://doi.org/10.1057/9781137406897>
23. Lee, E., Han, S., Chung, Y.: Internet use of consumers aged 40 and over: Factors that influence full adoption. *Soc. Behav. Pers.: Int. J.* **42**, 1563–1574 (2014)
24. Lee, Z.W., Chan, T.K., Balaji, M., Chong, A.Y.-L.: Why people participate in the sharing economy: an empirical investigation of Uber. *Internet Res.* **28**, 829–850 (2018)
25. Leismann, K., Schmitt, M., Rohn, H., Baedeker, C.: Collaborative consumption: towards a resource-saving consumption culture. *Resources* **2**, 184–203 (2013)
26. Lessig, L.: *Remix: Making Art and Commerce Thrive in the Hybrid Economy*. Penguin, London (2008)
27. Malhotra, A., Van Alstyne, M.: The dark side of the sharing economy... and how to lighten it. *Commun. ACM* **57**, 24–27 (2014)
28. Martin, C.J.: The sharing economy: a pathway to sustainability or a nightmarish form of neoliberal capitalism? *Ecol. Econ.* **121**, 149–159 (2016)
29. McArthur, E.: Many-to-many exchange without money: why people share their resources. *Consum. Mark. Cult.* **18**, 239–256 (2015)
30. Möhlmann, M.: Collaborative consumption: determinants of satisfaction and the likelihood of using a sharing economy option again. *J. Consum. Behav.* **14**, 193–207 (2015)
31. Nica, E., Potcovaru, A.-M.: The social sustainability of the sharing economy. *Econ. Manag. Financ. Mark.* **10**, 69 (2015)
32. O'Reilly, D.: Social inclusion: a philosophical anthropology. *Politics* **25**, 80–88 (2005)
33. Parker, G.G., Van Alstyne, M.W., Choudary, S.P.: *Platform Revolution: How Networked Markets Are Transforming the Economy and How to Make Them Work for You*. WW Norton & Company, New York (2016)
34. Puschmann, T., Alt, R.: Sharing economy. *Bus. Inf. Syst. Eng.* **58**, 93–99 (2016)

35. PwC: The sharing economy: how is it affecting you and your business? PricewaterhouseCoopers (2015)
36. Richardson, L.: Performing the sharing economy. *Geoforum* **67**, 121–129 (2015)
37. Schor, J.B., Fitzmaurice, C.J.: Collaborating and connecting: the emergence of the sharing economy. In: *Handbook of Research on Sustainable Consumption*, p. 410 (2015)
38. Sen, A.: *Development as Freedom*. Oxford University Press, Oxford (1999)
39. Sen, A.K.: *The Idea of Justice*. Harvard University Press, Cambridge (2009)
40. Silverman, D.: *Interpreting Qualitative Data: Methods for Analyzing Talk, Text and Interaction*. Sage Publications Ltd, Thousand Oaks (2006)
41. Slee, T.: *What’s Yours is Mine: Against the Sharing Economy*. Or Books, New York (2017)
42. Stake, R.E.: *The Art of Case Study Research*. Sage Publications Ltd., Thousand Oaks (1995)
43. Standing, G.: *The Corruption of Capitalism: Why Rentiers Thrive and Work Does Not Pay*. Biteback Publishing, London (2016)
44. Stewart, F.: Groups and capabilities. *J. Hum. Dev.* **6**, 185–204 (2005)
45. Sundararajan, A.: From Zipcar to the sharing economy. *Harv. Bus. Rev.* **1** (2013)
46. Sundararajan, A.: *The Sharing Economy: The End of Employment and the Rise of Crowd-Based Capitalism*. Mit Press, Cambridge (2016)
47. Tambulasi, R.I.: Pushed to the abyss of exclusion: ICT and social exclusion in developing countries. *J. Inf. Commun. Ethics Soc.* **7**, 119–127 (2009)
48. Trauth, E.M., Howcroft, D., Butler, T., Fitzgerald, B., DeGross, J.I. (eds.): *Social Inclusion: Societal and Organizational Implications for Information Systems*. IIFIP, vol. 208. Springer, Boston (2006). <https://doi.org/10.1007/0-387-34588-4>
49. Trauth, E., Joshi, K.D., Kvasny, L.: ISJ editorial - special issue of information systems journal on social inclusion. *Inf. Syst. J.* **28**, 989–994 (2018)
50. Urquhart, C., Underhill-Sem, Y.: Special issue on “ICTs and social inclusion”. *J. Inf. Commun. Ethics Soc.* **7**, 96–210 (2009)
51. Van Winden, W.: The end of social exclusion? On information technology policy as a key to social inclusion in large European cities. *Reg. Stud.* **35**, 861–877 (2001)
52. Voegelé, T.: Data-led governance of self-driving vehicles for urban shared mobility. In: Finger, M., Audouin, M. (eds.) *The Governance of Smart Transportation Systems*. TUBS, pp. 81–101. Springer, Cham (2019). [https://doi.org/10.1007/978-3-319-96526-0\\_5](https://doi.org/10.1007/978-3-319-96526-0_5)
53. Warschauer, M.: *Technology and Social Inclusion: Rethinking the Digital Divide*. MIT Press, Cambridge (2004)



# Strategies for Standardizing Health Information Analysis

## Flexible Standards Revisited

Olav Poppe<sup>(✉)</sup>, Johan Ivar Sæbø, and Jørn Braa

Department of Informatics, University of Oslo, 0316 Oslo, Norway

olavpo@ifi.uio.no

**Abstract.** *Purpose:* This paper analyses an initiative led by WHO within the health information domain to standardise analysis of health information through the use of analytical dashboards, using the concept of flexible standards. We focus on the implementation of these standards within existing, working information systems, analysing the implementation strategies used, and how these are enabled by the flexibility of the standards. *Design/methodology/approach:* The study follows an action research approach, where the authors have been involved in the development and implementation of the initiative being discussed. *Findings:* By analyzing the approaches taken by several countries to implement these standards we show how these different approaches are enabled by the flexibility of the standards. *Practical implications:* This paper demonstrates the potential importance of flexibility in standardisation initiatives around health information, with particular relevance to voluntary standardisation efforts involving independent actors, in this case Ministries of Health. *Originality/value:* The flexible standards concept is employed to study a multi-country initiative involving WHO and several national governments. We contribute to the literature on flexible standards by showing that beyond flexibility in the standards, flexibility in the software platform in which the standards are implemented, and the variation allowed in the standardisation process at an organisational level, are important factors that facilitate standards implementations.

**Keywords:** Health information systems · Standards · Information use

## 1 Introduction

In a widely cited 2007 MISQ paper, Braa *et al.* [1] proposed the concept of flexible standards, arguing that use of such adaptable standards can be a strategy for development of integrated health information systems (HIS) in developing countries. Empirically, they use examples from three countries of bottom-up processes that lead to the emergence of health information standards. In this paper we use the *flexible standards* concept to understand a top-down initiative led by WHO within the same domain.

The underlying problem that WHO seeks to address with this initiative is the lack of agreed data standards, overlapping and siloed data systems and poor data quality and

data use in many developing countries. One of the key roles of WHO as a normative organisation is to develop standards and guidance for its member states, including in the area of health information. However, a pervasive challenge has been the limited penetration and *use* of these standards by countries. Thus, while great strides have been made towards improving the capacity of HIS to *collect* data, the challenge remains that the relevant data is not always collected, and the quality of the data is often poor.

As an effort to promote information use and adoption of its guidance, WHO decided to develop a set of standardized packages centred around *dashboards*. A dashboard for health management is typically a collection of appropriately defined visualizations like charts, maps, and simple tables, focusing on key *indicators* used to monitor the provision and quality of health services. The dashboards encompass standards at several layers: which indicators to display, how these indicators are defined, and how they should be presented to communicate key information in the most appropriate manner to support decision making. To strengthen the inherent normative values related to the use of the dashboards, WHO also developed a related public health curriculum. In summary the packages and curriculum include different types of standards, related to design, terminology, performance, and procedure [2].

The standard dashboards have been configured for the open source DHIS2 software platform, which is used for health information management in over 70 countries. Countries using this software platform can import a configuration file to install the WHO standard packages in their national systems.

The process of developing the standard configuration packages (hereafter referred to as just standard packages) described above is elaborated in Poppe *et al.* [3]. The focus of this paper is on the implementation of these standard packages within existing, working systems in countries. Key problems associated with implementing standards in countries are related to lack of a clearly defined and authoritative procedure by WHO to facilitate their implementation, acceptance by user organisations, perceived use value in relation to cost of implementation and a certain momentum of users and other stakeholders implementing or being willing to implement the standard [2].

Different strategies have been followed to implement these international standards in national HIS. In this paper, we will identify and describe these strategies, and seek to identify what characteristics of the standards and the standardisation approach have enabled these strategies. The rest of the paper is organised as follows: in the next section, we review the literature related to the *flexible standards* concept. In Sect. 3, we present our methodology, and in Sect. 4 experiences from several countries that have implemented the standard packages. We then discuss the role of the flexibility of standards to our case, before concluding.

## 2 Related Literature

Braa *et al.* [1] argue that standards should be designed so that “they emerge as a complex adaptive system that can adapt to a changing environment and thereby contribute to the sustainability of the HIS”, and that this “can only be achieved if the standards themselves are flexible” (pp. 396–397). Drawing on Hanseth *et al.* [4], they argue that standards can have two forms of flexibility: *Use* flexibility, which refers to

how a standard can be applied for different purposes or in different environments, and *change flexibility*, meaning how easy it is to change a standard. Change flexibility can be achieved by vertical and horizontal modularization, that results in a system of simple standards rather than one large and complicated standard.

Van der Ende *et al.* [5] use a similar concept of “standard flexibility”, referring to “the number and degree of changes to a standard over time”. They argue that not enough attention has been given by researchers on standard’s characteristics and the effect of those characteristics on the content and survival of standards. They argue that more flexible standards are easier to adopt and have a better likelihood of succeeding.

## 2.1 Standardisation Strategies

The main topic of the 2007 Braa *et al.* paper is not *flexible standards* as such, but to propose a *strategy* for developing flexible information systems standards [1]. The strategy presented has two parts. First, to create an *attractor* “that emerges as a new standard and which evolves into a system of standards” (p. 396). Second, that “individual standards must be created in a manner which allows the whole complex system of standards to be adaptive to the local context” (p. 396). The strategy allows “radical change through small steps” (p. 399).

Hanseth and Bygstad [6] identify three different strategies for information system standardisation: *Anticipatory standardisation* is the traditional, formalized standardisation model; *integrated solutions* are, like anticipatory standardisation, a formalized approach, but focused on supporting user requirements rather than message specifications; finally, *flexible generification* is different in that it has “more focus on users’ practices and needs, a stronger focus on developing working solutions and a correspondingly lower focus on standardization as such” [6] (p. 656). This latter strategy is thus similar to the one proposed by Braa *et al.* [1], who suggest creating working solutions that become attractors and *emerge* as new standards. Nguyen *et al.* [7] suggest that *meta-standardisation* should be added as a fourth strategy, which they define as developing new (meta) standards by connecting and mapping existing standards.

## 2.2 The Role of Technology

Several researchers also point to the role of technology in information systems standardisation, as well as for integration of HIS, which, we argue, is strongly related in that integration implies a level of standardisation. Effah and Abousi [8] study a national standardisation effort around a proprietary software system. While the top-down standardisation of the software itself succeeded, it failed to meet the information needs at sub-national level, and to support integration and interoperability with other systems.

Sæbø *et al.* [9] studied strategies for integrating previously vertical information systems into a national data warehouse in four countries. In South Africa, a new minimal data set standard was developed in parallel with existing information systems. Zanzibar followed a more traditional standardisation process, where different stakeholders agreed in advance to a new data set standard, which was then implemented. The approaches pursued in Sierra Leone and Botswana were similar in the sense that no

immediate harmonization or standardisation was agreed at the organizational level. However, in Sierra Leone, a form of semantic standardisation was handled in the data warehouse, solving the standardization “backstage” without involving the various actors. This was not done in the case of Botswana, and this lack of semantic standardisation created a complicated and difficult to use system. This highlights the role played by the HIS software platform as an enabler in integration and standardisation processes.

Braa *et al.* [1] also highlight the importance of a flexible software solution that supports the development of flexible standards. Similarly, Nyella and Kimaro argue that the ability of the software platform being implemented to address needs of diverse actors made it an important tool in coordinating the process of developing of an integrated HIS in Tanzania [10].

### 3 Methodology

The research described here has been conducted as part of the Health Information Systems Programme (HISP). HISP is a large, long-term action research project doing research related to the development and implementation of sustainable HIS in low- and middle-income countries. HISP has evolved into a heterogeneous network of Ministries of Health, universities, individuals and organisations, described further in Braa *et al.* [11].

The activities related to the standardisation initiative discussed here have been led by Ministries of Health, WHO and other global agencies. The authors have to varying degrees participated in the *development* of the standards from the start of the process in 2014, including discussing standard formats and potential implementation strategies, and creating the computer-based versions of the standards. This work is still ongoing. One of the authors was seconded to WHO for a 2-year period between 2014 and 2016, working primarily on this initiative.

We have been directly involved, to varying degrees, in the *implementation* of these standards in Sierra Leone, India, Guinea, Laos and Ghana. From these countries, we have collected data in the form of notes, documents and electronic communication. Furthermore, we have received additional data from colleagues in the HISP network who have been involved in the implementation of these standards both in some of the above-mentioned countries, as well as Uganda, Bangladesh, Togo and Mozambique.

Work in countries have generally involved, first, to assess the reporting structure of the national Health Management Information System (HMIS), e.g. existing reporting tools, indicator definitions, analytics dashboards and so on, and secondly, based on the assessment, country needs, and decision-making processes in-country, pursuing different strategies to implement relevant WHO standard packages. This has in most cases been done for one or a few health areas at the time. The various strategies used is the topic of this paper.

## 4 Case

The project described here is part of a standardisation effort started by WHO in 2014, and later incorporated into the Health Data Collaborative (HDC) initiative. HDC is a “partnership of international agencies, governments, philanthropies, donors and academics, with the common aim of improving health data” [12]. The standardisation effort is centred around the development of best practice *dashboards* for analysis of health data within different health programme areas, which together with a training curriculum is meant to help countries improve their health information systems and make better use of the data that is collected routinely from health facilities.

A dashboard can be defined as “a graphical summary of various pieces of important information”<sup>1</sup> (see Fig. 1). The graphics in this case are charts, maps and tables, which visualise, in different ways, key health *indicators*. Indicators are, within public health, used to denote information used to measure the extent to which health targets are met, e.g. “Immunisation coverage”. In addition to the dashboards and indicators, *data elements* denoting variables collected at facility level (e.g. “BCG doses given” or “Confirmed malaria cases”) are included, together with additional disaggregations (e.g. “0–11 months”, “1 + years” or “Male”, “Female”).

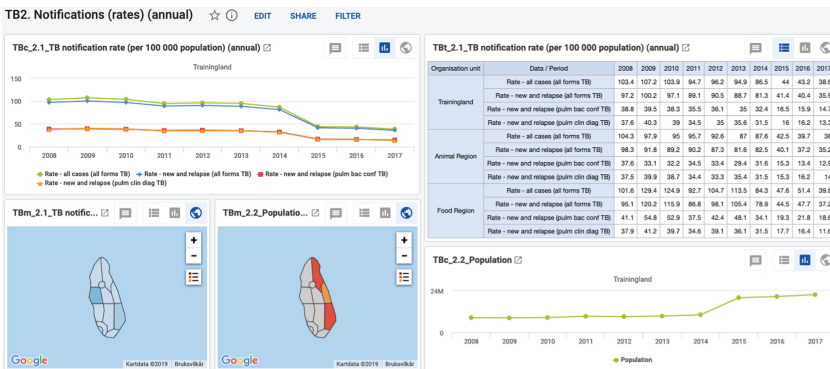


Fig. 1. Example of a dashboard, with visualisation of TB indicators.

The specifications for the WHO dashboards, as well as the accompanying public health curriculum, can in theory be applied to any suitable technology, be it paper or various software applications. However, these dashboards, indicators, data elements and disaggregations have so far been configured only in the DHIS2 software. The configurations have then been exported as JSON files in the “DHIS2 Metadata Exchange Format” so that they can be imported into any DHIS2 database to produce the standard WHO configuration for one particular disease programme. Two versions of the packages have been created for each programme, in order to facilitate their

<sup>1</sup> <https://en.oxforddictionaries.com/definition/dashboard>.



adoption in different countries: one complete package including all content for data collection and data analysis (which we refer to as the *complete* package), and one that includes only the indicators and dashboards (which we refer to as the *dashboard* package). These are the *standard packages* discussed here.

DHIS2 itself is an open source, web-based software for collection, management and analysis of health information. The fact that DHIS2 has become a *de-facto* standard in Sub-Saharan Africa and parts of South-East Asia, which includes countries with a high burden of priority diseases such as Malaria, HIV and Tuberculosis, was the motivation for WHO to develop the standard packages.

In the rest of this section, we will look at the approaches taken in some of the countries that have adopted or adapted one or more of the standard packages. We focus on Sierra Leone and Laos, but present briefly some experiences from India, Uganda and Guinea as well.

#### 4.1 Sierra Leone

In Sierra Leone, work on the WHO packages have been done both for TB and Malaria, following different approaches. For TB, a subset of the recommended data was already being collected in DHIS2 through the HMIS reporting tools, while the national TB programme collected data through a separate system. The national TB programme had been using data collection tools according to an older WHO standard and were in a process of updating these, and it was thus decided to make a coordinated shift both to using DHIS2 for TB data, and at the same time to start using the most recent WHO standard. The TB package was installed in the national DHIS2 database, and modified with the addition of some variables needed by the national TB programme.

The malaria programme already used DHIS2 as their main data collection and reporting tool, but only a limited set of analytical outputs had been configured. The WHO malaria package was not imported, but a consultant worked with staff from the programme and discussed their needs and the applicability of the indicators and dashboard items as suggested by WHO. The result was an “WHO inspired” dashboard, that built on and used the data and metadata already present in Sierra Leone.

#### 4.2 Laos

DHIS2 has been used in Laos since 2014 and gradually most major health programs have been included in the national DHIS2 platform. In 2017 the Ministry of Health (MoH) decided that all routine data should be reported through the DHIS2. However, several health programs continued parallel reporting through their own systems, resulting in discrepancies in numbers between the two sources of data.

The EPI program was among the programs that were included in the national DHIS2-based system, but continued to collect more or less the same data in their own excel based system as well. When the standard package for immunisation became available, it was decided to install the dashboard version of this and link it to the existing immunisation data collection tools in DHIS2. This demonstrated that the MoH DHIS2 system included the data required by the EPI program, according to the WHO recommendations.

The use of the TB, Malaria, and HIV packages follow a similar trajectory. The dashboards were imported in full, whereupon they would mostly display no data as little was in fact collected through DHIS2. However, the case of Laos illustrates how the implementation of the disease dashboards set off a range of other activities, which are worth noting. The various dashboards only work well if there is reasonably complete data, and if the right disaggregations are available. By importing the dashboards and using them to make visible the data quality issues, the various health programs would see both what would be possible with an integrated DHIS2, and what was missing to make it work properly. The process of setting up the dashboards for TB led to a revamp of the whole reporting structure for TB, which was previously managed with an Access based system. The same was done with Malaria and HIV; the former has implemented the standard package as part of a full revamp of their own system, including implementation of individual case-based management in DHIS2. The latter program implemented anonymous registration of all STI cases, which could be used to calculate any of the indicators in the dashboard.

### 4.3 Other Country Experiences and Summary

Table 1 summarises the experiences from Sierra Leone and Laos, as well as from implementations in India, Guinea and Uganda. These provide an illustration of the various approaches taken; however, the standard packages have also been implemented elsewhere. For example, a workshop was organised in January 2019 where the TB package was installed in the national HMIS of Benin, Burkina Faso, Mali, Ivory Coast, Liberia and Cameroon.

**Table 1.** Overview of implementation approach in countries

Country and programme	Prior situation	Implementation approach
<b>Sierra Leone - TB</b>	Subset of data in HMIS, parallel reporting by programme	Complete TB package implemented in DHIS2 and customised with additional variables
<b>Sierra Leone - Malaria</b>	Data collection in HMIS but limited analytical outputs	Existing indicators and dashboards updated with WHO standard as reference/inspiration
<b>Laos - EPI</b>	In HMIS, programme used parallel system	Dashboard package installed and mapped to existing data elements
<b>Laos - TB, HIV, malaria</b>	Subset of data in national HMIS	Dashboard package installed and mapped to existing data elements, highlighting gaps in current data collection
<b>India – malaria<sup>a</sup></b>	DHIS2-based system being established. Malaria data collection tools being revised	Malaria dashboard installed and modified according to available data. Standard package used as reference to identify gaps in revision of data collection tools

(continued)

**Table 1.** (continued)

Country and programme	Prior situation	Implementation approach
<b>Guinea - TB</b>	Data collection configured in national HMIS, not yet used and without dashboards configured	Complete TB package installed, replacing the existing data set
<b>Uganda - TB, HIV, malaria</b>	Data collection integrated in HMIS	Dashboard packages modified to re-use existing indicators, before being installed and mapped to existing data elements. Modifications made according to national programmes' needs

<sup>a</sup>National Vector-Borne Disease Control Programme

## 5 Discussion

Above, we presented some experiences from countries that have implemented WHO standard packages in their national HIS. While the standard packages cover different categories of standards as defined by Timmermans and Berg [2], the procedural standards, namely to manage various health programs by pre-defined steps of analysis, is the most important for WHO to achieve. How each country arrives there is to a large degree flexible and dependent on the existing system. We will in this section look at first, the different strategies pursued in these countries to implement the packages. Then, we discuss where the flexibility that enables countries to follow these different standardisation strategies lie: in the design of the standards; the software platform in which they are implemented; and at the organisational level. Finally, we identify some lessons learned and look at the broader implications of this initiative.

### 5.1 Adoption Strategies

Looking across the strategies or approaches to implementing the standard packages, we can identify two dimensions. The first dimension is *how* the package was implemented: installed and used as-is; installed with modifications done before or after the installation; if it was manually replicated in the software platform without installing the standard package; or if it was used as an inspiration to make modifications to the existing system. Where metadata was installed or imported, a second dimension is the *type* of packages used for a particular health programme, i.e. the complete or dashboard version. This is illustrated in Fig. 2.

### 5.2 Levels of Flexibility

Countries have been able to follow a number of different approaches in implementing the WHO standards. This, we argue, is a result of flexibility at several levels: in the standards packages themselves; of the software platform in which the packages are implemented; and at the organisational level, where some variations and modification to the standards being implemented is “permitted”.

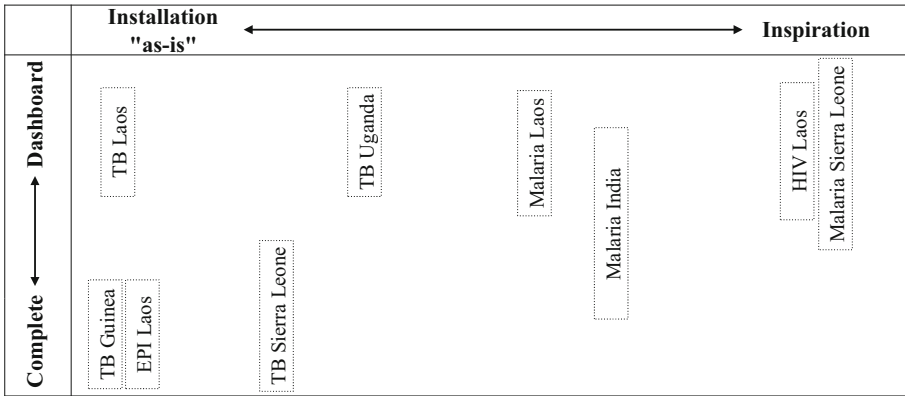


Fig. 2. Overview of implementation strategy taken by countries for different standard packages.

Braa *et al.* [1] argue that for standards to be adaptable to different settings, they should be developed as a simple system of standards, rather than one complex standard. Seen as a whole, the standard packages developed based on requirements from different WHO departments and health programmes can be seen as exactly such a system of standards. As described above, countries have adopted different packages, sometimes gradually with some time between each. The decision to adopt each of these packages can be politically sensitive, because it can have broader implications than the adoption of the standard itself, and this decision is typically made by the national health programmes. WHO *could* have developed one large, complex package covering all the relevant health programmes, that would have had to be implemented as a whole. This would have required simultaneous agreement and support from all national health programmes and would have had less chance of being adopted.

For the individual standards that make up the system of standards, Hanseth *et al.* define two types of flexibility: *use* flexibility and *change* flexibility [4]. We argue that each of the standard packages have both types of flexibility. The many ways in which the standards can be implemented, either as something that is installed in a software, used as a template which is replicated, or as inspiration, show that they have a high degree of *use* flexibility. *Change* flexibility, according to Braa *et al.* [1] is achieved through modularization. The standard packages discussed here are modularized vertically by health programme, and layered horizontally, broadly speaking into a dashboard layer and a data collection layer. The importance of the vertical modularisation of the standard packages into health programmes was discussed above. It is also clear from our empirical material that the horizontal modularization has been important, enabling strategies of, broadly speaking, implementing complete packages or dashboard-only packages where existing data elements and data collection forms are used.

This horizontal modularization was possible because of the software in which the standards were being implemented. The DHIS2 data model has a layered structure, where all the key elements like visualizations, indicators, data elements and disaggregations into e.g. age and sex categories are independent units that can be combined and configured independently of each other. This enables, for example, that the standard

WHO *indicators* can be imported in the software, and then easily be configured and mapped to existing data elements that are not part of the imported configuration.

The flexibility of the software also allows for quite different implementation processes, technically, leading to the same result in terms of dashboards and indicators. One fundamental aspect of this is the flexible and layered data model, as explained above. However, another key element of the flexibility of the software platform is that it allows system administrators (as opposed to software developers) to import, modify or replicate the standard packages, or modify existing content with the standards as reference, largely through a graphical user interface.

While the flexibility built into the standards and in the software platform in which they are being implemented are important, flexibility in the approach to this process by WHO has also been important. We call this flexibility at the organisational level. While there is some variability in the view of different health programmes in WHO in how much countries should ideally change the standard configurations provided by WHO; the overall sentiment is that countries can, and in some cases should, adjust and adapt the standards to their context. It is also acknowledged that changes to data collection, which might be necessary in order to fully produce the outputs of the recommended dashboards, can be a multi-year process that involves development and printing of register and paper forms for all health facilities, training of health workers and so on. In those cases, it would be better to immediately configure a dashboard that is close to but not identical to the reference standard, rather than waiting for something “perfect”. The standards should be seen as enablers for information use, not constraints. Had the purpose of the standardisation effort been primarily to enable countries to provide reports to WHO, requiring semantic standardisation with identical identifiers etc., such a flexible approach would not be feasible.

Table 2 summarises the different dimensions of flexibility that have enabled the implementation strategies discussed in Sect. 5.1.

**Table 2.** Dimensions of flexibility enabling diverse implementation strategies.

Flexibility	Enabled by	Level
Choice of standard package - dashboard only or dashboard and data collection	Design of standard, with two versions of each module	Design
	Loosely coupled data model in DHIS2 software, allowing configuration of indicators to existing data collection instruments	Software
Technical implementation – installation of package as-is, installation with modifications, or manual replication	Configurability of the software platform by administrators (as opposed to software developers)	Software
	Focus on procedural standardisation, i.e. data analysis, rather than semantics (e.g. indicator identifiers)	Organisational
Adaptations and modification to the implemented packaged	Focus on procedural standardisation, i.e. improved data analysis, rather than semantics	Organisational

### 5.3 Outcomes of the Standardisation Processes

All cases show some relation between the standardization processes and wider health information system design and development. In Guinea and Uganda, the health programs in question were already collecting or in the process of starting to collect their data through DHIS2, and only minor changes were done either to the imported material or the native configuration. In Sierra Leone, the decision to integrate TB into the national DHIS2 was seen as a non-controversial and logical concurrent project to setting up the WHO dashboard and reporting tools.

However, the events followed a different trajectory in Laos, where the introduction of the WHO standard packages worked as a key attractor for change both at the overall MoH level as well as within each of the programs. MoH had already decided that all health programmes should report through the national DHIS2 system, and the standard packages from WHO have been important in mobilising stakeholders behind this position, both through the authority of WHO as a standard setter and through the momentum building up by seeing other programs joining the approach. In particular in the EPI program this has been the important convincing factor for their acceptance.

The standardisation process in Laos provided an impetus for alignment of different health programmes into one integrated HIS. Similarly, it contributed to the integration of TB reporting in the national HMIS in Sierra Leone and in Guinea, though in the latter case the integration process had already started prior to the standardisation initiative. We see a similar tendency in other countries not presented here. This points to an interesting paradox of integrated independence, that is also revealed in particular in the case of Laos; while each of the health programs are strengthening their information system, the overall MoH DHIS2 platform framework is also strengthened and allowing data to be correlated and analysed across programs and through integrated dashboards.

One question that surfaces from the above discussion is to what extent this can be called standardisation, when there is so much flexibility in the standard itself and the way it is implemented? As stated above, while the standard packages cover different categories of standards [2], procedural standardisation, namely to manage various health programs by pre-defined steps of analysis, is the most important for WHO. Consequently, what needs to be achieved for the standardisation effort to be successful is standardisation related to practices of information use. Standardisation of the underlying components, i.e. the data elements, data collection forms, disaggregations and so on is of secondary importance. This is somewhat similar to the flexible generification strategy, with emphasises working solutions over standardisation as such [6]. The implication of this is that potential international reporting or exchange of data etc. in the future is not necessarily facilitated by this standardisation effort.

## 6 Conclusion

This paper draws on experiences from a handful of countries that have adopted one or more WHO standards for data analysis. Ministries of Health have followed different strategies in order to adopt these international standards in their national HIS, and in this paper we have sought to identify the characteristics of the standards and the standardisation approaches that have enabled these strategies.

Drawing on the concept of *flexible standards*, we have shown how implementation of the standards by countries have been facilitated by flexibility built into the standards, flexibility of the software platform in which the standards are implemented, and flexibility at the organisational level. This distinction, in particular the importance of flexibility in the software in which the standards are implemented, adds to the existing literature around flexible standards. Furthermore, this paper shows how the flexible standards concept can be applied also within an international standardisation process, involving independent national Ministries of Health.



Our empirical data also shows that this standardisation process, nominally focused on standardising and encouraging information use, has wider implications. For example, by highlighting data management and quality issues, and as a driver for integration of vertical information systems. How the WHO standards can be attractors for change is an area for further research.

## References

1. Braa, J., Hanseth, O., Heywood, A., Mohammed, W., Shaw, V.: Developing health information systems in developing countries: the flexible standards strategy. *Manage. Inf. Syst. Q.* **31**, 381–402 (2007). (Special Issue)
2. Timmermans, S., Berg, M.: *The Gold Standard*. Temple University Press, Philadelphia (2003)
3. Poppe, O., Sæbø, J.I., Nielsen, P., Sanner, T.A.: Standardising Through Software. *Selected Papers of the IRIS*, 3(8) (2017)
4. Hanseth, O., Monteiro, E., Hatling, M.: Developing information infrastructure: the tension between standardization and flexibility. *Sci. Technol. Hum. Values* **21**, 407–426 (1996)
5. van den Ende, J., van de Kaa, G., den Uijl, S., de Vries, H.J.: The paradox of standard flexibility: the effects of co-evolution between standard and interorganizational network. *Organ. Stud.* **33**(5–6), 705–736 (2012)
6. Hanseth, O., Bygstad, B.: Flexible generification: ICT standardization strategies and service innovation in health care. *Eur. J. Inf. Syst.* **24**(6), 645–663 (2015)
7. Nguyen, T., Pham, T.C., Santos, E., Son, H.T.: Meta-standardization as a remedy for tensions and complexities: the case of medical service lists in Vietnam. *Electron. J. Inf. Syst. Develop. Ctries.* **84**(2), e12017 (2018)
8. Effah, J., Abuosi, A.: Standardizing a developing country health information system through proprietary software: Ghana’s experience. *J. Health Inf. Develop. Ctries.*, 7(2) (2013)
9. Sæbø, J.I., Kossi, E.K., Titlestad, O.H., Rolland, T.R., Braa, J.: Comparing strategies to integrate health information systems following a data warehouse approach in four countries. *Inf. Technol. Dev.* **17**(1), 42–60 (2011)
10. Nyella, E.E., Kimaro, H.: HIS standardization in developing countries: use of boundary objects to enable multiple translations. *Afr. J. Inf. Syst.* **8**(1), 4 (2015)
11. Braa, J., Monteiro, E., Sahay, S.: Networks of action: sustainable health information systems across developing countries. *Manage. Inf. Syst. Q.* **28**(3), 337–362 (2004)
12. Health Data Collaborative. *Who We Are* (2018). <https://www.healthdatacollaborative.org/who-we-are/>. Accessed 10 Oct 2018



# An Institutional Perspective on the Adoption of Open Dashboard for Health Information Systems in Tanzania

Wilfred F. Senyoni<sup>1,2</sup> , Honest C. Kimaro<sup>2</sup> , Jørn Braa<sup>1</sup>,  
and Claud Kumalija<sup>3</sup>

<sup>1</sup> University of Oslo, Blindern 0317, Oslo, Norway  
senyoni@gmail.com, jbraa@ifi.uio.no

<sup>2</sup> University of Dar es Salaam, Dar es Salaam, Tanzania  
honest\_c@yahoo.com

<sup>3</sup> Ministry of Health, Dar es Salaam, Tanzania  
claudjohnk@yahoo.com

**Abstract.** This article attempts to understand the adoption and institutionalisation of open dashboards in the health information system in Tanzania as part of the national initiative in strengthening the routine health information systems through data-driven approaches. Using an institutional perspective, specifically the concept of institutional work, the article analyses the efforts of a group of actors aimed at disrupting existing structures, thereby creating new ones and diffusing them within and across organisations. We argue that for the institutionalisation of open dashboards in health information systems, serendipity moments are necessary and should be coupled with actors willing to mobilising others within the network. Furthermore, we argue that the use of participatory approach has the potential to align interests from diverse stakeholders hence providing a mechanism for transforming rooted organisational routines.

**Keywords:** Dashboards · Open data · Open dashboard · Institutional work

## 1 Introduction

Dashboard can simply be termed as a visualisation tool which summarise and present information from multiple data sources in a single screen. With organisations adopting a data-driven approach, the application of dashboards in various sectors has seen a surge of interest. An increasing number of organisations are or in the process of adopting dashboards as a means of staying close to their data [1] leading to its various naming conversions and applications; such as intelligent dashboards [2]; performance dashboards [3]; interactive dashboards [4]; traffic light dashboards, commonly known as scorecards [5]. Some of the factors attributing to the growing interests in dashboards include their ability to monitor performance, to convey information easily to diverse or specific stakeholders, to be used for planning purposes and to enforce consistency in measurements across organisations [6]. In this era of information where managers are faced with increasing data volume, information complexity and diversity; dashboards



have the potential of playing a prominent role in responding to such challenges as well as tipping the balance between information load and decision accuracy.

In the healthcare domain, dashboards have also seen a larger share of interest and use. Specifically, they have been used as a tool to provide information and feedback to the central organisational structure down to the specific health provider. In a sector characterised by information systems fragmentation and a multitude of diverse stakeholders [7, 8], dashboards provide data managers, practitioners, donors, implementing partners, and the public at large the ability to access and analyse information from different data sources and monitor progress at various administrative levels through a comprehensive set of visualisation configurations. They can be used to monitor organisation's performance and progress towards reaching global, national and sub-national goals such as Sustainable Development Goals (SDG) and national strategic plans. For example Edward et al. [9], through a five years evaluation of Afghanistan health systems, reports that the application of dashboards helped in improving health service capacity and service delivery. The enhancement of evidence-based decision making culture and organisation learning are some of the elements attributed to the application of dashboards.

Nonetheless, despite the wider application of dashboards, still organisations are faced with several challenges in dashboard implementation ranging from design [10] to organisational issues [6]. For example, Few [10] emphasises the challenges dashboard implementation faces with some of them failing to live up to their potential, mentioning '*visual design*' as a key component to '*most dashboard implementations fail[ing] miserably*'. While the advance of technology has enhanced the dashboard design, little has been reported in the scientific literature and studies understanding the adoption of dashboard in organisations are still few [6]. With this backdrop, our study positioned itself to understand how dashboards could be adopted and institutionalised within the Health Information Systems (HIS) in developing countries. Taking an institutional perspective, we aim at understanding the change process needed to introduce and diffuse dashboard within existing organisational structures. Applying the concept of open data, we broaden our understanding to how organisations can embrace the idea of 'open dashboard' when much reluctance to publically shared information is observed; even more from public agencies [11]. An institutional perspective provides a better insight on how open dashboard can be institutionalised within an organisation while challenging existing institutions. Using the concept of institutional work [12], we seek to address the research question of "what are the required institutional change processes in adopting open dashboards in the health information systems". We argue that for the optimum adoption of the open dashboard in HIS, serendipity moments are necessary and should be coupled with actors willing to mobilising others within the network. Empirically, we draw on experiences of a group of actors in Tanzania, aimed at implementing a web-portal to disseminate routine health information to Ministry of Health's stakeholders.

## 2 Literature Review

### 2.1 Open Data and Open Dashboards

Recently, government institutions have experienced increased pressure to openly make available their dataset to the public. The motivations behind such pressures are arguments that open data could involve the citizen in analysing the large quantity of datasets [13] as well as promoting policymakers to address complex problems through the use of data [14]. By far, public organisations lead the path in creating and collecting a huge number of data in various sectors [15]. This is very true in the health sector as well. Making the data available openly has the potential to mend the traditional boundaries existing between government institutions and the public, its largest client and beneficiary. Through interviews, Janssen [16] identified some benefits from open data ranging from political and social, to economic, operational and technical benefits. However, despite the significance of open data, one needs to be wary of the potential challenges to its adoption. Exposure of incomplete, inaccurate, obsolete information and failure to enable users to understand and use information have the potential to raise significant barriers limiting the potential for open data. Thus having useful structures and support in handling open data within an organisation are seen as significant elements in reducing the organisation's 'red tape' and shift them from the traditional reporting structures.

Dashboard is a concept attracting significant attention in various sectors and plays a role in information dissemination within and across organisations. Generally, dashboard is a visualisation tool that collects, summarise, and present information from multiple data sources so that the users can view at a glance how various organisations' indicators are performing. Stephen Few [10] defined the dashboard as '*visual display of the most important information needed to achieve one or more objectives that fit on a single computer screen so it can be monitored at a glance*'. Dashboards are not new and started as normal reports. In recent years and with the advancement of visualisation tools, dashboard has evolved into metric reports and taking up a new purpose by being able to present information from different data sources and allow users with different background to understand the information and manipulate them, thus, giving it a ubiquitous status [16, 17]. The adoption and application of dashboards in the health care system have also seen some of its shares. Edward et al. [9] report on a five years evaluation on how dashboards were adopted to improve the health service capacity and service delivery within the Afghanistan health care system. The application of dashboards enhanced transparency in the decision-making process and created a culture of accountability at all levels within an organisation. On the other hand, the dashboard's application in providing regular information to the public particularly from data collected by the government institutions has yet to receive extensive attention. The notion of open dashboard containing collection of information and allowing them to be accessed publicly is of interest and has not been explored enough. Open dashboards have taken different names at different times such as web-portal and open web-portal. The understanding of how public organisations can adopt open dashboards is of interest and this article seeks to address it.

## 2.2 Institutions and Institutional Work

Institutions are considered as formal rules and informal constraints which guide individuals in their routine activities. Once established, institutions become authoritative guidelines for social behaviour and facilitate the social interactions and actions among groups of individuals [18]. The concept of institutional work examines the agency of actors in creating, maintaining, and disrupting existing institutions [19]. It illustrates the internal shifts within the structured processes as the consequences of actions taken by actor or group of actors, concurrently being shaped by the same institutions. Institutional work concerns with what an actor or group of actors can do in order to create, maintain or disrupt the institutional structures in a manner which suits their interests and needs. It contributes to the understanding of agency in institutions by bringing to the forefront the routine and mundane efforts aimed at affecting existing organisations structures [20].

Lawrence and Suddaby identified three categories of institutional work with potential different institutional effects, namely creative, disruptive and maintenance institutional work [12]. The creative institutional work entails the activities to reconstruct rules, and shuttering the existing boundaries within the organisations [21]. It puts attention to the planned actions performed by actors in the construction of new organisational structures as opposed to or beyond the existing ones. In disruptive institutional work actors may strategically choose to undermine the ‘existing mechanisms’ by tearing them down or rendering them ineffectual should their interests no longer be served by the existing arrangements. On the other hand, the institutional maintenance involves supporting, repairing or recreating the social structures ensuring the introduced institutions continue to be reproduced and routinized [22].

In this study, we take the institutional work lens to analyse the changes needed for a group of actors to adopt open dashboards in the Health Information System (HIS) in Tanzania. We analyse how a group of actors, through a set of activities, purposefully aimed at introducing and changing existing routines in disseminating routine health information. The lens allows us to see the adoption process as a process involving a group of actors engaged not only in the design and development process but rather in establishing new practices of information dissemination within the organisation.

## 3 Method

The empirical setting for the study was in Tanzania as part of the larger global Health Information Systems Programme (HISP). HISP initiatives have been on-going for the last 20 years involving software development and country implementation of District Health Information Software 2 (DHIS 2) in several countries in Africa, Asia, South America and Europe [23]. DHIS 2 is a platform adopted by several ministries of health as their preferable Health Management Information System (HMIS) backbone software to collect, analyse and share routine health information.

This study entails the project established to formulate open dashboard in Tanzania as a joint effort to improve access to routine health information. The project work followed an action research model which involved joint participation in the planning,

implementation, evaluation and data dissemination activities [24]. The project planning and its evaluation took place in various periods throughout the project life cycle in terms of face to face meetings and electronic communications with other evaluation mechanisms centred on workshops and fieldwork. Discussions on the key finding were conducted during and along the implementation phases giving insight to the next planning phases and in several peer to peer meeting. Knowledge dissemination has been done by documenting the processes, challenges and recommendations in the final project documentation.

Authors of this article were actively involved in the project work from its conceptualization to the implementation phases in Tanzania. Throughout the study, principal data collection methods used includes semi-structured interviews, participatory observation during the meeting and workshops and participation in the database design. Additional data were drawn from meeting minutes and email correspondence, informal discussions and reports submitted by the authors. It is worth noting that, one of the authors heads the HMIS unit in the Ministry of Health in Tanzania, a unit among other things, responsible for the routine collection, analysis and dissemination health information within the ministry. Other authors have been part of the global HISP network for over a decade and engaged in similar projects in other countries in Africa and Asia. Two of the authors are part of the Tanzania HISP group supporting the Ministry of Health in HIS strengthening activities. Both their experience and historical background provided additional information to the study.

The iterative review was employed in analysing the data collected from various sources for example: field notes, transcripts and meeting minutes. Thematic analysis which involves examining, and recording patterns as a means to identify themes which formulates the basis of interpretation was used as an analytical technique during the study [25]. The results have been presented and discussed in multiple occasions in peer review sessions and in other general meetings and workshops.

## **4 Open Dashboard Implementation**

The health structure in Tanzania mainland is organized at four main levels; the health facility, as the point of service delivery for health; the district council level, as the lowest administrative centre for HMIS activities after the health facilities; the regional level, coordinating between the districts and national level and lastly the national level where the HMIS unit address the information processing and dissemination for MoH. During a period of 2011–2013, the MoH with the support from its implementing partners and donors implemented an open source, web-based system named DHIS 2 as part of its Monitoring and Evaluation Strengthening Initiative (ME&SI) to strengthen the routinely HMIS. The national-wide implementation of the system in Tanzania enabled data collected by paper tools at the facility level to be entered in the online DHIS2 national system at the district council level enabling information analysis based on the analytical tools and dashboards configured in the system. Following the national wide implementation covering mostly data collected by HMIS, other vertical health programs (such as HIV, Human Resource, Logistics, Malaria and TB) were integrated in the national system either by the national system to collect their data or by

facilitating systems interoperability. Access of information in this online DHIS2 national-wide system was through credentials provided by the MoH. Alternatively, information could be extracted with request to the HMIS unit at MoH or through the production of Annual Health Sector Performance Profile Report (AHSPPR), presenting a clear picture on the performance of routine health delivery as well as trends in key health indicators, performance of interventions and comparisons over different regions and time. The AHSPPR is annually produced after series of data validation processes, compilation using national standards and endorsement from high-level officials in the MoH.

The availability of an online DHIS2 national system comprising of vast information from various health programs prompted a wide scale demand for system access from the implementing partners supporting the MoH and the local administrative councils. Previously, implementing partners could access data directly from the health facilities or at the district councils they support. However, with now a nation-wide system in place, MoH emphasised DHIS 2 as the source of data for all health stakeholders, putting pressure on implementing partners and local health officials to report and use health information emanating from the national system. While annually, the AHSPPR and other statistical information bulletins were produced and shared with health stakeholders; partners had ad-hoc demands for information, requiring more regular access to the health information, posing a new challenge.

University of Dar es Salaam (UDSM) DHIS2 project being part of the global HISP network and the local partner of MoH in health information system activities was thus involved to address such a challenge. UDSM supported the MoH in the national wide implementation of DHIS2 and had a Memorandum of Understanding (MoU) to provide technical and user support for MoH and its partners. An initial assessment which included participation from various departments under the MoH, vertical health programs, implementing partners and agencies from other sectors such as National Bureaus of Statistics (NBS) revealed that the information demands were quite diverse and needed a comprehensive solution to be addressed. While AHSPPR addressed some of the demands, partners required a more regular information outlet and with different granularity i.e. multi-level, processed information vs raw data. For example some required raw data disaggregated by health facilities to import into their organisation's software for further internal analysis while others were content with processed information shared routinely such as monthly or quarterly.

With the limited available resources, the HMIS unit and UDSM took the task head on and designed an online web-portal, also called 'open dashboards', extracting routine health information collected by the DHIS2 nation-wide system. Combining the previous experience of using national system dashboards, which resonate well with data managers, as a tool which summarises and visually presents information for instant data interpretation and the knowledge assimilated from similar efforts in the HISP network; prototypes of the 'open dashboard' were constructed and presented to stakeholders for feedback and review. This proved to be another challenge with conflicting feedbacks at a time, as one interviewee noted.

*“So we ended up showing at sometimes all three versions (of the web-portal), of course, we had to go an extra mile doing three things all together just to show why one thing is better than the other two, That was one of the selling points to get the idea across.”*

*“Trick was to have a simple design without a lot of information to the extent of becoming crowded. People cannot really process too much information. But still putting enough information across without holding back a lot of details was necessary.”*

Feedback gathered through workshops and internal meetings provided a good stream for improvements and localising the web-portal to the stakeholders needs. Compromises had to be reached to enable progress to be made. For example, limiting information presented on the web-portal to district council level only, with a provision to the health facility data upon access request and agreement for quarterly data cleaning processes, were some of the issues which needed clarification and resolution. Other thorny issues raised were the use of data for publication and availability of raw data, requiring member’s agreement prior to the open dashboard deployment. Nevertheless, these challenges and their resolution enabled the open dashboard to gain acceptance and trusts among stakeholders as well as facilitate its localisation to their needs.

While AHSPPR had more regulated processes in its formulation and had been used for several years: the dissemination of information through open dashboard seemed to by-pass some rigours standardised processes. However, its use by partners to extract key indicator performance by districts and regions they support or national wide, enable some of the data quality elements to improve. For example, completeness and timeliness of routine data submission improved significantly because information was now available not only to the users accessing the national system but rather to the public in general with easy accessibility mechanisms. When asked about this, one interviewee said.

*“In one session, two conflicting data were presented, with one coming from the web-portal. We showed the information from web-portal and pointed the data source being the DHIS2 system from the health facility to the web-portal. This alerted the partner supporting the region to streamline their activities and data quality processes.”*

The design of the web-portal categorises its information by key health programs (i.e. HIV, TB, Malaria, Maternal and Child Health, Human Resource) enabling users to access a full yet coherent picture of the health status (see Fig. 1).

The number of requests and feedback for new features increased, indicating it’s acceptance among the health stakeholders. Similarly, other units within the MoH adopted and used the open dashboard to disseminate their information. In one of its presentation to a high level manager’s meeting from several sectors, one senior official from another sector said:

*“During my working experience, it is quite rare to come across a sector in the local government able to compile a comprehensive set of its routine sectorial information and regularly share them publically. This will definitely be a good example for other sectors to follow suit.”*

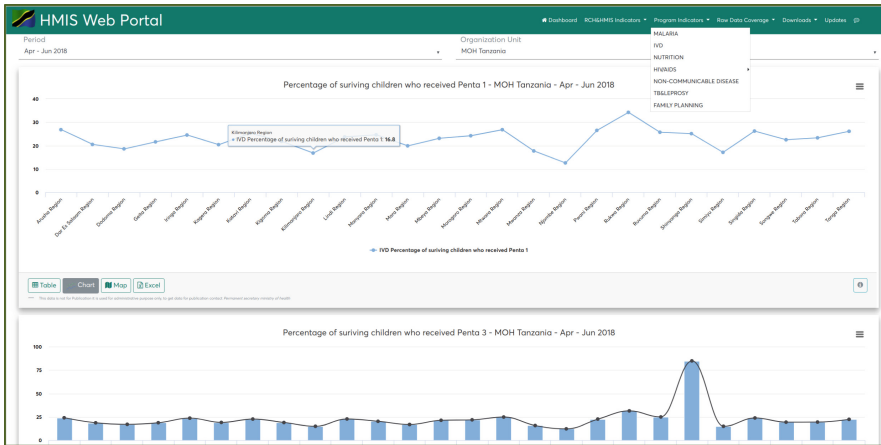


Fig. 1. Tanzania HMIS open dashboard.

## 5 Analysis

Using an institutional work lens, this section analyses the efforts of a team of actors engaged in the implementation and diffusion of an open dashboard as set of changes using the three categories of creating, maintaining and disrupting as suggested by Lawrence and Suddaby [12].

### 5.1 Disruptive Works

DiMaggio and Powell [26] described institutions as norms, practices and logic which structure organisations as ‘iron cage’ limiting one’s actions or reaction to some of the emerging challenges. When not appropriately addressed, the emerging challenges from disruptive elements to the existing structures eroding their legitimacy. Our study illustrates a regulated and ‘taken for granted’ process which the MoH has for several years used to communicate and share the routine health information to its stakeholders. While not the only means for communication, the annual health sector performance profile report was a prominent mechanism with regulated process for MoH to communicate with stakeholders, its performance and achievements. The process involved but was not limited to the validation and verification of information, supported by endorsement from high-level managers prior to sharing the report with the public. The introduction of online national wide system aimed at strengthening routine health systems; however, its adoption had unforeseen consequences to MoH’s routines for information sharing and dissemination triggering disruptive elements to the existing routines for information sharing and dissemination. The massive demand for up-to-date routine health information could not be handled by the existing regulated processes, creating an opportunity for actors to tinker the existing structures. While the actors did not initiate the breaching of the existing structures, their mobilisation and continuous work towards undermining the existing structures while introducing alternative ones

are seen as disruptive works. Their activities aimed at providing opportunity for new structures to challenge the existing ones within the organisation.

## 5.2 Creation Works

Zietsma and McKnight [27] illustrate the institutional creation work as '*a process of collaborative co-creation and/or competitive convergence, involving experimentation undertaken by multiple actors*'. They further argued that, to attain a common template among diverse stakeholders, the interests of multiple actors should be embedded in the solution through multiple iterations of negotiations and active co-creation. This underpins the need for actors in such a competitive environment to focus on translating some of the requirements and feedback from others' stakeholders into the emerging solution for it to gain legitimacy.

The UDSM team and HMIS represent a group of actors determined to formulate a solution to the emerging challenge. While they did not have a solution at hand, they had expertise and knowledge which proved to be valuable in addressing the problem. Their involvement on the national wide implementation of DHIS 2 provided them with a better position among the health stakeholders. Once the solution was identified, a participatory mechanism was employed in several iterative sessions to engage various key stakeholders and localise the new solution through negotiations and concession. This provided a common understanding in creating the open dashboard and its routines. For example, the team selected first the major vertical programs and stakeholders to diffuse the idea of open dashboard through workshops and working sessions while at the same time gathering their requirements. This enabled the stakeholders to come to terms and reach a compromise when faced with new requirements or difficult choices to take. The use of prototypes for experimentation and learning was central in such a collaborative environment with diverse stakeholders and provided an ideal approach for enhancing knowledge sharing and diffusion of the solution. The creation works cultivated by a group of actors was thus able to form new routines and root themselves in the organisation structures as they compete for dominance.

## 5.3 Maintaining Works

While the actors were engaged with adopting the open dashboard in the MoH routines, there was a need for antidotes to existing or emerging undermining elements threatening to destabilise the diffusion of the introduced solution. For example, the team needed to address the legal aspect of routinely sharing information publically before launching the open dashboards. Through consultations with stakeholders in the government and outside as well, a compromising position was reached which allowed sharing of routine aggregate information to the public with limitation for publication. Furthermore, the diffusion and scaling of the solution across vertical health programs was another strategy deployed to ensure sustainability and strengthening ownership while resisting new and existing pressures. For example, key vertical health programmes were identified and took part in the initial negotiation processes. Identifying their requirements as well as hosting their indicators in the open dashboards generated momentum for other programs to follow. Regular presentations of the routine health information using the



open dashboard raised awareness as well as providing a way to disseminate information to diverse stakeholders. To further enhance the momentum, demonstration to senior level managers was necessary in cementing its legitimacy within the ministry. The nature and occurrence of such maintenance work underscore the Zietsma and McKnight [27] argument that, all three categories might occur simultaneously as actor's tries to undermine the existing organisational structures while at the same time creating their own and drive them to be diffused and maintained.

## 6 Discussions and Conclusion

Ciborra [28] argues for serendipity moments as a 'petri dish for tinkering' allowing effective solutions to be embedded into everyday practices. Recognising challenges as stepping stones for creating innovation and engagement in a collaborative process on unfamiliar territory, or even involving competitive agents, are some of the elements which can be attributed to such moments. When different organisational actors came together to discuss their information needs for the first time, it was a new situation ('moment') triggered by the potentials seen by the actors on the open dashboard concept. When the existing structures within the MoH did not address these new demands, some of their legitimacy eroded allowing new structures to potentially be introduced. However, such conditions required to be coupled by willing actors with capacity to instigate and drive such changes in the organisation as well as convincing others to align their interests. The team from UDSM and HMIS represent actors who were determined to formulate a solution to the presented challenges. While they did not have any solution at hand, they had experience, expertise and knowledge which proved to be valuable in addressing the problem. Drawing from experience in previous work formulating open access dashboards and their position in mobilising stakeholders in the implementation of the national wide health information system, the actors engaged in iterative processes of breaching the 'iron cage' while introducing new routines to the organisation.

While there are many benefits to rip from public organisations to routinely share information with the public, doubts still exist on how the public will react or not to the shared information. Previous research indicates that opening of information publically might reinforce existing practices rather than changing them [15], however, our analysis indicates the opening of data publically might stimulate change not only within the organisation but rather across public sectors.

We thus argue that for the optimum adoption of the open dashboard in health information systems, serendipity moments are necessary and should be coupled by actors willing to mobilising others within the network and align interests from diverse stakeholders. Furthermore, we argue that a participatory approach in formulating open dashboards has the potential of not only aligning interests from diverse stakeholder but also provides a better mechanism to transform rooted organisational routines and make them susceptible to new structures. Open dashboards have the potential to better connect the public organisations with the public mending the traditional separation between them. Additionally, the participatory approach in the designing process enables dashboards to 'live up to their potential' and address the design challenges

[10]. However, we argue that, it is not enough to publish the information publically; rather there is a need to actively engage public stakeholders in gathering feedback and responding to issues raised.


## References

1. Davenport, T.H., Harris, J.G., Morison, R.: *Analytics at Work: Smarter Decisions, Better Results*. Harvard Business Press, Brighton (2010)
2. Martin, N., Buxey, F., Zlatev, V.: *Intelligent Dashboards*. U.S. Patent Application 12/036,287 (2009)
3. Eckerson, W.W.: *Performance Dashboards: Measuring, Monitoring, and Managing Your Business*. Wiley, Hoboken (2010)
4. Al-Hajj, S., Pike, I., Fisher, B.: Interactive dashboards: using visual analytics for knowledge transfer and decision support. In: *Proceedings of the 2013 Workshop on Visual Analytics in Healthcare*, Washington, DC, USA, pp. 37–40 (2013)
5. Senyoni, W., Braa, J.: Boundary object in HIS: designing and implementation of a regional scorecard. In: *IST-Africa Week Conference, IST-Africa 2017*, pp. 1–8. IEEE (2017)
6. Pauwels, K., et al.: Dashboards as a service: why, what, how, and what research is needed? *J. Serv. Res.* **12**(2), 175–189 (2009)
7. World Health Organisation: *Framework for standards for country health information systems*, Geneva, World Health Organisation (2008)
8. AbouZahr, C., Boerma, T.: Health information systems: the foundations of public health. *Bull. World Health Organ.* **83**(8), 578–583 (2005)
9. Edward, A., et al.: Configuring balanced scorecards for measuring health system performance: evidence from 5 years' evaluation in Afghanistan. *PLoS Med.* **8**(7), e1001066 (2011)
10. Few, S.: *Common pitfalls in dashboard design*. Perceptual Edge (2006)
11. Janssen, M., Charalabidis, Y., Zuiderwijk, A.: Benefits, adoption barriers and Myths of open data and open government. *Inf. Syst. Manage.* **29**(4), 258–268 (2012)
12. Lawrence, T.B., Suddaby, R.: Institutions and institutional work. In: Clegg, S.R., Hardy, C., Lawrence, T.B., Nord, W. (eds.) *Handbook of Organisation Studies*, pp. 215–254. Sage Publications Ltd., London (2006)
13. Surowiecki, J.: *The Wisdom of Crowds: Why The Many are Smarter Than The Few and How Collective Wisdom Shapes Business, Economies, Societies and Nations*, vol. 296. Doubleday, New york (2004)
14. Arzberger, P., et al.: An international framework to promote access to data. *Science* **303** (5665), 1777–1778 (2004)
15. Janssen, K.: The influence of the PSI directive on open government data: an overview of recent developments. *Gov. Inf. Q.* **28**(4), 446–456 (2011)
16. Presthus, W., Bergum, I.: Business Intelligence to the People. A Case Study of Dashboard Adoption in the Health Care sector. In: *Nor. Konf. Organ. bruk av IT*, vol. 23(1) (2015)
17. Sharda, R., Delen, D., Turban, E., Aronson, J., Liang, T.P.: *Business Intelligence and Analytics: Systems for Decision Support-(Required)*. Prentice Hall, London (2014)
18. North, D.: *Institutions, Institution Change and Economic Performance*. Cambridge University Press, Cambridge (1990)
19. Lawrence, T.B., Suddaby, R., Leca, B.: Institutional work: refocusing institutional studies of organisation. *J. Manage. Inq.* **20**, 52–58 (2011)
20. Thorseng, A.A., Grisot, M.: Digitalization as institutional work: a case of designing a tool for changing diabetes care. *Inf. Technol. People* **30**(1), 227–243 (2017)

21. DiMaggio, P.J.: Interest and agency in institutional theory. In: *Institutional patterns and organisations culture and environment*, pp. 3–21 (1988)
22. Lawrence, T.B., Leca, B., Ziber, T.B.: Institutional work: current research, new directions and overlooked issues. *Organ. Stud.* **34**(8), 1023–1033 (2013)
23. Braa, J., Hanseth, O., Heywood, A., Mohammed, W., Shaw, V.: Developing health information systems in developing countries: the flexible standards strategy. *MIS Q.* **31**, 381–402 (2007)
24. Baskerville, R.L.: Investigating information systems with action research. *Commun. AIS* **2** (3es), 4 (1999)
25. Braun, V., Clarke, V.: Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**(2), 77–101 (2006)
26. DiMaggio, P., Powell, W.W.: The iron cage revisited: collective rationality and institutional isomorphism in organisational fields. *Am. Sociol. Rev.* **48**(2), 147–160 (1983)
27. Zietsma, C., McKnight, B.: Building the iron cage: institutional creation work in the context of competing proto-institutions. In: *Institutional Work: Actors and Agency in Institutional Studies of Organisations*, p. 143 (2009)
28. Ciborra, C.U.: From thinking to tinkering: the grassroots of strategic information systems. In: *Proceedings of ICIS 1991*, vol. 30 (1991)



# Tracing the Impact of the City of Cape Town's Open Data Initiative on Communities and Development

Mbongeni Hlabano  and Jean-Paul Van Belle  <sup>(✉)</sup>

University of Cape Town, Cape Town, South Africa  
jean-paul.vanbelle@uct.ac.za

**Abstract.** This paper attempts to measure the extent of impact of the City of Cape Town's open government data initiative, which has been operational since 2013. Given the relative scarcity of impact measurement frameworks, a framework is adapted from that of Verhulst and Young [1], as well as the Social Return on Investment (SROI) framework suggested by Stuermer and Dapp [2]. The idea is to trace the developments resultant from the use of open data from various sources, mainly the City of Cape Town's open data portal. Several activities and developments are identified and classified under a classification scheme adapted from development pathways relevant to a developing country context. The development pathways are identified from literature. After the developments are traced, critical impact analysis is carried out using the SROI framework. The findings suggest that although there are some indications of impact, such impact is only confined to groups with specialised and specific interest in various types of open data. Additionally, awareness of the existence of open data-sets is also minimal, which significantly decreases the likelihood of use, ergo, impact. Policy suggestions to increase likelihood of use and impact are then presented.

**Keywords:** Open data · Impact measurement · Development pathways · Social return on investment · Sustainable development goals · Tracing development

## 1 Introduction

This research looks at the Open Data (OD) phenomenon as a driver for developmental impact and government transparency. Most of the OD research in Africa has focused on national governments; there is currently not a single research study which looks at a local government OD implementation. This research aims to bridge this gap by looking at the OD phenomenon in the first African city to embrace and adopt OD wholeheartedly.

The research objectives are to present the case study of Open Data Cape Town and to assess its impact using a sound theoretical framework. The ultimate aim of the research is to present concrete recommendations on how the open data initiatives can be enhanced to further improve the impact on community development and local government transparency.

## 2 The City of Cape Town's Open Data Initiative

The CCT is the first city in Africa to establish an open data presence, a remarkable achievement given the relatively slow development of the national open data initiative. Inception for developing the open data initiative was the initiation of an Open Data Forum by the Western Cape's Member of the Executive Council for Finance, Economic Development and Tourism, which prompted the City Mayor's Office to conceptualise the idea of the initiative [3]. The forum brought together stakeholders interested in open data, which resulted in the idea of establishing an open data policy being suggested. The City Mayor's Office then tasked the city's Development Information and Geographic Information Systems (DI & GIS) Department with initiating discussions about developing a document on open data policies and practices, and how the city could implement these [3]. The resulting document served as a basis for the eventual Open Data Draft Policy published in February 2014 [4]. The city's open data portal was then launched in January 2015. The portal currently has 119 datasets (as of 02 July 2018) covering several areas including agricultural land, fiscal data, air quality, industrial statistics, and locations of amenities among others. The datasets clearly cover important areas that would be significant in driving socio-economic impact.

## 3 Other Non-central Government OD Providers in South Africa

The open data "movement" is relatively nascent in South Africa, although some notable progress to facilitate awareness of the concept has been fostered by some stakeholders. A relevant example is OpenUp (formerly known as Code 4 SA). They are a civil society group advocating for data liberation, data literacy, citizen empowerment, active citizenry, co-governance, and civic technology [5]. They run several initiatives to support a culture of data innovation, active use, and information use to empower people in South Africa. They run data training courses, and 'conscientise' society on the importance of active citizenry through the use of available data. Furthermore, OpenUp has partnered with some multilateral organisations to create APIs that facilitate data retrieval from various sources (including governmental). The data retrieved by their APIs is consolidated into an open data portal, which currently has 125 datasets [6]. Data from the portal is downloadable in machine readable formats and the APIs allow users to see visualisations of the data. However, there is no explicit open license attached to the datasets.

At local level in South Africa, the City of Cape Town has made the most significant strides relating to open data, as discussed earlier. Other open data initiatives in other major cities have emerged. Open Data Durban [7] is a civic technology lab that implements and advocates for open data, open government, and civic technology through various activities (projects, hackathons, workshops, etc.). Although they do not, as yet, actually supply data, they work with civic society, the media, government and any interested stakeholders advocating for the use of information to empower citizens. Although the Durban local government is not directly involved with the

initiative, they have taken a keen interest in the initiative, attending some of their activities, perhaps an indication that the city would also like to develop and launch an open government data initiative [8].

## 4 The Impact of Open Government Data

### 4.1 Measuring the Impact of OGD

Measuring the impact of OGD has proven to be notoriously difficult, given the vast nature of the social, economic, political, and environmental implications of the intended and actual use of OGD. The complexity involved in such measurement has been acknowledged, as well as demonstrated, by the rarity of established frameworks to measure the phenomenon [1], or studies that clearly assess impact of OGD in great detail [8, 9]. In light of this “counterproductive” scenario in the OGD research space (given the investments made towards OGD initiatives), the Open Data Barometer has emphasised the need for more structured research and analysis on the impact of OGD in order to demonstrate the value of the initiatives [8].

The most prominent dimension of impact that has been measured is economic impact, with some studies attempting to quantify the capital contribution open data potentially makes towards economies (e.g. [10–12]). The Open Data Barometer reported a 14 per cent increase in economic impact for the surveyed countries, whilst also pointing out the least impact on social issues (14 per cent decrease), as well as a decrease in political impact [8]. The actual social impact of open data is most likely higher than estimated in studies that have attempted to measure it. Some studies only give approximate estimates (for specific countries) of the value resultant from the social impact of open data, given the lack of appropriate framework to make more formalised estimates [11].

Given the apparent lack of appropriate framework to measure the impact of open data, some researchers have suggested some frameworks for measuring the impact and social value of open data. Some of these are discussed in the following section and how the suggested frameworks are adapted to attempt to measure the impact of open data for the City of Cape Town’s open data initiative.

### 4.2 Open Data Impact Measurement Frameworks

It has been suggested that context should be considered when assessing the impact of open data [2, 9, 13]. This is particularly relevant for assessing open data initiatives in Africa (or developing countries in general), which has a different political climate to that in the more developed countries in Europe and the Americas. The report from the International Open Data Conference in 2016 suggests that different impacts require different indicators and methods, hence recommending the need for sector specific impact studies [9]. Adopting this recommendation, this research assumes a thematic approach to the analysis and measurement of the impact of the City of Cape Town’s open data initiative. Themes are identified, and the associated inception points for the actual use of the various datasets on the city’s open data portal, as well as other open

data sources such as OpenUp. Thereafter, the subsequent activities and the resultant impacts are traced and measured as far as practicable.

It is also important to focus on themes relevant to a developing country context. In attempting to develop framework for assessing open data initiatives in developing economies, [1] identified (in literature) six features of open data that are distinctly relevant to developing economies. These include participation, trust, equity, scrutiny, value amplifier, and flexibility. These intersect with the features of open data identified (in literature) by [11] in their study of how public sector information can have broader impacts (increasing democratic participation, promoting greater accountability, greater social cohesion, generating environmental benefits, identifying previously unknown links between different policy areas). [1] went on to categorise pathways along which open data impacts on development. These pathways include creating economic opportunities, helping to solve complex public problems, improving governance, and empowering citizens. Given the developing country context of this research, the pathways would be a good guideline to trace the impact of the City of Cape Town's open data initiative. Inception points, including events directly associated with the use of data from the city's open data portal, are identified, and the subsequent developments are traced along the pathways.

[1] also identified 27 enabling conditions and disabling factors as testable premises for determining the conditions under which open data works within developing economies. These factors and conditions were arranged into a periodic table under five categories. These premises could be used to identify and assign indicators of the extent of impact, and the metrics compiled could then be used quantify, or qualify, impact. This approach could also be merged with the Social Return On Investment (SROI) approach adapted by [2] to develop their open data Impact Monitoring Framework. For each data category/dataset, the framework exhaustively identifies all the inputs, outputs, outcomes, and impacts. In tracing the pathways along which open data impacts on development, the identified enabling conditions and disabling factors could then be arranged into the Impact Monitoring Framework in order to put the premises in perspective, in a structured and logical manner. This approach actually coincides with the Change Theory and/or Logic Model posited by [1]. Their theory/model states that *"Open data (supply), when analysed and leveraged by both governmental and non-governmental actors (demand), can be used in a variety of ways (actions and outputs), within the parameters established by certain enabling conditions (and disabling factors), to improve government, empower citizens and users, create economic opportunity, and/or solve societal problems (impact)"* [1:8]. The theory/model also adopts the SROI approach, and is useful in qualitatively analysing and discussing the impact of open data in various sector specific contexts.

## 5 Research Approach

A phenomenological research approach is adopted, which is predominantly qualitative. The method uses relatively unstructured methods of data collection and places emphasis on inductive logic. Additionally, the method is particularly concerned with contextual description and analysis of phenomenon [14], which is essential for this

research, given the implied need for contextual impact assessment. In this research vein, the method is applied in a cross sectional manner, with data collected for a “point” or a period in time, specifically the last three years. Data is collected from various sources including published papers, national and local government reports, commercial white papers, reports from supra-national and local non-government organisations, interest groups, news/press articles, blogs, and any other credible sources tracing the development of the open data initiatives in Cape Town. For the City of Cape Town, the impact of open data has evidently been minimally publicised, with no papers, reports, or news/press articles identified in this regard. What has gotten coverage, particularly in the press, has been the preceding events and plans related to workshops and hackathons related to open data. As such, mainly unstructured follow-up interviews with various stakeholders in the local open data ecosystem are used to collect more data for impact assessment.

The approach taken to measure the impact of the City of Cape Town’s open data initiative is thus be thematic and sector specific, adapting the frameworks discussed above. Specifically, this involves first identifying inception points for the direct uses of datasets from the city’s open data portal. Then, the subsequent developments directly attributable to the uses of the data are traced and analysed within the frameworks. The following sections discuss the inception points for the uses of datasets from the city’s portal that have been identified so far, and how the resultant impact are traced.

## 6 Critical and Theoretical Assessment

A constructivist epistemology is adopted. Constructivism essentially subscribes to the notion that truth and meaning are resultant from a subject’s interaction with the external world, thus subjects construct their own meaning (ergo meaning is constructed, not discovered) in varying manners in relation to the same phenomenon [14]. Open data has been quoted and motivated as a tool for facilitating positive social processes including government transparency, public participation and collaboration in governance, improvement of service delivery, complementing personal decisions such as farming practices to adopt or travelling itinerary to use, and several other social processes. The impact of open data is viewed as a constructed “meaning” relating to any of the various social processes meant to be impacted on by open data, and resultant from subjects’ interaction with the external world. Subjects are notably viewed as having aspirations when deciding to make use of open data in their interaction with the external world. Thus open data is construed as a facilitating agent in subjects’ interaction with the external world in different contexts, incepted by various forms of aspiration. The associated aspirations are considered as social investments made with an eventual goal to realise meaning (the impact).

The theoretical perspective adopted is interpretivism, which asserts that natural reality and social reality are different, hence advocates for differences in method when attempting to understand either realities [14]. The particular interpretivist approach is phenomenology. The approach asserts that people’s social experiences should be used in any attempt to understand a social reality, thus it is crucial to disregard any current understanding or preconceptions, and let phenomena speak for themselves to result in



new meaning, fuller meaning, or renewed meaning [14]. This approach is justifiably appropriate, given how relatively new the concept of open data is, particularly in African contexts. In the developed countries in Europe and the Americas, in which the concepts of open data and open government data are relatively more mature, the meaning and promises of open data and open government data have been established (although not exhaustively). Often, it has been the case that these established meanings and promises have been used to motivate the need for open data initiatives in African contexts, and those that have been incepted have been expected to follow the trend previously assumed by the now more mature open data initiatives in the developed countries. Such expectations are justifiable, although not absolutely, given the obviously different contexts, most notably the different political climate in African contexts. Thus, a phenomenological approach seems appropriate here, in order to apply an inductive approach, in order to develop new, fuller, or renewed meaning of the social reality involving the use of open data.

Critical assessment of the achieved extent of meaning (impact) is then carried out using the SROI approach adapted by [2], which takes into account four different factors: input, output, outcome, and impact. Their open data Impact Monitoring Framework is used to analyse open data activities within the City of Cape Town, in retrospect, in a themed, and contextualised manner based on identified aspirations, and the eventual extent of impact.

## **7 Tracing the Development and Impact of Capetonian Open Data Initiatives**

The launch of the City of Cape Town's open data portal has preceded and inspired some notable developments over the past three years. Most notably, the existence of the open data portal has enabled and facilitated the organisation and execution of hackathons aimed at finding innovative solutions to some complex problems the city has been facing over the past three years. The overarching goals of the hackathons can be placed within the four pathways along which open data impacts on development. Thus, any developments and impact on communities resultant from activities such as these hackathons are traced and critically analysed.

The City of Cape Town's open data initiative has certainly gotten communities and organisations involved in the conversation and developments around open government data. Tracing the impact thus involves following up on the extent of achievement of the objectives set by the events and activities on Table 1. This involves following up on the organisers of the events, finding out what ideas and developments were resultant of the initiatives, and finding ways to determine the extent of impact directly or indirectly facilitated by the inception of the City of Cape Town's Open Data Initiative. This is carried out along the identified pathways, and the enabling conditions and disabling factors are identified as well.

It is interesting to note that there have already been some current developments that can be attributed to the expected effects of open government data. One such relevant development is the case of the problems that have been faced by the Mayor of the City of Cape Town. Patricia De Lille has recently been criticised owing to speculations and

reports from the office of the Auditor General which found inconsistencies about some tendering process for a transport tender, and renovations to the Mayor's private home using city funds [15]. Such matters would be clear to resolve if the city's open government data was truly open and such information would be available for the public to see [15]. Clearly, questions are being asked that have been motivated by the open government data concept, and this constitutes part of the intended impact of open data.

Using the framework suggested by [1], the impact of the City of Cape Town's Open Data Initiative is traced along the lines of the objectives set forth by the events and developments surrounding open government data in the city. The objectives identified certainly border around creating economic opportunities (Business and Government Data Exchange Workshop), creating solutions to complex public problems (water crisis hackathon), improving governance, and empowering citizens. These themes are explored in depth to paint a clearer picture of the extent of impact from open data in the city of Cape Town.

## 8 Impact Findings

The preliminary themes indicated by the initial data collected (interviews) include data-literacy training facilitation, and data intermediation. Inception points of impact include the usage of open data by data-science training initiatives, and the open data usage advocacy championed by open data intermediaries. Impact is only possible when there is significant usage of open data, and these two areas practically facilitate the usage of open data. The extent of usage, and subsequent impact, may not be definitively determined, but from the interviews, there seems to be promising indications of impact from the initiatives.

One important developing country context feature into which open data is contributing is the nurturing of one critical and scarce skill, data literacy. Lack of data literacy has been acknowledged as an inhibitor of increased usage of open data, or data in general [16]. Explore Data Science, an academy in Cape Town that offers a one-year data science training course, is one initiative that is actively addressing this challenge. The academy trains students to use real world data, some of which is obtained from the City of Cape Town's open data portal, to explore relevant social problems and develop innovative solutions [17]. This coincides with another developing country context feature, which is the use of open data as a tool to facilitate scrutiny of relevant public services. In using the data from the city's data portal, students at Explore Data Science explore the data in-depth, critically scrutinising the quality and context of the data. A relevant example is the students in the current (2018) stream noticing the inconsistencies in the City of Cape Town's weather data when compared to other purchased data, and expressing concerns about the water consumption data [18]. Impact in this regard may not be substantial given that it is confined to the students, but it does contribute towards creating a culture of critical data usage.

OpenUp is also playing an active role in contributing towards the developing country features discussed in the previous paragraph. They provide two-day data storytelling short courses that are open to the public, in which they train people on the use of data (and open data) to communicate information in an effective way [19]. They also

facilitate data usage by obtaining data from various sources (by means of downloading already available data, web scrapping, pdf scrapping, prior requests etc.) including government ministries, departments, and agencies, and then clean and make it available to the public in more useful and understandable formats on their portal [6, 20]. This contributes to another developing country context feature, value amplifying. Presenting data from various sources in more understandable and useful formats increases the likelihood of increased usage, and thus impact, hence amplifying the value of the data. The actual extent of impact may be difficult to discern, but there have been indications of appreciation, ergo impact, of the efforts made by OpenUp. [20] points out appreciation expressed by doctors for the Medical Price Registry tool which checks medicine prices before filling a prescription, checks for possible generics, and basically ensures that patients are not being overcharged for medicine [21]. Businesses have also expressed appreciation for the Trace tool which makes corporate data freely available, enabling businesses to keep track of their competition and empowering the public to hold the corporate sector accountable for their actions, should it be necessary [19, 22].

Within the developing country context discussion, we can identify the pathways along which open data specifically impacts on development. One such pathway is open data as a tool in helping to solve complex social problems. Students at Explore Data Science are given real world data, and tasked with finding plausible real world solutions from the problems indicated by the data. A relevant example is their use of the City of Cape Town's dam levels and water consumption data to attempt to find solutions to the Cape Town water crisis resultant of the draught that has affected the city since 2015 [18]. This is a practical use of open data, which addresses a critical social problem. Again, although the impact may be minimal, given the confined usage, it still inspires interest in the students, which could eventually lead to impact. At this stage, the impact cannot be discerned, given that the academy only started running this year. The academy also makes recommendations to the City of Cape Town based on their findings, although they would not know if the city heeds their recommendations [18].

Specific impact factors can then be identified within the pathways along which open data impacts on development. Within the overarching impact theme of 'Culture and Expertise' (as suggested by [1]), open data contributes towards the development of skills and expertise, and technological literacy. This is demonstrated by the use of open data in the Explore Data Science Academy, and in the use of open data by OpenUp to train the public on data literacy. Furthermore, the academy has developed a dashboard for the City of Cape Town, which gives a live interactive interface for pointing out where the issues with data are [18]. This facilitates a feedback loop, another specific impact factor within the 'Culture and Expertise' overall impact theme.

## 9 Critical Impact Assessment

The open data and Impact Monitoring Framework [2], which is based on the SROI approach, will be used to base a critical assessment of the impact of open data, as observed in the context of the City of Cape Town's open data initiative. Table 1 gives the impact monitoring framework, with details obtained from information collected from stakeholders in the open data 'ecosystem' in Cape Town, and South Africa in general.

**Table 1.** The open data impact monitoring framework applied to Cape Town’s OD initiative

Data category	Input <i>Native data, money, people, infrastructure, equipment etc.</i>	Output <i>Open data portal with metadata, updated content, open format etc.</i>	Outcome <i>Hackathons, apps, new firms, linking of data, research, etc.</i>	Impact <i>Intended and/or realised net effect of output intervention</i>
Water	Dam levels for the City of Cape Town’s supply dams The city’s water consumption data	Regularly updated data portal with granular dam level information, and water consumption data	Hackathons making use of water data to propose solutions for the city’s water crisis Data literacy training programs making use of the water data	Increased usage of data to help solve complex social problems Better informed city residents on critical issues that affect them
Medical	Official prescription medicine prices as regulated by the Department of Health Pricing information on generic alternatives to prescription medicine	OpenUp’s open data portal with regularly updated data	Medicine price registry – Web application on which patients can check for official prescription medicine prices, and generic alternatives	Patients not having to overpay for prescription medicine Better informed patients on generic alternatives which could save them money
Company	Corporate information Tender award information Information on restricted suppliers Company information on open gazettes and the stock exchange news service	OpenUp’s open data portal with regularly updated data	Trace – Web application which consolidates corporate information from various sources	Empower the public to hold corporations accountable Enable companies to keep track of their competitors and facilitate fair business practices

Although there are some indications of impact from open data usage, the impact seems confined to few groups of people with specific interest in specific open data. The data science academy makes specialised use of the data, with the students being the beneficiaries of the open data usage. The confined impact essentially includes inciting inquisitive and innovative use of data on critical and relevant social issues. The academy also created a live and interactive dashboard for the City of Cape Town to see where the issues are with the data on their portal. However, there has not been any

discernible indication that any changes are made to take advantage of this feedback loop [18]. Thus, the impact of the projects and services that have open data as an input is at a specialised interest confined level, and far from a national level, or even a subnational level.

Impact from the use of the open data inspired web applications by OpenUp is evidently present, indicated by open data stakeholders expressing appreciation for the influence from usage of information from their web applications [19]. Doctors express appreciation for savings made by their patients, whilst business personnel appreciate the ability to be able to keep track of their competitors. These are positive indications of impact, although the nature of how widespread the impact is cannot be definitively stated.

A relevant indicator of impact, or at least substantive likelihood of eventual impact, is awareness of the existence of open data. Awareness may be seen to indicate the usage of open data, or at least the intention to use it. It would seem though, that awareness of the presence of open data is very low. [18] states that they (at the academy) only got aware of the existence of the data after actively looking for it. A review of the relevant literature (media articles) reveals that most references to open data are for the periods and activities preceding the launch of the City of Cape Town's portal, and the hackathons. There seems to be no follow up articles on the progression of the open data initiatives. It is as if the media articles only serve the purpose of 'hying up' open data milestone events such as portal launches and high-profile hackathons. There are no follow up articles, which would at least maintain the consistency of awareness around open data usage and resultant impact.

## 10 Research and Policy Recommendations

There is evidence of impact from the reviewed open data initiatives. However, it seems confined to specialised groups, and the extent of impact from projects/services resultant from the use of open data is hardly on a subnational scale. A notable indicator of this lack of widespread impact is the minimal awareness of the existence of open data. In this regard, open data suppliers need to make better efforts to publicise the existence of open data. The media articles reviewed seem to focus on the activities preceding milestone open data events such as launches and hackathons. Thus, consistent media coverage of the milestone events and activities relating to open data is encouraged. The data suppliers could champion such a drive. They could possibly achieve this by imploring the media to consistently cover any significant activities resultant from the use of open data, for instance, if applications are developed, how the usage of those applications progresses.

Another notable observation relating to the media coverage of open data events is the absence of links to the open data portals anywhere on online articles. Such links could help publicise the open data portals, and, at the least, increase the likelihood of usage.

## References

1. Verhulst, S., Young, A.: *Open Data in Developing Economies Toward Building an Evidence Base on What Works and How*. African Minds, Stellenbosch (2017)
2. Stuermer, M., Dapp, M.M.: Measuring the promise of open data: development of the impact monitoring framework. In: *Conference for Democracy and Open Government E-Democracy and Open Government (CeDEM)* (2016)
3. Willmers, M., Van Schalwyk, F., Schonwetter, T.: Licensing open data in developing countries: the case of the Kenyan and City of Cape Town open data initiatives. *Afr. J. Inf. Commun.* **16**, 26–37 (2015)
4. City of Cape Town Open Data Draft Policy. Cape Town, SA (2014)
5. OpenUp: About OpenUp (2018). <https://openup.org.za/about.html>
6. OpenUp: OpenUp Open Data Portal (2018). <https://openup.org.za/tools/dataportal.html>
7. Eyal, A.: Open Data Durban (2015). <http://code4sa.org/2015/07/17/open-data-durban.html>
8. World Wide Web Foundation 2016 Open Data Barometer Global Report. Third Edition
9. Open Data for Development Network International Open Data Roadmap: Global Goals, Local Impact. In: Walker, S., Perini, F., (eds.) *International Open Data Conference 2016 Summary Report and the Second Action Plan for International Collaboration* (2016)
10. Manyika, J., Chui, M., Groves, P., Farrell, D., Van Kuiken, S., Almasi Doshi, E.: *Open data: Unlocking innovation and performance with liquid information*: McKinsey (2013)
11. Deloitte: *Market Assessment of Public Sector Information*. Translated by Department for Business Innovation & Skills: Deloitte (2013)
12. Tinholt, D.: *The Open Data Economy Unlocking Economic Value by Opening Government and Public Data*: Capgemini Consulting (2013). <https://www.capgemini.com>
13. Helbig, N., Creswell, A.M., Burk, B.G., Luna-Reyes, L.: *The Dynamics of Opening Government Data*: Center for Technology in Government, University of Albany (2012)
14. Gray, D.E.: *Doing Research in the Real World*, 3rd edn. SAGE Publications, London (2013)
15. Diphoko, W.: *Opinion: Open data can save cities and government* (2018). <https://www.iol.co.za/business-report/opinion/opinion-open-data-can-save-cities-and-governments-12820956>
16. Janssen, M., Charalabidis, Y., Zuiderwijk, A.: Benefits, adoption barriers and Myths of open data and open government. *Inf. Syst. Manage.* **29**(4), 258–268 (2012)
17. Data Science Academy. *Explore Data Science Academy* (2018). <https://www.explore-datascience.net/>
18. Dewald, S.: Interview with Mbongeni Hlabano. Personal interview. Cape Town, 05 September 2018
19. Eyal, A.: Interview with Mbongeni Hlabano. Personal interview. Cape Town, 12 September 2018
20. OpenUp: Data Training (2018). <https://openup.org.za/trainup/>
21. OpenUp: Medicine Price Registry (2018). <https://mpr.code4sa.org/>
22. OpenUp: Trace (2018). <https://openup.org.za/trace>



# Exploring Hybridity in Digital Social Entrepreneurship

Silvia Masiero<sup>(✉)</sup> and M. N. Ravishankar

School of Business and Economics,  
Loughborough University, Loughborough, UK  
{s.masiero,m.n.ravishankar}@lboro.ac.uk

**Abstract.** In this paper we introduce the concept of Digital Social Entrepreneurship (DSE), which refers to the entrepreneurial work of social ventures centred on digital technologies. DSE presents one particular form of hybridity, related to the need to blend digital and non-digital capabilities in the same organisational unit. To understand how such capabilities come together we draw on a qualitative case study of an Indian digital platform providing microloans to vulnerable borrowers. Using concepts from the literature on organisational hybridity, we identify three mechanisms – centred on activity integration, selective framing, and enactment of new operational practices – through which digital and non-digital capabilities are blended in DSE. The paper contributes to the emerging theorisation of the role of the digital in social entrepreneurship and draws implications for it to contribute to tackling global societal challenges.

**Keywords:** Social entrepreneurship · Digital platforms · Hybridity

## 1 Introduction

### 1.1 A Subsection Sample

Over the last 10–15 years, social enterprises have increasingly taken up digitally-enabled business models. Digital platforms are being used to enable services catering to vulnerable groups [1–3] and digitally-enabled jobs are increasingly being outsourced to underprivileged communities, a phenomenon referred to as impact sourcing [4–9]. While diverse, all such experiences apply digital models to social enterprise, placing the digital at the core of the social mission pursued by such ventures. In this paper we introduce the term Digital Social Entrepreneurship (DSE) to refer to the entrepreneurial work of social ventures centred on digital technologies.

The potential of DSE to generate incomes for marginalised communities is highlighted in extant literature [10–12]. Challenges of the DSE model have been examined too, such as the importance of obtaining institutional support from government bodies [9], the need to frame ventures in different ways to different audiences [6], and employees' need to engage in sociocultural transitions from their communities of origin to the workplace [7]. These accounts examine DSE as social-commercial hybrids, seeking a balance among the charity and business logics that they combine [13, 14].

While the social-commercial lens is relevant for DSE, it does not encompass all aspects of hybridity that such ventures entail. Bridging the gap [15] between digital work and the reality of beneficiaries, DSE presents one more form of hybridity, based on the need to combine two skillsets: *digital capabilities*, required to operate and maintain the digital core of the venture, and *non-digital capabilities* related to building direct relations with its users. Similarly to social and commercial aspects in social enterprise, such skillsets need to be blended with each other, however their combination is not sufficiently explored in the emerging literature on DSE. This limits our ability to fully understand this new phenomenon, where hybridity extends to more dimensions than just the social-commercial spectrum. This leads us to ask, how do digital and non-digital capabilities come together in DSE?

We draw theoretically from the literature on hybridity, using the sensitising lens of hybrid organising to frame our problem area. For their liminality between social and commercial identities, social enterprises are at the core of literature on hybrid organising [16, 17], which offers numerous concepts for understanding how disparate identities, organisational forms and institutional logics are blended with each other. This lens is thus seen as appropriate to conceptualise the hybridisation of digital and non-digital capabilities in DSE.

We address the question through a qualitative case study of Rang De, an organisation providing India's first platform for digital microfinance. Using concepts from the literature on organisational hybridity we illustrate three mechanisms through which the combination of such capabilities takes place, adding to the notion of hybridity as blending of social and commercial goals. By doing so the paper seeks to expand emerging theory on the role of digitality in social entrepreneurship, drawing implications for developers of DSE in resource-constrained settings.

## 2 Hybrid Organising

Drawing on insights from different strands of literature, Battilana and Lee [18] view hybridity as combinations of (a) organisational identities, (b) organisational forms, and (c) institutional logics. So defined, hybridity leads to a goal-balancing problem, where objectives of competing natures need to be conciliated. The risk of *mission drift* [19], leading organisations to gradually drift towards one of their identities and lose the other one, may lead non-profit organisations to shift to a for-profit nature, losing their original identity and ability to serve needful recipients [20]. Tackling the goal-balancing problem is seen as important to avoid mission drift and reduce the risk of failure derived from inability to combine different objectives [17].

Our review of the literature on hybrid organising reveals three types of solutions to the goal-balancing problem. One type lies in integrating different activities to create a common organisational identity: Battilana and Dorado [17] argue that hiring and socialisation policies help balance competing goals in commercial microfinance by forming a common identity, which harmonises banking and development logics. Activity integration is seen to help preventing the formation of subgroups in the organisation, contributing to achieve a coherent action path. Mason and Doherty [21]



similarly argue that fair-trade organisations integrate different sets of activities, creating a ‘third identity’ from the combination of existing ones.

A second type of solutions lies in managing the impressions of different stakeholders by selectively framing the hybrid’s identity as socially- or commercially-oriented according to context. A study of work integration social enterprises (WISEs) illustrates how these firms emphasise their social identity when interacting with the public, bracketing their commercial identity to gain acceptance as socially-oriented [22]. Impact sourcing providers similarly adopt techniques to frame their own image [6], as they seek acceptance from prospective clients and local communities at the same time.

Thirdly, goal tensions can be resolved adopting new operational practices [23]. Ebrahim, Battilana and Mair [24] argue that reporting tools in NGOs are designed for multiple stakeholders, seeking to meet the needs of socially and commercially minded audiences. Ramus, Vaccaro and Brusoni [25] show that social enterprises develop novel practices of stakeholder engagement to harmonise social and financial goals.

For their reflection of charity and business identities, social enterprises have been identified as ‘a ready-made laboratory to study a creative variety of hybrid’ [26]. The concepts of activity integration, selective framing, and enactment of new operational practices have informed our investigation of digital and non-digital capabilities in DSE.

### 3 Digital and Non-digital Capabilities in DSE

While still combining a social and a commercial logic, DSE has to combine two more different domains: the digital, meaning work that directly involves digital technologies, and the non-digital, meaning the field-immersion work that DSE needs to do directly with beneficiaries. Extant literature already points to domain discrepancies that DSE actors have to bridge, for example the sociocultural transitions that impact sourcing employees make between their communities of origin and the new digital workplace [7]. In DSE, while one type of work involves digital technologies, another type of work related to field immersion entails very limited involvement of these, and points to the need for staff to engage in direct interaction with served communities.

Recognition of the tension between digital and non-digital work, while important for DSE, is still limited in the literature on the subject. Practice literature speaks about impact sourcing as grounded on a digital basis, framing DSE as preeminently digital rather than resulting from combination of digital and field-immersion work [8, 11]. What is not sufficiently recognised is the presence, in DSE ventures, of different capabilities associated to digital and non-digital domains: digital capabilities pertain to the ability of carrying out digital work, operating through the platforms and technologies that the organisation relies on. Conversely, non-digital capabilities pertain to staff’s ability to engage in direct immersion in the field [17], feeding into the organisation’s capacity to know and serve the needs of the targeted community.

The tension between the two strands of capabilities is motivated by the intrinsic diversity of the tasks they require, balancing responsiveness to beneficiaries with accountability to the wider client/investor audiences reached through the digital means. Nevertheless, while a wide literature is present on the combination of social and

financial goals in social enterprise, limited knowledge is available on the hybridisation of digital and non-digital capabilities, which prevents the formation of a complete understanding of the emerging DSE phenomenon. The question on the ‘hows’ of capability combination is therefore investigated here.

## 4 Research Methods

Our research focuses on Rang De, an Indian organisation providing a platform for delivering microfinance to rural borrowers. We have adopted an interpretive methodology [27] to understand the lived reality of actors and their experience of actions involved in their day-to-day work. Concepts from the literature on hybrid organising served as sensitising lenses throughout the investigation.

### 4.1 Research Setting

Rang De was founded in 2006 by two social entrepreneurs aiming at leveraging technology to reduce the cost of credit to below-poverty-line borrowers. The organisation’s website, which went live in January 2008, consists of an Internet platform for the provision of microloans to vulnerable borrowers around India.

The Rang De website connects social investors to borrowers, crowdsourcing the cost of each loan among multiple investors. The website features a set of borrowers’ profiles, each of which contains the borrower’s demographic data and the type of activity for which the loan is requested. Based on this information, social investors are enabled to choose the borrowers they wish to lend to and lend money through online payment. Borrowers repay on a monthly basis and Rang De pays a monthly fee to intermediaries, retains 2% of the total and pays its social investors an interest of 2% plus the original amount invested.

The platform leverages a set of non-governmental organisations (NGOs) known as ‘impact partners’, which manage the direct relation with borrowers. From its Bangalore office, Rang De works with impact partners in 18 Indian states. These identify potential borrowers, enable them to perform loan applications and maintain the relation with them, whether they operate individually or in self-help groups (SHGs). Constructed as a hybrid of digital and non-digital domains, Rang De constitutes a typical case of DSE.

### 4.2 Data Collection

We conducted four field visits to Rang De after a first introductory meeting that took place in Bangalore in November 2016. Data collected at the Rang De office were integrated with two visits to impact partners in Karnataka (a wastepickers organisation in Bangalore and a social work organisation in rural Mysore) and a meeting with social investors belonging to the Rang De UK chapter in London. During our visits we combined interviews to Rang De staff with impact partners, social investors and borrowers, leading to a total of 48 in-depth interviews as our primary data sources. Numerous informal conversations with the Rang De staff supported interpretation of our interview data.

Primary data were combined with web sources related to Rang De's work. Thousands of borrower profiles are available on the website, along with blog posts and social media reports which were progressively added to our empirical material. Throughout the research we followed the Rang De website and blog updates and the social media accounts of the organisation, to better understand functioning of Rang De's online operations and their significance for the organisation's mission. Our analysis was conducted on the composite corpus constituted by field data and the web sources collected.

### 4.3 Data Analysis

We analysed our data in three different phases. We started by compiling our corpus of data consisting of interviews, observations in the Rang De office and during the field visits, and contents generated on the website and social media. Secondly we analysed this database to identify digital and non-digital capabilities developed at Rang De, and the ways these were combined with each other. To do so, we coded our data to identify a set of theoretical categories describing the main actions undertaken by Rang De staff [28]. Abstracting at a higher level, we found that three of these actions (digital attention-, credibility, and empathy-building) underpinned development of digital capabilities, whereas two more (intermediary and user relationship-building) related to capabilities of a non-digital nature, as reported in the empirical section.

The third phase of the analysis aimed at understanding how the two sets of capabilities come together at Rang De. In doing so we consulted existing literature on hybrid organising, which led us to derive three theoretical categories to represent combination of digital and field immersion capabilities. As illustrated below, categories of 'activity integration' and 'selective framing' illustrate forms of blending of extant capabilities, whereas the category of 'enactment of new operational practices' points to the creation of new composite capabilities.

## 5 Analysis

### 5.1 Digital and Field Immersion Capabilities

Rang De employees engage in a mixture of actions bridging the distinct domains of digital and non-digital work. Actions recorded in our database belong to the five theoretical categories detailed below.

**Digital Attention-Building.** A first challenge for Rang De is that of attracting potential social investors, highlighting the differences between its work and that of other microcredit providers. Attention-building, meaning the activity of attracting social investors, is conducted through digital technologies, comprising social media and the organisation's website. The digital platform is utilised to tell the stories of borrowers' lives, highlighting how loans have generated a positive impact on these. In doing so, digital means emerge as fundamental to attract investors' attention.

**Digital Credibility-Building.** Another challenge concerns the perception of credibility, which is negatively affected by reports of numerous microfinance initiatives that ended up not fulfilling their purposes. Many social investors reveal that at least in the beginning, it was hard for them to distinguish Rang De from the many projects that resulted in misuse of investors' money. In the Rang De model technology is used towards the challenge of building credibility: an active presence on social media is considered by staff as particularly important, as it is oriented to the truthful documentation of changes brought to people's lives by Rang De. By reporting stories of life-changing loans, social media are turned into a tool for credibility-building.

**Digital Empathy-Building.** Staff reveals that the Rang De platform creates an "emotional connection" with the borrower, triggering a purposive mechanism of self-identification. Social investors are preeminently residents of India or members of the global Indian diaspora, and interviews with them reveal their intention to make a change. In-person awareness of poverty in the country often triggers the decision to invest, as exemplified in the words of a social investor:

[...] I do understand, coming from India, I do know like what is really going on there in terms of income levels and things like that and the situation over there. So I was just if I could do something, then I would be more than happy to do it and that's where Rang De gave me the ability to help out people.

As observed by a member of the communications team, Rang De seeks to 'build a bridge between urban and rural India', configuring the platform as the virtual space where social investors can meet their borrowers. For this purpose, the representation of borrowers' struggle leverages the awareness of social investors: there is a specific organisation behind the creation of each borrower's profile, positioning the activity of empathy-building in the digital space.

**Intermediary Relationship-Building.** Rang De's relations with borrowers are mediated by impact partners with direct knowledge of their realities, which are periodically met by the Rang De staff on their fields of operation across India. Impact partners identify borrowers, screen applications and maintain the relations with them as they lead their microbusinesses. These organisations play a critical role of linkage with the borrowers, allowing a relatively small organisation to extend its work to many Indian states. Their proximity to borrowers enables them to monitor repayments and keep track of developments of each borrower's microbusiness, often organised into self-help groups.

**User Relationship-Building.** An important part of staff work are field visits to impact partners, during which staff members from Rang De interact closely with borrowers. This happens in the form of structured interviews that Rang De staff members hold with borrowers, as individuals or in groups: such interviews are, in the first place, appraisals of how the loan money was spent, and of the extent to which the loan has satisfied the borrowers' needs. Rang De therefore integrates the mediation of impact partners with creation of direct relations with borrowers, conducting direct appraisals of their situation. As it emerged in interviews with the staff, being constantly driven by borrowers' specific needs is one of the primary objectives of the organisation, and its ability to

provide financial products that meet the needs of borrowers increases Rang De's appreciation within the social investors' community.

Attention-, credibility- and empathy-building are enacted through digital work, and thus underpin the development of digital capabilities within the organisation. Conversely, actions of intermediary- and user-relationship building are enacted through field immersion, and thus underpin the development of non-digital capabilities. DSE is characterised by the coexistence of the two skillsets.

## 5.2 DSE: Mechanisms of Capability Combination

Coexistence of digital and non-digital capabilities leads to the question on how these are combined. Drawing on the literature on hybrid organising, three types of combination are suggested below. While two of these refer to the blending of existing capabilities, a third one involves the creation of operational practices *ex novo*, requiring staff to develop new capabilities of digital and non-digital natures.

**Activity Integration.** The digital and non-digital types of work that Rang De staff engages are distinct from each other. The former pertains to development and maintenance of digital contents on the Rang De platform, while the latter is about interacting with borrowers and intermediaries in their rural locations. At the same time, some of Rang De's activities do not emerge from a purely digital or field-immersion related skillset, but from the conflation of the two. An example is that of digital attention-building, as illustrated by a member of the communication team:

To attract social investors, we need to create an attractive digital interface. But to offer valid content on such interface, we need to spend long hours in the field: interviewing borrowers, getting to know the people, becoming aware of their struggles. The digital interface has no value if it is not supported by fieldwork with borrowers in rural areas.

During the field visits that we observed in rural Karnataka, members of the impact team conducted interviews and group meetings with borrowers, in order to transpose contents on the platform when back in the Bangalore office. Several borrowers' interviews are made accessible as videos, to give a clear image of the impact that loans have generated on borrower's lives. Credibility- and empathy-building follow a similar process: creation of trust relies on usage of real images and videos, collected during field visits and made available online. As another staff member points out, even the generation of empathy is grounded on content from the field:

Emotional connection [with social investors] come from content that is powerful, taken straight from the field. This triggers a sort of self-identification of the social investor with the borrower.

All these instances see Rang De staff combining digital and field immersion capabilities by using what Battilana and Lee [18] refer to as *activity integration*. To function properly, hybrids need to integrate different identities in the same activities: for example, social enterprises need to integrate their social and commercial objectives, to create a common identity and be recognised as having one. In a similar way, DSE needs to engage in activities that integrate digital and non-digital capabilities: attention-, credibility and empathy-building are constructed as digital, but are only effective if integrated

with field immersion capabilities. So conceived, activity integration is the first way in which digital and non-digital capabilities are combined.

**Selective Framing.** The literature suggests that some hybrids solve their intrinsic tensions by framing themselves as socially- or commercially-oriented, depending on the context of the interaction and on their interlocutors. In approaching users and intermediaries on the field, Rang De staff members are found to bracket their digital skillset, emphasising instead the field immersion capabilities that characterise their work. As it emerges from the words of a member of the impact team,

[With borrowers] we do not talk about our digital job. We talk about loans, how they are using them, what they have gained from them, and how the self-help groups can make them work better. In fact there is no digital work when we are on the field, very often we are isolated and completely disconnected from the Internet for many days.

During field visits Rang De staff is immersed in the life condition of borrowers: interviews take place in private or public village spaces and very little remains of the digital identity that the organisation projects with its social investors. This resonates in the fact that, in the discussions that take place with borrowers, Rang De's operators do not refer to the digital aspect of the organisation, but only discuss the loans made, the ways these are managed by the individuals and SHGs, and any issues they may have encountered with loan management and repayments. The same holds for intermediaries, whose representatives are met in remote areas and villages and interactions with whom do not contemplate the digital aspects of the work. In meetings with NGOs, Rang De just presents themselves as microfinance operators, as highlighted by a member of the impact team:

[With field staff] we only discuss borrowing and lending, not what we do on the platform. For them we are a microfinance organisation (...) we teach field staff and borrowers to manage loans and keep an eye open on other organisations, which sometimes charge very high interest rates to the poor.

When interfacing with users and borrowers, Rang De does not resort to integration of digital and non-digital activities, but selects the most useful aspects to present itself to a particular audience. This echoes Sandeep and Ravishankar's [6] argument that impact sourcing ventures frame themselves differently to the different audiences they speak to, adopting different identities when facing clients and local communities. DSE similarly selects particular aspects of its identity to speak to particular audiences, making selective framing another way in which digital and non-digital are combined.

**Enactment of New Operational Practices.** So far we have interpreted 'capability combination' as blending digital and non-digital capabilities that already exist in the organisation. But hybrid organisations also seek to solve goal-balancing problems by enacting new operational practices, which were not present at the onset of their work. Ramus and Vaccaro [34] show that WISEs have introduced social accounting as a new instrument to balance different institutional logics, reporting to recipients and commercial audiences at the same time. A similar argument lies behind Rang De's creation of new tools, requiring operational practices that merge the digital with the non-digital.

This emerges from Rang De's latest project, known as *Swabhimaan* (meaning self-respect in several Indian languages) and recently piloted in a village of rural Karnataka.

The project is based on the installation of digital kiosks equipped with *bioscopes* in villages, enabling potential borrowers to follow a financial literacy module and, at the end of it, take a test of basic financial literacy. People who pass the test are enabled to apply for a loan without the mediation of impact partners, bypassing the self-help group structure as explained by a Rang De developer:

The (SHG) model works great in getting people, especially women, to come together but we are not blind to its problems (...) there is a coercive element to the loans being made through SHGs. What we are trying to achieve with Rang De Swabhimaan is to allow individuals to seek loans at low interest rates. The money will directly be transferred to their bank accounts.

Self-help groups are normally organised among borrowers, however the impossibility of doing so in some particular contexts currently limits the ability of Rang De to cater to India as a whole. While the Swabhimaan kiosks is digital, it is supported by dedicated staff based in the village: they impart key notions of financial literacy to borrowers, assist them as they take the test through the bioscope, and act as a first point of contact as they start their microbusinesses. By creating a new digital tool, Rang De coins new operational practices that combine novel digital and field-immersion capabilities, which were not present in the organisation when it started its work.

While the categories of ‘activity integration’ and ‘selective framing’ illustrate how existing capabilities are blended, the category of ‘enactment of new operational practices’ refers to creation of new composite capabilities through Swabhimaan. We submit that these categories provide an exploratory conceptualisation of a new form of hybridity, characterised by the combination of digital and non-digital capabilities and adding to the social-commercial liminality that is intrinsic to social enterprise.

## 6 Discussion

Our analysis illustrates a dimension of hybridity that contributes to theorising the emerging phenomenon of DSE. Through our study of the combination of digital and non-digital capabilities at Rang De, at least three implications are drawn for theory and practice on this novel phenomenon in resource-constrained settings.

First, the data structure presented here illustrates that field-immersion work still plays a role of major importance in DSE. Heeks’ [15] argument on design-reality gaps as a cause for failure in ICT4D projects resonates here: a substantial component of Rang De’s positive outcomes is predicated on field immersion, which bypasses the digital aspect and directly appraises the rural reality of borrowers. Existing works on impact sourcing [6, 7] resonate with this point, highlighting the importance of non-digital capabilities such as image framing and management of sociocultural transitions for employees. This leads to argue that in emerging models of DSE the digital does not substitute the non-digital, but acts in multiple combinations with it.

Second, hybridity of digital and non-digital is present even in those capabilities that apparently manifest just one of the two aspects. Digital attention-, credibility-, and empathy-building at Rang De would not be possible without the field immersion work on which they are based, which enables the provision of persuasive content for social investors accessing the platform. When building relations with users and

intermediaries, Rang De employees present themselves through the organisation's non-digital aspects, but then proceed to convert the content of such interactions (e.g. borrower interviews) into digital form to increase investors' awareness. Framed in this light, DSE does not simply constitute an example of digital innovation, but emerges as a form of organisational innovation that combines existing capabilities, while also creating new ones through the Swabhimaan experience of digital financial literacy.

Finally, Rang De belongs to a type of initiatives aimed at reducing the cost of lending to the poor, which is one of the core problems of microfinance organisations [23]. This leads DSE research to intersect with the emerging domain of financial technology ('fintech') for development, showing how a hybrid of digital and non-digital capabilities may constitute one way for such 'fintechs' to operate in developing country contexts. As attention of ICT4D increasingly turns to fintech, the argument highlighting the development potential of these technologies is criticised in terms of their ability to serve the needs of lower-income groups, with may bring perverse implications for the power distribution between lender and borrower [30]. Future research is needed on whether hybrid models, combining a digital core with strong capabilities of field immersion, may contribute to reconciling such discrepancies.

## 7 Conclusion

Emerging research on digital models of social entrepreneurship, conducted here through the qualitative case study of Rang De, needs clear contextualisation in ICT4D. The field's recent turn towards issues of ethics, power and justice [31, 32] requires examination of the socioeconomic impact of such business models, and of the power structures that come into play in their design and implementation. This paper has offered an exploratory study of DSE in context, adopting the lens of hybrid organising to understand its combination of digital and non-digital capabilities. Building on the themes emerging in this study, further research is needed on the positioning of DSE in the global digital economy [30], its ability to enable fair conditions for employees and recipients [33], and more at large its effects on the entitlements and wider livelihoods of the communities that these models seek to benefit.

## References

1. Cui, M., Pan, S.L., Newell, S., Cui, L.: Strategy, resource orchestration and e-commerce enabled social innovation in Rural China. *J. Strateg. Inf. Syst.* **26**(1), 3–21 (2017)
2. Jha, S.K., Pinsonneault, A., Dubé, L.: The evolution of an ICT platform-enabled ecosystem for poverty alleviation: the case of eKutir. *MIS Q.* **40**(2), 431–445 (2016)
3. Heeks, R.: Information technology impact sourcing. *Commun. ACM* **56**(12), 22–25 (2013)
4. Madon, S., Sharanappa, S.: Social IT outsourcing and development: theorising the linkage. *Inf. Syst. J.* **23**(5), 381–399 (2013)
5. Sandeep, M.S., Ravishankar, M.N.: Social innovations in outsourcing: an empirical investigation of impact sourcing companies in India. *J. Strateg. Inf. Syst.* **24**(4), 270–288 (2015)




6. Sandeep, M.S., Ravishankar, M.N.: Impact sourcing ventures and local communities: a frame alignment perspective. *Inf. Syst. J.* **26**(2), 127–155 (2016)
7. Sandeep, M.S., Ravishankar, M.N.: Sociocultural transitions and developmental impacts in the digital economy of impact sourcing. *Inf. Syst. J.* **28**(3), 563–586 (2018)
8. NASSCOM: Next generation outsourcing: opportunities through impact sourcing. Working paper, NASSCOM foundation 2014 (2014)
9. Madon, S., Ranjini, C.R.: Impact sourcing in India: trends and implications. *Inf. Syst. J.* (2018, in press)
10. Heeks, R., Arun, S.: Social outsourcing as a development tool: the impact of outsourcing IT services to women's social enterprises in Kerala. *J. Int. Dev.* **22**(4), 441–454 (2010)
11. World Bank: Digital Dividends. World Development Report, Washington DC (2016)
12. Carmel, E., Lacity, M.C., Doty, A.: The impact of impact sourcing: framing a research agenda. In: Hirschheim, R., Heinzl, A., Dibbern, J. (eds.) *Socially Responsible Outsourcing*, pp. 16–47. Palgrave Macmillan, London (2016). [https://doi.org/10.1007/978-3-662-43820-6\\_16](https://doi.org/10.1007/978-3-662-43820-6_16)
13. Malik, F., Nicholson, B.: Interplay of competing institutional logics: the case of socially sustainable global outsourcing. In: *Academy of Management Proceedings*. Academy of Management, Briarcliff Manor (2015)
14. Masiero, S., Ravishankar, M.N.: Digital social entrepreneurship: balancing social and commercial goals in an Indian 'fintech' organisation. In: *Proceedings of the 34th EGOS Colloquium*, Tallinn, Estonia (2018)
15. Heeks, R.: Information systems and developing countries: failure, success, and local improvisations. *Inf. Soc.* **18**(2), 101–112 (2002)
16. Battilana, J., Lee, M., Walker, J., Dorsey, C.: In search of the hybrid ideal. *Stanford Soc. Innov. Rev.* **10**(3), 50–55 (2012)
17. Battilana, J., Dorado, S.: Building sustainable hybrid organizations: the case of commercial microfinance organizations. *Acad. Manag. J.* **53**(6), 1419–1440 (2010)
18. Battilana, J., Lee, M.: Advancing research on hybrid organizing—insights from the study of social enterprises. *Acad. Manag. Ann.* **8**(1), 397–441 (2014)
19. Mersland, R., Strøm, R.Ø.: Microfinance mission drift? *World Dev.* **38**(1), 28–36 (2010)
20. Ramus, T., Vaccaro, A.: Stakeholders matter: how social enterprises address mission drift. *J. Bus. Ethics* **143**(2), 307–322 (2017)
21. Mason, C., Doherty, B.: A fair trade-off? Paradoxes in the governance of fair-trade social enterprises. *J. Bus. Ethics* **136**(3), 451–469 (2016)
22. Pache, A.C., Santos, F.: Inside the hybrid organization: selective coupling as a response to competing institutional logics. *Acad. Manag. J.* **56**(4), 972–1001 (2013)
23. Kannothra, C.G., Manning, S., Haigh, N.: How hybrids manage growth and social–business tensions in global supply chains: the case of impact sourcing. *J. Bus. Ethics* **148**(2), 271–290 (2018)
24. Ebrahim, A., Battilana, J., Mair, J.: The governance of social enterprises: mission drift and accountability challenges in hybrid organizations. *Res. Organ. Behav.* **34**, 81–100 (2014)
25. Ramus, T., Vaccaro, A., Brusoni, S.: Institutional complexity in turbulent times: formalization, collaboration, and the emergence of blended logics. *Acad. Manag. J.* **60**(4), 1253–1284 (2017)
26. Billis, D. (ed.): *Hybrid Organizations and the Third Sector: Challenges for Practice, Theory and Policy*. Macmillan International Higher Education, London (2010)
27. Walsham, G.: Doing interpretive research. *Eur. J. Inf. Syst.* **15**(3), 320–330 (2006)
28. Strauss, A., Corbin, J.M.: *Basics of Qualitative Research: Grounded Theory Procedures and Techniques*. Sage Publications Inc., Thousand Oaks (1990)

29. Malik, F., Nicholson, B., Morgan, S.: Assessing the social development potential of impact sourcing. In: Nicholson, B., Babin, R., Lacity, M.C. (eds.) *Socially Responsible Outsourcing*, pp. 97–118. Palgrave Macmillan, London (2016). [https://doi.org/10.1007/978-1-137-55729-2\\_6](https://doi.org/10.1007/978-1-137-55729-2_6)
30. Gabor, D., Brooks, S.: The digital revolution in financial inclusion: international development in the fintech era. *New Polit. Econ.* **22**(4), 423–436 (2017)
31. Dearden, A.: (2012). See no evil? Ethics in an interventionist ICTD. In: *Proceedings of the Fifth International Conference on Information and Communication Technologies and Development*, pp. 46–55 (2012)
32. Heeks, R., Renken, J.: Data justice for development: what would it mean? *Inf. Dev.* **34**(1), 90–102 (2018)
33. Graham, M.: A fair work foundation. Oxford Internet Institute. <https://www.oii.ox.ac.uk/publications/fairwork.pdf>



# What Motivates ICT4D Champions?

Jaco Renken<sup>(✉)</sup> 

University of Manchester, Manchester M13 9PL, UK  
jaco.renken@manchester.ac.uk

**Abstract.** The paper seeks to identify the factors that motivate a person who champions ICT4D initiatives. Given the important contributions of ICT4D champions to initiative success, better understanding of their motivations holds the potential to identify, develop and deploy such individuals more effectively, harnessing their potential positive contributions to ICT4D initiative success. A multiple case study strategy is used to explore the motivational factors of three successful ICT4D champions in the South African context. The Work Preference Inventory (WPI) of personal motivations was used to design in-depth interviews with the champions and semi-structured interviews with 29 other stakeholders. It found ICT4D champions are motivated by the need for personal actualization, business success and to address social concerns – origins of these motives could be traced to various internal and environmental stimuli. Practical implications drawn from the research are that profiling of stakeholder motivations in an ICT4D initiative is feasible and that organizations can use such information to create a conducive environment for grooming and empower new and existing champions to function more effectively. This first investigation of ICT4D champion motivations shows its importance and the potential thereof towards improving initiative success and emphasizes the need for further research of this nature.

**Keywords:** ICT4D projects · ICT4D success · Work motivation

## 1 Introduction

Champions of information and communication technologies for development (ICT4D) are critical to initiative success; they are, “*individuals who make decisive contributions to ICT4D initiatives by actively and enthusiastically promoting their progress through critical stages in order to mobilise resources and/or active support and cooperation from all stakeholders*” [1:129]. More than two-thirds of ICT4D initiatives fail completely or partially [2–5]; the importance of champions is amongst often-recurring reasons for ICT4D initiative failure [6–10]. Better understanding these critical actors, it is reasoned, may contribute to the improvement of initiative success rates. To paraphrase the words of Schön [11:84], “*Where ICT4D innovation is concerned, the presence of an ICT4D champion is required ... the new ICT4D initiative either finds a champion or dies*”.

The paper explores champion motivations by seeking to answer the following research question: *what are the factors that motivate a person who champions ICT4D initiatives?* This is an important question for three reasons. Firstly, leadership and

organizational studies literature offer a breadth of evidence of the causality between an individual's motivation and their behavior, such as leadership, in the organization [12]. Understanding the motivational factors of champions is therefore a promising line of enquiry because it might assist ICT4D practitioners to more effectively identify, develop, deploy and support such individuals.

Secondly, organizational environments can be crafted towards being more conducive to higher levels of employee engagement, including leadership behavior [13]. Better understanding the motives of successful champions is therefore needed in order to inform organizations what such conducive environments should look like. To this end, 'greenhouse' or 'incubator' services in organizations has been recommended [14]. Yet many questions remain about effectively identifying or developing champions, for example: what profiling tools would be most effective to identify potential champions, or, what factors in the organizational environment are most conducive to the emergence and development of champions [15]? These questions can be answered, in part, by gaining insight into the motivational factors of ICT4D champions.

Thirdly, on a more general level, literature about the effective identification of champions are scarce and studies that explicitly explore this aspect are divergent in their findings [16]. This paper therefore responds to explicit calls for more research into the champion identities and motivations [15, 16]. In so doing it aims to contribute knowledge deemed necessary to improve the success of ICT4D initiatives.

The paper is structured in familiar order, starting with literature foundations, then methodology, findings, discussion and conclusions.

## 2 Literature and Conceptual Foundations

Work motivation can be defined as "*the process by which behavior is energized, directed, and sustained in organizational settings*" [12:970]. The study of personal motivation in the workplace has a long and rich history [13]. This history shows the evolution in understanding personal motivations vis-a-viz the organization. Early conceptions revolved around *intrinsic* factors postulating that a person's workplace behavior stems from internal factors, such as a belief system, personal needs, values and aspirations. This view implies motivation to champion ICT4D initiatives is derived from within and that organizations cannot create a favorable environment to develop such individuals or encourage their emergence.

Fortunately, understanding of motivations in the workplace broadened to recognize the importance of *extrinsic* factors. This view postulates that a person's motivation is shaped by pressures, stimulants, incentives and constraints emanating from the organizational environment and larger social context. It follows that organizations can proactively shape those motivations. Because motivations shape behavior, organizations, such as those conducting ICT4D projects, can stimulate desirable behaviors, such as leadership and championing, by creating conducive environments [17].

Today, reasonable consensus exists that a person's motivation in the workplace can best be understood by combining multiple perspectives: intrinsic and extrinsic theories should be considered together, and even more perspectives, such as the role of self-concept, can be added [18]. However, the exact nature of interaction and causality

between these perspectives are still debated [12]. The important conclusion to draw is that an individual’s behavior in the organization stems from internal motivations and motivation-shaping factors in the work environment, such as the organization’s aims, work practices, culture and values. It therefore stands to reason that research on the motivations of key ICT4D actors – including champions – has practical potential to stimulate behavior that would be conducive to positive development outcomes.

However, it is beyond the scope of this paper to engage with these debates; the approach taken to explore ICT4D champion motivations will rather be pragmatic. The interest in ICT4D champion motivations is driven by the objective to explore ‘the factors that influence their behavior when promoting ICT4D innovations’ or, differently phrased, their ‘centroids of motivation’. The first step towards incorporating motivational factors in ICT4D practice could be to understand the motives of successful champions and how those motives played out in the organizational setting; this research aspires to make such a contribution.

The Work Preference Inventory (WPI) of personal motivations offers a set of motivational factor measures to assess peoples’ work motivation [19]; it is a set of motivational factors based on underpinning personal trait and social behavior theories, mainly Self-Monitoring Theory [20] and Self-Perception Theory [21].

**Table 1.** Customized Work Preference Index of motivational factors

Motivational factors	
1. To create my own job	13. To have financial autonomy
2. To develop an idea	14. To gain more flexibility in my personal life
3. To do things your way	15. Warm work relations
4. Personal growth	16. To fulfil a dream
5. To exploit a business opportunity	17. To contribute to the welfare of the community
6. To have an interesting job	18. To earn a lot of money
7. Personal self-realization	19. Social status and prestige
8. To be your own boss	20. Family tradition
9. A desire to be independent	21. To follow the example of someone admired
10. To cover my personal needs	22. To be accepted socially
11. To have economic security	23. Work frustration
12. To overcome a challenge	24. To succeed with the initiative

*Source: Adapted from Barba-Sánchez and Atienza-Sahuquillo [22]*

If the championing of an ICT4D initiative can be considered work – which is the position taken in this paper –, then the WPI has the potential to guide the exploration of their motivations for doing it. Within the stream of research that subsequently developed from the initial WPI, the work of Barba-Sánchez and Atienza-Sahuquillo [22] is of particular interest: they modified the WPI to investigate the motivations of entrepreneurs for starting new businesses. This progression is seen as relevant because similarities between champions and entrepreneurs are widely acknowledged in the literature [23–26]. It is for this reason that the customized 24-scale WPI will be used to explore the motivational factors of ICT4D champions (Table 1).

### 3 Methodology

A case study strategy was followed because it does not require control over behavioral events, it does not have generalization as primary purpose, and it can be used for exploratory, descriptive and explanatory purposes [27]. This was particularly appropriate to explore the intrinsic motivating factors of ICT4D champions, as well as the motivation-stimuli from the organizational and wider environment. Multiple cases were deemed fitting to explore the phenomenon of interest; on the one hand, it could illuminate how champions differ, and on the other, provide an opportunity to identify any converging aspects that might be distinctive of ICT4D champion motivations.

For reasons raised earlier, much care was taken to select champions for inclusion in the study. Drawing on best practices from the champion literature (e.g. [28]), a two-part process was followed: peer nomination and verification. Four program managers and research staff at a South African parastatal organization, where access for the research has been obtained, were interviewed. Their involvement in multiple ICT4D initiatives over extensive periods of time placed them ideally to point out champion-type individuals from the range of projects. They were asked to nominate individuals that resembled the profile of the ICT4D champion definition introduced earlier; nine nominations were received. Next, the champion identification process aimed at verifying that the nominees were indeed ICT4D champions. Practically, this involved discussing nominations in more detail with the managers, meeting and interviewing the nominees themselves, and where possible observing the nominees in their work environment. Three candidates were selected for inclusion as cases.

The customized 24-scale WPI was used for designing in-depth champion interviews and semi-structured interviews with 29 key stakeholders in the three initiatives (Case 1: 10; Case 2: 8; Case 3: 11). Qualitative data was analyzed following the six phased approach to thematic analysis forwarded by Braun and Clark [29].

The Table 1 factors were used to code and analyze the interview data for each champion. Starting analysis with the champion interviews, it explored the reasons why they do the things related to the ICT4D initiatives that they do; their self-reported motivations were of interest. In seeking to triangulate from different data sources, the next step was to explore other stakeholder interview data identifying what, in their opinion, motivates the champion; and then to search for any alignment or misalignment that may emerge. A profile of the factors that motivate the ICT4D champions could then be compiled by evaluating the weight of evidence (frequency and triangulation); this could subsequently be interpreted and described in the anonymized case studies, introduced next.

## 4 Three ICT4D Champions in South Africa

### 4.1 Case 1: Mandisa

Mandisa grew up in The Village and is now in her early thirties. The Broadband Access Initiative (BAI) was launched in the region as part of a government-backed, digital inclusion initiative. She pursued an opportunity to become a BAI village operator. This

involvement brought together her ICT passion and a desire to improve the social conditions in The Village community. She became an ICT4D champion.

Table 2 presents a synthesis of the findings for Mandisa’s case. From this summary it can be observed that Mandisa’s own account of what motivates her largely corresponds with those of other stakeholders; they are aligned, perhaps because she is effective in communicating her intentions to others, but more importantly, they can be considered as validated by this triangulation.

**Table 2.** Case one – champion motivators

Motivational category	Motivational factor	Identifying stakeholders
<i>Personal actualisation</i>	Personal self-realisation	A1; A4; A5; A8; Self
	To have financial autonomy	A2; A4; A7; Self
	Personal growth	A2; A5; Self
	To create her own job	A2; Self
	A desire to be independent	A2; Self
	To be her own boss	A2
<i>Business success</i>	To exploit a business opportunity	A3; A7; Self
	Warm work relations	A6
	To succeed with the initiative	A4, A5
<i>Social concern</i>	To contribute to the welfare of the community	A1; A2; A3; A4; A5; A6; A8; A9; A10; Self
	To overcome a challenge	Self
	To follow the example of someone admired	Self

The identified motivational factors were grouped, as illustrated in Table 2, into three motivational categories: personal actualization, business success and social concern. All Mandisa’s actions can in some way be traced back to these three pillars or centroids of motivation. Responding to a question about her motivation for becoming involved in the BAI, Mandisa explained, “... *they (the parastatal organization that started the BAI) wanted to develop young people to small entrepreneurs. So, that gave me the positive mind to where I could express myself, have my own business and grow myself to a better person, of having one computer and typing business profiles for my father. Doing CVs for my community and also to be helping them on how to use the Internet ...*”. This extract illustrates how all three motivational pillars were in play when she decided to become involved in the BAI: there is an element of personal realization and growth; a clear business aspiration is present; and her social concern for the upliftment of the community is evident.

One stakeholder’s explanation of what motivates Mandisa also reveals these three pillars: “*Deep down I think she is a person who is not necessarily thinking of herself, as much as she thinks of herself going up (growing and developing as a person) in terms of expanding her knowledge, at the same time she is also thinking about the benefit and*

*the impact she can make to her community. So, it's like the person who is: 'I am here for myself and my community'. If I can go up, I can go together with my community ... At the end of the day she would like to be a successful business woman, that's what I think.*" (Interview A5). His explanation is congruent with Mandisa's own account as well as with those of other stakeholders. Having identified these motivating pillars for an ICT4D champion is already helpful as a lens for interpreting actions, but the data affords an opportunity to extend the analysis one step further.

What factors led to the development of these motivators? Firstly, the socio-economic environment and cultural context in The Village is characterized by widespread poverty, unemployment, substance abuse and crime, on the one hand, and the prevalence of a rather vibrant civic culture – community members caring for and looking after each other – on the other hand. Mandisa lives within this reality and takes part in it. It can therefore be argued that this potentially influenced her identity and motivation; particularly her concern for the welfare of the community. Secondly, her upbringing has, most likely, shaped her motivations, particularly the influence of her grandfather and her dad who are important role models for Mandisa. They inspired her in three areas in particular: work ethic, financial and business acumen, and deep concern for the welfare of others. Finally, Mandisa had been on the receiving end of community care during her childhood; her dad needed to work away from home and spent lots of time on his business, they relied on the community to assist with Mandisa's childcare. This civic-mindedness left a deep impression on Mandisa who is now keen to reciprocate.

## 4.2 Case 2: Kagiso

Kagiso is a social entrepreneur in his early thirties. For many years he attempted to address the digital divide by finding ways to reduce the cost of telecommunications and expanding access to previously disadvantaged communities in the peri-urban settlements of a large South African city. Following a financial breakthrough resulting from meeting a suitable business partner, the Wireless Connectivity Initiative (WCI) was launched in The Township. He became an ICT4D champion.

Table 3 presents the motivators that were extracted from Kagiso's interview data as well as qualitative data from other WCI stakeholder interviews. Similar to the first case study, motivating factors were synthesized into three categories: personal actualization, business success and social concern. The ICT4D champion's actions can be explained from the perspective of these 'centroids of motivation'. Consider Kagiso's account to starting WCI: *"I had to think what is it that I am going to do in terms of coming up with a business that is firstly going to sustain me, my livelihood and the next thing is it obviously has to transcend to my family and you know those are the main things. I mean coming from a background where you have seen the challenges especially when it comes to poverty and some of the social challenges that people have within the black community – I mean it was basically to say alright fine let me start looking at myself ... what can I do?"* Note how all three motivational pillars were in play when he decided to champion the ICT4D initiatives in The Township.

Kagiso's own account largely corresponds with those of other stakeholders. One exception to this – pertaining to money and wealth – is worth pointing out. A few



stakeholders identified ‘*To earn a lot of money*’ (interviews B1, B6, B9) as a motivating factor, which is contrary to Kagiso’s own account only indicating ‘*To cover my personal needs*’ as a factor. One possible explanation would be that, as the CEO of the WCI, Kagiso is seen as the driving force behind growing the organization’s profitability; his personal motivation is therefore equated with the profit motive of WCI. However, considering Kagiso’s decisions and actions throughout the early years of the initiative, another explanation is revealed; that he is indeed concerned about making money, but only as a means of sustaining himself and his family, not necessarily the pursuit of personal riches. For example, consider the following account from Kagiso, “... *am not driving a Ferrari, I still have those headaches where I have got a six-month-old son, you know he runs out of milk and I have to think where I am going to scrounge around for him you know because all the money that comes in goes back into this thing (WCI).*” This reveals some sense of prioritization – in terms of finances, putting money back into WCI is a higher priority than personal enrichment.

**Table 3.** Case two – champion motivators

Motivational category	Motivational factor	Identifying stakeholders
<i>Personal actualisation</i>	To earn a lot of money	B1, B6, B9
	Social status and prestige	B1, B6
	To do things my/their way	B6
	To cover my/their personal needs	Self
	To be my/their own boss	B1
	To fulfil a dream	Self
	Personal growth	B2
<i>Business success</i>	To succeed with the initiative	B2, B9, B10 + Self
	To exploit a business opportunity	B1, B5 + Self
<i>Social concern</i>	To contribute to the welfare of the community	B1, B2, B6, B9, B11 + Self
	To overcome a challenge	B1, B2, B11 + Self

Three aspects could be identified as potential sources of Kagiso’s motivation. Firstly, he grew up during the Apartheid era and, as a black person, experienced the negative impacts of forced racial segregation – he is deeply motivated by this to correct the evils of the past by leveling the playing field, most notably through widening access to ICTs. Secondly, his father is his business mentor and role model – it is his dad who kindled Kagiso’s interest in business and a sense of social responsibility towards the community. Finally, Kagiso was raised in a rather poor household and consequently places a high priority on providing sufficiently for his family. In sum, both the influence of people and wider environmental factors fundamentally shaped his motives for championing the ICT4D initiative today.

### 4.3 Case 3: Sarah

Sarah, in her late fifties, was an mathematics teacher for more than 20 years. The rise of social media awakened a passion for the potential of ICT to improve the failing education system and gave her the capability to share good practices. She quickly became influential in the SA teaching community where she built online communities of practice for maths teachers and became an ICT4D champion promoting the use of technology-enabled means to improve the struggling education system. This profile led to her involvement in the Tablet Teaching Initiative (TTI) in The District where she made a decisive contribution to the success thereof.

**Table 4.** Case three – champion motivators

Motivational category	Motivational factor	Identifying stakeholders
<i>Personal actualisation</i>	Personal self-realization	C2, C3, C4, C5, C6, C7, C8, C10, C11, C12, +Self
	To be my own boss	C4, C5, C6
	Personal growth	C6, C10, C11
	To fulfil a dream	C3, C7
	To create my own job	C2
	To have financial autonomy	C4
<i>Business success</i>	To exploit a business opportunity	C2, C4
	To succeed with the initiative	C6, C7
<i>Social concern</i>	To contribute to the welfare of the community	C2, C3, C4, C5, C8, C10, C11, C12, +Self

Table 4 presents a synthesis of the findings from analyzing interview data from Sarah herself and other TTI stakeholders that she nominated as key collaborators. The identified motivational factors were grouped, as in the other cases, into three motivational categories, which can be perceived as ‘centroids of motivation’ influencing Sarah’s actions as an ICT4D champion. Consider, for example, Sarah’s own explanation: “*what motivates me is to love the people around me and help them be the best people they are because then I can be the best person I am.*” It is clear that two of the motivational pillars – personal actualization and social concern – stand out as key reference points for Sarah in guiding her life decisions generally, but also in her role as ICT4D champion in TTI. Furthermore, the sheer weight of evidence shows that she is transparent about her intentions and motivations – stakeholders almost unanimously pointed to both these aspects, for example, “*(it is) her passion for moving the education system (that motivates her). [Sarah] – what drives her – it is not something material; it is not a name on a certificate; it’s not an interview with a journalist; it’s not money, huge project bonus, no, no. It is some sense of achievement within her*” (interview C6). The dominance of these two motivational pillars is validated by this triangulation and the importance of intrinsic motivation, as opposed to extrinsic motivation, is notable.

While business success, the third motivational pillar, is not as prominent compared to the other two pillars, traces of its prevalence can be observed throughout the data. Other stakeholders, such as the TTI programme manager, recognized a business perspective along with the personal actualization and social concern as part of her motivation, *“I think she wants to make a difference. I think she really enjoys doing this kind of thing (referring to the TTI). She loves technology; she is a kind of technology evangelist; social media evangelist; education evangelist and I think from a kind of business level obviously this is where she wants to see herself moving into the future as well.”* (interview C2). The interaction between business interests, on the one hand, and a genuine concern for the community and a desire for personal actualization, on the other, was evident.

Three factors in particular led to the development of these motivators. Firstly, Sarah is a Christian – all stakeholders, without exception, pointed to her faith and belief system as the source of her motivation that provide impetus for her champion behavior. Secondly, Sarah cited the importance of a secondary school teacher who deeply inspired her future career decisions, specifically becoming a mathematics teacher. Finally, the poor education system resulting from the history of racial segregation in South Africa and the opportunities afforded by emerging ICTs were environmental push- and pull-factors that impelled her to become a successful ICT4D champion.

## 5 Discussion

All three motivational pillars were found relevant in all three cases, but the pillars were not always equally important; it appeared as if champions prioritized the motivating pillars differently. Figure 1 attempts to illustrate this sense of prioritization of motivating factors. These priorities were deduced from interview data based on triangulation between the champions’s own reports and those of other stakeholders, as well as between different stakeholders. The results show differences between the three champions in terms of the relative importance of each motivational pillar – ICT4D champion motivations differ from one individual to the next; assuming homogeneity of characteristics in this regard is therefore flawed.

While the relative importance given to the different motivational pillars is clear from Fig. 1, the interaction and balance between the motivational pillars for each champion is less visible. It was observed how the champions balance these sometimes conflicting motives. For example, Kagiso launched WCI in The Township, which is a community some distance away from his own, because of the better business prospects to succeed in that setting; in so doing he had to compromise on his social concern for uplifting his home community. This ongoing prioritization, compromising and balancing between the different motivational pillars, could be observed in all three cases. It can even be suggested that this balancing skill – aligning their internal identities with the external requirements of successful performance – could be one basis for a champion’s success.

Two practical implications can be drawn from the findings. Firstly, the congruence between the champions’ own accounts of their motivations and those of other stakeholders suggest the practical feasibility to *profile* stakeholder motivations. The

leadership development literature then shows, for example, how the emergence of more leaders and improved leadership behavior can be encouraged through targeted interventions in the organizational environment based on motivational profiles [17]. For instance, potential champions<sup>1</sup> could thus be identified for development through targeted training (e.g. communication, leadership, entrepreneurship), mentoring and job role design conducive to both their motivational aspirations and the organizational goals.

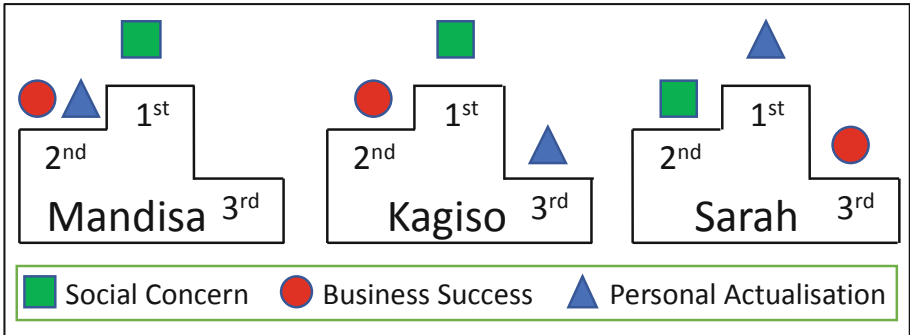


Fig. 1. Combined results for ICT4D champion motivation analysis

Secondly, motives of ICT4D champions in the three cases could be seen to *align* significantly with the organizational goals, values and aspirations. Sarah, for example, agreed to participate in the TTI because she could identify with the social objective to empower teachers in remote, rural areas with technology and skills to improve the educational offering to the poorest of the poor. The business prospects of earning an income from the consulting work can be seen to aligned with her business motive and the freedom to meaningfully influence the project with her own ideas created adequate room for self-actualization. These findings suggest that ICT4D organizations might create favorable environments for champions to emerge by framing their objectives, values and approaches in terms of the social concerns they seek to address, the business success that could be derived and the opportunities for stakeholders to actualize their aspirations. Involving potential champions in identifying projects, setting goals and long-term strategic planning are practical suggestions organizations could implement to help shape motivations and create better alignment between the individual’s and organizational aspirations.

Similar interventions, based on work motivations, have in the past been proposed and is an integral part of organizational change and development models today [12]. It is therefore suggested that such practices be incorporated in ICT4D initiatives, particularly given the potential thereof to encourage the emergence of champion behavior which could ultimately contribute to improved ICT4D initiative success.

<sup>1</sup> Such profiling was used by the BAI for Mandisa’s initial recruitment.

## 6 Conclusion

The paper makes two main contributions. Firstly, it offers a knowledge contribution about the characteristics of ICT4D champions by answering the research question concerning their personal identities, specifically by explicating the motivating factors that influence a person's behavior who champion ICT4D initiatives. This finding is summarized as follows: ICT4D champion motivations – the factors that influence their decisions when promoting ICT4D innovations – center around three pillars: personal actualization, business success and social concern. On the one hand, these motivations are inextricably linked to the champions' social context. On the other hand, they respond to their context by continually balancing these pillars in their decisions in order to succeed with the initiative. While all three pillars are important, a sense of prioritization is often given to addressing social concerns – this might be a characteristic that differentiates them from other champions of technological innovations [30].

Secondly, a contribution towards ICT4D practice is forwarded. Based on the evidence presented it is proposed that the motivational profile of stakeholders in an ICT4D initiative can quite easily and accurately be obtained; this will enable project managers to identify potential champions and create an organizational environment conducive to champion emergence. Furthermore, a better understanding of the motivational factors of champions will enable managers to better support these key stakeholders thereby maximizing the potential positive influence on project success.

It is acknowledged that this research does not provide much details for implementing the practical suggestions, but this was not the aim at the outset of the paper; further work is needed to translate these recommendations into practice. This work is also bound by its limited scope to three cases in a single context; future research could extend these findings by investigating the motivational factors of ICT4D initiatives much more broadly.

## References

1. Renken, J.C., Heeks, R.B.: Conceptualising ICT4D project champions. In: The Sixth International ICTD Conference, Cape Town, South Africa, pp. 1–4 (2013)
2. Masiero, S.: The origins of failure: seeking the causes of design–reality gaps. *Inf. Technol. Dev.* **22**, 1–16 (2016)
3. Dodson, L.L., Sterling, S.R., Bennett, J.K.: Considering failure: eight years of ITID research. In: ICTD 2012, Atlanta, GA, USA (2012)
4. Heeks, R.B.: Information systems and developing countries: failure, success, and local improvisations. *Inf. Soc.* **18**(2), 101–112 (2002)
5. Heeks, R.B.: Most E-government-for-Development Projects Fail: How Can Risks Be Reduced? Institute for Development Policy and Management, Manchester (2003)
6. Diaz Andrade, A., Urquhart, C.: The value of extended networks: social capital in an ICT intervention in rural Peru. *Inf. Technol. Dev.* **15**(2), 108–132 (2009)
7. Hosman, L.: Policies, partnerships, and pragmatism: lessons from an ICT-in-education project in rural Uganda. *Inf. Technol. Int. Dev.* **6**(1), 48–64 (2010)
8. Yonazi, J.: Exploring facilitators and challenges facing ICT4D in Tanzania. In: Proceedings of the 11th European Conference on E-government, pp. 578–588 (2011)

9. Thapa, D.: The role of ICT actors and networks in development: the case study of a wireless project in Nepal. *Electron. J. Inf. Syst. Dev. Ctries.* **49**, 1–6 (2011)
10. Pitula, K., Radhakrishnan, T.: On eliciting requirements from end-users in the ICT4D domain. *Requirements Eng.* **16**(4), 323–351 (2011)
11. Schön, D.A.: Champions for radical new inventions. *Harvard Bus. Rev.* **41**(2), 77–86 (1963)
12. Leonard, N.H., Beauvais, L.L., Scholl, R.W.: Work motivation: the incorporation of self-concept-based processes. *Hum. Relat.* **52**(8), 969–998 (1999)
13. Latham, G.P.: *Work Motivation: History, Theory, Research, and Practice*, 2nd edn. Sage, Thousand Oaks (2012)
14. Beath, C.M.: Supporting the information technology champion. *MIS Q.* **15**(3), 355–372 (1991)
15. Renken, J.C., Heeks, R.B.: Champions of information system innovations: thematic analysis and future research agenda. In: UK Academy for Information Systems (UKAIS) International Conference, Oxford, UK (2014)
16. Renken, J.C., Heeks, R.B.: A conceptual framework of ICT4D champion origins. In: 14<sup>th</sup> International Conference on Social Implications of Computers in Developing Countries (IFIP WG 9.4), Yogyakarta, Indonesia (2017)
17. Barbuto Jr., J.E.: Motivation and transactional, charismatic, and transformational leadership: a test of antecedents. *J. Leadersh. Organ. Stud.* **11**(4), 26–40 (2005)
18. Steel, P., König, C.J.: Integrating theories of motivation. *Acad. Manag. Rev.* **31**(4), 889–913 (2006)
19. Amabile, T.M., Hill, K.G., Hennessey, B.A., Tighe, E.M.: The work preference inventory: assessing intrinsic and extrinsic motivational orientations. *J. Pers. Soc. Psychol.* **66**, 950–967 (1994)
20. Snyder, M.: Self-monitoring processes. In: Berkowitz, L. (ed.) *Advances in Experimental Social Psychology*. Academic Press, San Diego (1979)
21. Bem, D.K.: Self-perception theory. In: Berkowitz, L. (ed.) *Advances in Experimental Social Psychology*. Academic Press, San Diego (1972)
22. Barba-Sánchez, V., Atienza-Sahuquillo, C.: Entrepreneurial behavior: impact of motivation factors on decision to create a new venture. *Investigaciones Europeas de Dirección y Economía de la Empresa* **18**(02), 132–138 (2012)
23. Maidique, M.A.: Entrepreneurs, champions, and technological innovation. *Sloan Manag. Rev.* **21**(2), 59–76 (1980)
24. Shane, S.A.: Are champions different from non-champions? *J. Bus. Ventur.* **9**(5), 397–421 (1994)
25. Coakes, E., Smith, P.: Developing communities of innovation by identifying innovation champions. *Learn. Organ.* **14**(1), 74–85 (2007)
26. Hendy, J., Barlow, J.: The role of the organizational champion in achieving health system change. *Soc. Sci. Med.* **74**(3), 348–355 (2012)
27. Yin, R.K.: *Case Study Research: Design and Methods*, 5th edn. Sage Publications, Thousand Oaks (2015)
28. Howell, J.M., Higgins, C.A.: Champions of technological innovation. *Adm. Sci. Q.* **35**(2), 317–341 (1990)
29. Braun, V., Clarke, V.: Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**(2), 77–101 (2006)
30. Renken, J.C., Heeks, R.B.: Champions of IS innovations. In: *Communications of the Association for Information Systems* (2019, in press)



# Digital Platforms in the Global South: Foundations and Research Agenda

Kari Koskinen<sup>1</sup>, Carla Bonina<sup>2</sup>(✉), and Ben Eaton<sup>2</sup>

<sup>1</sup> Department of Management, London School of Economics and Political Science, Houghton Street, London, UK

k.m.koskinen@lse.ac.uk

<sup>2</sup> Surrey Business School, University of Surrey, Guildford, UK  
{c.bonina, b.eaton}@surrey.ac.uk

**Abstract.** Digital platforms have become integral to many of the everyday activities that people across the globe encounter in areas like transportation, commerce and social interactions. Research on the topic has largely concentrated on the general functioning of these platforms in terms of platform governance, business strategies and consumer behaviour. Despite their significant presence in the global South, the developmental implications of digital platforms remain largely understudied. In part, this is because digital platforms are a challenging research object due to their lack of conceptual definition, their spread across different regions and industries, and their intertwined nature with institutions, actors and digital technologies. The aim of this paper is therefore twofold: to provide a conceptual definition of digital platforms, and to identify research strands in international development contexts. To do so, we draw from digital platforms literature, differentiate between transaction and innovation platforms and expose their main characteristics. We the present four strands in the form of research questions, illustrated with concrete examples, that can assist to pursue relevant studies on digital platforms and international development in the future.

**Keywords:** Digital platforms · Development · Global South · Research agenda · Information systems

## 1 Introduction

Digital platforms hold a central position in the business plans of some of the biggest companies of today, such as Facebook, Google, Alibaba and Apple. A survey conducted in 2015 identified 176 platform companies in the world, with an estimated global market capitalisation of 4.3tn USD - larger than Germany's gross domestic product [16]. The same study revealed that publicly traded platforms alone gave direct

---

We gratefully acknowledge funding from the UK ESRC Development Implications of Digital Economies (DIODE) research network to conduct part of this work. We also benefited from useful comments from Richard Heeks, the members of the DIODE network and the participants at the Development Studies Association Conference at the University of Manchester in June 2018.

© IFIP International Federation for Information Processing 2019

Published by Springer Nature Switzerland AG 2019

P. Nielsen and H. C. Kimaro (Eds.): ICT4D 2019, IFIP AICT 551, pp. 319–330, 2019.

[https://doi.org/10.1007/978-3-030-18400-1\\_26](https://doi.org/10.1007/978-3-030-18400-1_26)

employment to around 1.3 million people. Even though many of these platforms have their origins in the global North, they are becoming important also to the people in the global South due to increased access to devices and connectivity in these regions. Overall, digital platforms occupy more significant roles in areas like employment opportunities, social networking and innovation activities, which are all moving online in growing quantities. In addition, more companies in the global South have built digital platforms of their own, which at first targeted local markets but have also expanded to other areas of the globe [7, 17].

No doubt that, given these figures, digital platforms have the potential to generate social and economic value in the global South, yet their developmental impacts are not entirely understood. Practitioners and scholars acknowledge their significance for the societies in the global South [7, 28, 32, 35], but it is less obvious how digital platforms should be studied from a developmental perspective. Part of the problem is the lack of clarity regarding the understanding of what a digital platform is and how they should be conceptualised. In addition, digital platforms are a challenging research object as they spread across different regions, disrupt industries, and are intertwined with surrounding institutions, markets and digital technologies [9].

This paper seeks firstly to contribute to the studies of digital innovation and international development [32] by providing a conceptual definition of digital platforms to scope their study. Second, we argue that digital platforms are likely to have both positive and negative impacts to the people and societies in the global South. The paper therefore suggests four research strands, potential theoretical angles and methods to provide digital economy and international development scholars a starting point for analysis and understanding of the developmental role of digital platforms in their respective contexts.

## 2 Defining Digital Platforms

Overall, most digital platforms can be seen as sharing three basic characteristics: they are technologically mediated, enable interaction between user groups, and allow those user groups to do particular things [6, 9, 16, 27]. Traditionally the definition of digital platforms has also depended on the field under which they have been studied. Within economics, the discussion has evolved more around the demand and supply functions within these platforms and how they differ from other types of market settings [15]. In studies concentrating on their technological components, the focus has been on their technological and digital characteristics such as layered architecture and modularity [40]. More generally, attention has been given for example to the socio-technical dimensions of digital platforms such as their impact on organisational structures or international standards [9]. Digital platforms themselves differ on characteristics such as market capitalisation, sector or industry they are situated in, governance model, country of origin and geographical reach [17], all of which might alter the ways a particular platform operates and the target segments it sets to cater.

Irrespective of this, for any type of research on digital platforms it is important to understand what type of platforms one is studying. Gawer [20] and Evans and Gawer [16] classify platforms according to their principal purpose and identify roughly three different types of digital platforms: transaction platforms, innovation platforms and integration platforms.



## 2.1 Types of Platforms: Transaction, Innovation and Integration

**Transaction Platforms.** Much research on digital platforms has concentrated around transaction platforms, which are sometimes referred to as multi-sided markets or exchange platforms. Their main purpose is to facilitate transactions between different organisations, entities and individuals, such as connecting buyers with sellers, drivers with passengers, composers with music companies, and so on. Transaction platforms can be especially useful in reducing transaction costs by allowing different agents to find each other more easily, and to overall reduce some of the frictions in the transaction process [16].

Transaction platforms make it possible to exchange digital services and can be divided according to their principal purpose. Common transaction digital platforms are found in social media (e.g. Facebook), e-commerce (Mercado Libre), the ‘gig’ economy platforms (Upwork), or those built around the notion of the sharing economy (Airbnb). These platforms are often studied from the viewpoint of economics as their management is related to areas like pricing and contractual factors. The core value created relies on the presence of network effects, whether direct or indirect. Direct network effects, in simple terms, refer to the fact that a network (or platform) becomes more valuable to each member as more users join [20]. Examples of these would M-Pesa and WhatsApp, since every new member joining creates value for the others as there are more users to interact with. Indirect network effects are to some extent similar to direct ones but refer instead to the value created as a result of increasing number of users in groups that are complementary to each other. That is, the decision to join a platform from the point of view of a member belonging to a given user group (e.g. sellers) depends on the amount of users in a given complementary group (e.g. buyers) [24]. Depending on the principle purpose of the platform, users are attracted to the platform by the number of available cleaners in the case of Domestly, work opportunities (Upwork), and drivers (Uber), and the same applies the other way around for people or companies looking to hire cleaners, provide employment or look for passengers.

Although network effects are among the most important features of transaction platforms, they provide a rather stable view of digital platforms and may easily miss other important research areas such as how platforms evolve over time. In addition, the focus on network effects often simplifies platform users to mere consumers and tends to view transactions generally as buyer-seller situations, where in reality, the relationships between platform users can be more varied [13, 14].

**Innovation Platforms.** Innovation platforms are formed of technological building blocks that provide a basis for developing services and products. A typical example of an innovation platform is mobile operating system Android, which enables third party developers to build applications on top of the operating system [16]. Innovation platforms provide third party developers their own set of tools and resources that developers then combine and use in ways to enable new applications for commercial or other type of use.

Some of the notions put forward by the economic perspective do not quite fit innovation platforms; the economic perspective, it is argued, does not take into account

design related factors and their implications to incentivise innovation [20]. As a result, studies on innovation platforms have often adopted an engineering, information systems or product management perspective. Their emphasis has often been on the technological architectures that enable innovation, in addition to the design and production aspects of these platforms as well as on the role of interfaces in the interaction between the platform and the third party complementors [2, 12, 37, 39].

The focus on digital innovation platforms is to understand how the relationship between the core (platform) and the periphery (the third party developers or complementors) is structured, what kinds of resources are being provided for the complementors, and what the usage of those resources implies [2]. In addition to enabling creation of innovations, innovation platforms also pose constraints for the complementors. For a platform owner, the issue is one of balancing between these two, as the platform owner needs to provide the complementors the necessary resources for them to build services on top, while at the same time controlling the platform and keeping it as stable as possible [22]. The relation between the core and the developers may also differ from one country to another for instance in terms of monetisation [5].

**Integration Platforms.** Integration platforms combine aspects of the two principal platform types – that is, transaction and innovation platforms [16]. It could be argued that any digital transaction platform requires an innovation platform beneath it, since as the name implies, transaction platforms are always built on a particular platform such as Android, Linux, Windows or something else. The key points of transaction and innovation platforms also apply to integration platforms, and therefore are not discussed in this study.

**Table 1.** Key characteristics of innovation and transaction platforms.

Type of digital platform	Transaction	Innovation
Purpose	Matches users or user groups, the value for a user increases with the number of users in a user group	An extensible codebase as a core that enables the adding of third-party modules that complement the core
Key target groups	Participants to a transaction	Application developers
Key governance issues	Attracting users from the relevant groups (indirect/direct)	Relationship between developers and platform owners
Theories	Multi-sided markets, indirect and direct network effects	Boundary resources, platform openness, platform ecosystem
Developmental questions	Income/job opportunities, filling institutional voids, removal of market frictions	Creation of app economies, development of tools (apps) to solve local challenges
Examples	MPesa, Whatsapp, Skype, Airbnb, Mercado Libre, Uber	Apple iOS, Linux, Android, SAP

Table 1 lists the key characteristics of the two types of digital platforms. Currently, a vast majority of digital platforms with the potential to generate societal impacts in developing countries are transaction platforms. However, as noted above, these transaction platforms have a technological basis that in some cases also offers tools to create complementary services and therefore holding characteristics of an innovation platform. A typical example would be Facebook, and its division Facebook for Developers. Therefore, we argue it is important to be aware of the key factors that underlie the functioning of innovation platforms as well. Furthermore, as the technologies needed for the creation of applications are reaching people in developing countries at an increasing pace, the importance of innovation platforms, and with that their societal impact, is likely to increase.

No matter the type of digital platform, in a research regarding platforms it is important to unfold how digital platforms are connected to other socio-technical dimensions, such as actors, institutions and entities. In this sense researchers need to be aware of platforms being part of ecosystems, which are crucial for making the platform function and ultimately to become successful.

## 2.2 Digital Platforms and Their Ecosystems

Innovation and transaction platforms are rarely isolated. As a result, mere definitions provide a basis for studying digital platforms but stop short in describing how platforms may or may not help in contributing to developmental factors, such as inclusion or equality in access. The latter requires taking a context-sensitive approach that extends beyond their mere technological constructs and organisational effects. De Reuver and colleagues [9] echo this claim and point out that “*the platform debate should also seek to address the broader issue of how digital platform innovation directly relates to issues of societal and global interest*” (p. 132).

Both innovation and transaction platforms tend to be linked to other platforms, organisations, regulators and other different types of entities and actors, and have implications to all of those in addition to their users. Together these form entire ecosystems, in which different parts of the ecosystem are in constant interaction and overall can capture a multitude of social, political and technological factors, agents and attributes. An example of a digital innovation platform ecosystem can be seen in the so-called “app economies”, with actors at its core creating and maintaining a platform and an app marketplace, plus small and large companies that produce apps that platform” [30]. As a consequence, an app economy offers a good example of both technological as well as business-driven aspects and their largely social dimensions built into them. More importantly, the notion of ecosystem questions where to draw digital platform boundaries. In part, this is why research on digital platforms is a complex undertaking. One has to be able to carve out the key actors and dimensions of the platform under study, whether they are included directly, or nevertheless affected by the phenomena under study.

### 3 Research Priorities on Digital Platforms and Development

Given their growing importance in the Global South, we build in this section what we think may be four important areas for future work on the subject. As a general rule, digital platforms are seen particularly useful in removing market frictions [15], which exist in abundance in many developing countries for example due to insufficient information, weak institutions and poor infrastructure [11]. As a result, digital platforms hold promise especially in the context of global South in solving different societal and developmental challenges. The impacts of digital platforms may come in various forms, some of which may be positive and others negative [10], and may work only to amplify existing developing conditions [38]. For example, as certain parts of transactions are hidden in a give digital platform, On a more macro level, there is also a danger of unfair distribution of resources and work between the global South and North, resonating with the arguments made by dependency theorists such as Frank [18].

Below we provide four research areas in the form of questions that we consider relevant for future research on the domain. We believe that each would enable us in different ways to have a better understanding of digital platforms operating in the global South.

#### 3.1 How to Release the Developmental Potential of Innovation Platforms?

One of the key characteristics of innovation platforms is to act as the foundation upon which other firms can build complementary products, services or technologies [21]. A relevant case to study the developmental potential of innovation platforms is presented in the realm of open government data - data released by governments in digital format, publicly available for anyone to use. New digital social innovation ventures based on open data promise to contribute to global development goals, such as economic growth, job creation, social and economic inclusion and access to public services such as healthcare. Whilst open government data implementations may have been referred to as platforms, there has been little research from a platform perspective. This is curious when, actually, a lot of what is happening in the field of open data is about growing and nurturing an ecosystem of third party innovators, which can capitalise on the datasets of an open data platform to provide services to citizens or the government itself. In this context, Bonina and Eaton [3] draw on boundary resource theory to study how to cultivate a vibrant ecosystem of open data innovators in Latin America. Using empirical data the authors compare and analyse three open government data initiatives in the cities of Buenos Aires, Mexico City and Montevideo to identify how platform innovation governance evolves over time. The outcome of the analysis proposes a theoretical model which describes a set of tools and rules open data platform authorities can use to stimulate, support and grow both data suppliers and data re-users with an innovation focus. This is an example on how theoretical strands from innovation platforms could be applicable to an international development context.

Another angle to study innovation platforms in the global South is to look at the particular affordances they offer. Affordances have been defined in slightly different ways, but in principle affordances are the acts and functions an artefact affords to its

users [19, 23, 33]. In relation to digital platforms, affordances provide a tool to analyse the impacts digital platforms have in terms of development. In general, the affordance lens places emphasis on how platforms are designed and developed; it asks questions such as what it allows its users to do and similarly, what kinds of actions it prevents. Usage of affordances in the study of platforms and development can be illustrated through the example of the Ugandan marketplace application Kudu [34]. Kudu enables farmers selling their harvest to connect with buyers and it uses simple SMSs to function. Despite this, the backend technology of Kudu is quite developed as it relies on specifically designed matching algorithms that connect the buyers and sellers (i.e. the matching is done by the application itself instead of the buyers and sellers themselves). What Kudu affords to the sellers is better access to the buyers while also providing certain protection for them of having a fair price. Similarly, it enables the buyers to connect with sellers that might otherwise be hard to reach. As a whole, the affordances Kudu provides enable the removal of market frictions and while doing so replacement of old or even creation of new institutional settings [1, 36].

### **3.2 How Do Digital Platforms in the Global South Differ from the Ones in the Global North and What Are Their Institutional Implications?**

Due to the socio-technical nature of digital platforms, the surrounding contextual factors are likely to impact the ways digital platforms are designed and the way they operate in different locations. The global South often faces challenges in areas like weaker infrastructure, institutions and also the local customs that vary when moving from one culture or society to another. As a result, digital platforms operating in the global South require certain adaptations or can be quite different in relation to their purpose, design or operation. One example of this can be seen in Facebook's drive to make its platform more usable in low bandwidth areas [4, 26], but also the types of platforms that are being developed often differ considerably from those that are being targeted for users in the global North as can be seen in the above mentioned agricultural market place application Kudu [34].

Seen through institutions, digital platforms can be challenging the prevailing institutional logics and replacing them; alternatively, they may set the basis for creating institutions in societal areas where there have not necessarily been any, which is claimed to often happen in a developing country context and referred to as institutional voids [29]. In the process of replacing existing institutions digital platforms may de-institutionalise current norms and practices and put in place their own. The users of digital platforms become therefore exposed to new ways of performing particular practices, and if those are accepted by users, the institutional characteristics offered by the platforms become the new norm and get institutionalised into the surrounding society. Especially in relation to weak institutions and institutional voids, digital platforms and the affordances they hold can form a basis for building institutions. Institutions often display themselves through relevant agents, making agent-focused research relevant also under this particular research area.

The institutionalisation of new norms and forms of practices can have both negative and positive impacts for developing countries as a whole. In order to better understand it, it is important to study how digital platforms in the global South differ from the ones

in the global North by mapping the key differences between them. From there one can adopt the institutional lens and investigate the impacts of the institutional settings that digital platforms are putting in place. This will enable researchers to also assess whether platforms originating in the global South are better positioned to take into account the contextual and institutional factors in their targeted locations and as a result, provide more positive developmental impacts to local communities and agents.

An example of the work on digital platforms and institutions can be seen in Go-Jek, which is an Indonesian ride-hailing app that started off by providing motorcycle taxi services in the form of passenger rides as well as food and package delivery. It has then expanded to other business areas, for example by launching its own payment system. What made Go-Jek particularly successful in comparison to the alike Uber was its usage of motorcycle taxis. In places like Jakarta that suffer from traffic congestion, motorcycles are a much faster method of transportation than cars. Go-Jek also provides employment to the motorcycle taxi drivers, and although many of them were motorcycle taxi drivers already before, they see that they have more work now and spend less time idle, seeing their incomes increasing. Go-Jek also gave loans to drivers so that they could buy a smartphone and provided assistance for drivers who lacked paperwork to register as a legal Go-Jek driver. By growing fast and employing hundreds of thousands of drivers and serving millions of users Go-Jek also had the political capital that helped it when a ban on ride-hailing transport apps was declared; leading to the ban being overturned only 12 h later. Overall, Go-Jek has to some extent institutionalised the ways motorcycle taxi services are used via an app, changing the existing landscape. At the same time, worries exist of the type of work that Go-Jek and other similar services provide, often providing little working protection if any [8, 31].

### 3.3 Do Transaction Platforms Exacerbate Inequalities?

The majority of biggest digital platforms operating in the global South are transaction platforms, which have the capability of shaping local institutional settings in various ways, both positive and negative. From a developmental perspective, the question that follows is whether the positives outweigh the negatives, and if not what can be done to rectify the situation. One clear research area on the developmental impacts of these transaction platforms is the issue of whether those actually diminish or exacerbate inequalities between different users and agents, be those connected to the platform or otherwise indirectly affected by the platform's existence.

For example, Heeks [25] has noted that online labour platforms have had positive impacts in developing countries in terms of employment opportunities, inclusion, objectivity, reasonable earnings, career development, flexibility and in reducing travel as well as environmental costs. Regarding opportunities and inclusion, platforms enable transfer of employment opportunities from global North to global South and at the same time help to remove some of the institutional barriers that may inhibit certain groups such as women from accessing work opportunities. Similarly, online labour platforms tend to be more objective as traditional cues like disability, accent or age are not necessarily present in an online environment. On average, online labour also pays better than many traditional jobs, allows workers to update their skills and progress in their careers, and enables flexibility regarding time and location. The latter also cuts

down travel, and with that, environmental costs. At the same time, online labour may also have negative impacts such as low levels of stability, limited or often non-existent social protection. Sometimes the type of work that labour platforms offer is repetitive and even to some extent harmful. In a similar manner, even some of the positive impacts are debatable as the flexibility in working hours may in some cases mean working late at night. Career development is neither guaranteed and can also be practically non-existent.

As this example shows, it is entirely possible for a platform to have both negative and positive impacts. In some cases the impact from a particular area like career development is likely to depend on the research perspective, for example is the issue studied from the perspective of the person doing the job or the overall situation that prevailed before the online platform in question was created.

In terms of inequalities, the key questions that are to be answered revolve around factors that are needed to participate in the platform and with that, who or which agents are able to do so. If understood from the perspective of frictions, transaction platforms are seen capable of removing many of those, but at the same time it is also necessary to understand if they actually also put some other frictions in place. Furthermore, not all frictions are automatically bad, and the removal of some of those may also entail negative consequences for particular agents or user groups. Finally, it is vital to have a holistic view on what are the reasons that make certain agents excluded from using the platform and others included.

### **3.4 What Are the Digital Platform Alternatives?**

All of the biggest transaction platforms and many of the innovation platforms are governed by private companies. However, digital platforms also offer public institutions and co-operatives a tool to drive their objectives. In such cases the main objective for the platforms is not necessarily profit-making. That may have a role in terms of the purposes of the platforms and also in the way the platforms have been designed, but it may not be the dominant logic. As a result, important research areas on the developmental impacts of digital platforms may inquire into what alternatives exist to the privately run digital platforms, and what kinds of implications that may have in terms of the platforms' impacts. Furthermore, digital platforms that have alternative governance models may not necessarily have to be strictly public, private or community-owned, but can also take the form of hybrids where several ownership types are present.

These platforms can also take a slightly different approach in terms of their offerings. Already many governmental institutions via the form of open data, but also some private ones (e.g. Uber Movement) are providing data for third party developers that can then be used for research purposes but also for building applications on top of these data sources. These kinds of data platforms fall under the innovation platform category, yet their objectives and overall functioning might differ quite a bit from the likes of Apple's iOS or Android. By being possibly primarily motivated by reasons other than profit and having more social goals built into them, these types of alternative digital platforms may also be more capable of delivering developmental results. Whether this actually occurs or not and what is their general impact, is a matter that requires further research.

## 4 Conclusion

In this work, we set out to provide a typology of digital platforms that could help to bring more clarity and to equip researchers to investigate the developmental implications of digital platforms. We outline four particular research strands that share the objective of uncovering the effects and developmental implications that digital platforms may have in developing country contexts. Of course, the strands we propose are by no means exhaustive. We suggest that understanding the developmental impact of digital platforms will benefit from an interdisciplinary view on the matter. We hope this foundational work can inspire both scholars and practitioners to move our understanding of both the benefits and costs that digital platforms can offer for international development. We hope a broader engagement with this increasingly important phenomenon can guide future interventions, including the need for regulation, the provision of fairer rules or the generation of new institutions in the world of digital platforms.

## References

1. Avgerou, C.: *Information Systems and Global Diversity*. Oxford University Press, Oxford, New York (2002)
2. Baldwin, C.Y., Woodard, C.J.: The architecture of platforms: a unified view. In: Gawer, A. (ed.) *Platforms, Markets and Innovation*. Edward Elgar, Cheltenham (2009)
3. Bonina, C., Eaton, B.: The governance of third party innovation in open government data platforms: evidence from Buenos Aires, Mexico City and Montevideo. In: *Academy of Management Global Proceedings*, vol. Surrey (2018)
4. Cabral, B.K., Kandrot, E.: The Technology Behind Preview Photos (2015). <https://code.fb.com/uncategorized/the-technology-behind-preview-photos/>. Accessed 29 June 2018
5. Caribou Digital: *Winners and Losers in the Global App Economy*. Caribou Digital Publishing, Farnham, Surrey, United Kingdom (2016). <http://cariboudigital.net/winners-and-losers-in-the-global-app-economy/>
6. Constantinides, P., Henfridsson, O., Parker, G.G.: Introduction-platforms and infrastructures in the digital age. *Inf. Syst. Res.* **29**(2), 381–400 (2018)
7. David-West, O., Evans, P.: *The Rise of African Platforms: A Regional Survey (The Emerging Platform Economy Series No. 2)* (2015)
8. Davis, J.: Digital Lessons from Go-Jek, Indonesia's Answer to Uber and Grab (2018). <https://knowledge.insead.edu/entrepreneurship/digital-lessons-from-go-jek-indonesias-answer-to-uber-and-grab-8871>. Accessed 30 June 2018
9. de Reuver, M., Sørensen, C., Basole, R.C.: The digital platform: a research agenda. *J. Inf. Technol.* **33**(2), 124–135 (2018)
10. Donner, J.: A Vision of Digital Development in 2028 (2018). <https://medium.com/caribou-digital/a-vision-of-digital-development-in-2028-43c8ff3c69e>. Accessed 13 May 2018
11. Drouillard, M.: Addressing voids: how digital start-ups in Kenya create market infrastructure. In: Ndemo, B., Weiss, T. (eds.) *Digital Kenya*. Palgrave Macmillan, London (2017). [https://doi.org/10.1057/978-1-137-57878-5\\_4](https://doi.org/10.1057/978-1-137-57878-5_4)
12. Eaton, B., Elaluf-Calderwood, S., Sørensen, C., Yoo, Y.: Distributed tuning of boundary resources: the case of Apple's iOS service system. *MIS Q.* **39**(1), 217–243 (2015)



13. Eisenmann, T., Parker, G., Alstyne, M.V.: *Opening Platforms: How, When and Why?* (SSRN Scholarly Paper No. ID 1264012). Social Science Research Network, Rochester, NY (2008)
14. Eisenmann, T., Parker, G., Alstyne, M.V.: Platform envelopment. *Strateg. Manag. J.* **32**(12), 1270–1285 (2011)
15. Evans, D.S., Schmalensee, R.: *Matchmakers: The New Economics of Multisided Platforms*. Harvard Business Review Press, Boston (2016)
16. Evans, P., Gawer, A.: *The Rise of the Platform Enterprise: A Global Survey* (The Emerging Platform Economy Series No. 1). The Center for Global Enterprise (2016)
17. Evans, P.: *The Rise of Asian Platforms: A Regional Survey* (The Emerging Platform Economy Series No. 3). The Center for Global Enterprise (2016)
18. Frank, A.G.: *Capitalism and Underdevelopment in Latin America*. NYU Press, New York (1967)
19. Gaver, W.W.: Technology affordances. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, pp. 79–84 (1991)
20. Gawer, A.: Bridging differing perspectives on technological platforms: toward an integrative framework. *Res. Policy* **43**(7), 1239–1249 (2014)
21. Gawer, A. (ed.): *Platforms, Markets and Innovation*. Edward Elgar Publishing, Cheltenham (2009)
22. Ghazawneh, A., Henfridsson, O.: Balancing platform control and external contribution in third-party development: the boundary resources model. *Inf. Syst. J.* **23**(2), 173–192 (2013)
23. Gibson, J.J.: The theory of affordances. In: Shaw, R., Bransford, J. (eds.) *Perceiving, Acting, and Knowing*, pp. 67–82. Lawrence Erlbaum Associates, New York (1977)
24. Hagi, A., Wright, J.: Multi-sided platforms. *Int. J. Ind. Organ.* **43**, 162–174 (2015)
25. Heeks, R.: *Decent Work and the Digital Gig Economy: A Developing Country Perspective on Employment Impacts and Standards in Online Outsourcing, Crowdwork, etc.* (Development Informatics, Working Paper Series) (2017)
26. Jackson, J.: *How Facebook Made Mobile Site Faster for Users with Limited Bandwidth* (2015). <https://www.computerworld.com/article/2960779/social-media/how-facebook-made-mobile-site-faster-for-users-with-limited-bandwidth.html>. Accessed 29 June 2018
27. Jacobides, M., Cennamo, C., Gawer, A.: Towards a theory of ecosystems. *Strateg. Manag. J.* **39**(8), 2255–2276 (2018)
28. Karippacheril, T.G., Nikayin, F., De Reuver, M., Bouwman, H.: Serving the poor: multisided mobile service platforms, openness, competition, collaboration and the struggle for leadership. *Telecommun. Policy* **37**(1), 24–34 (2013)
29. Khanna, T., Palepu, K.G.: *Winning in Emerging Markets: A Road Map for Strategy and Execution*. Harvard Business Review Press, Boston (2010)
30. Mandel, M.: *Where the Jobs Are: The App Economy* (2012). <http://www.technet.org/wp-content/uploads/2012/02/TechNet-App-Economy-Jobs-Study.pdf>
31. Nastiti, A.: *Drivers' stories reveal how exploitation occurs in Gojek, Grab and Uber* (2017). <http://theconversation.com/drivers-stories-reveal-how-exploitation-occurs-in-gojek-grab-and-uber-82689>. Accessed 30 June 2018
32. Nielsen, P.: Digital innovation: a research agenda for information systems research in developing countries. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017*. IAICT, vol. 504, pp. 269–279. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_23](https://doi.org/10.1007/978-3-319-59111-7_23)
33. Norman, D.A.: Affordance, conventions, and design. *Interactions* **6**(3), 38–43 (1999)
34. Ssekibuule, R., Quinn, J.A., Leyton-Brown, K.: A mobile market for agricultural trade in Uganda. In: *Proceedings of the 4th Annual Symposium on Computing for Development*, pp. 1–10. ACM, New York (2013)

35. Swaans, K., Boogaard, B., Bendapudi, R., Taye, H., Hendrickx, S., Klerkx, L.: Operationalizing inclusive innovation: lessons from innovation platforms in livestock value chains in India and Mozambique. *Innov. Dev.* **4**(2), 239–257 (2014)
36. Thornton, P.H., Ocasio, W.: Institutional logics and the historical contingency of power in organizations: executive succession in the higher education publishing industry, 1958–1990. *Am. J. Sociol.* **105**(3), 801–843 (1999)
37. Tiwana, A., Konsynski, B., Bush, A.A.: Platform evolution: coevolution of platform architecture, governance, and environmental dynamics. *Inf. Syst. Res.* **21**(4), 675–687 (2010)
38. Toyama, K.: Technology as amplifier in international development. In: *Proceedings of the 2011 iConference*, pp. 75–82. ACM, New York (2011)
39. Yoo, Y., Boland, R.J.J., Lyytinen, K., Majchrzak, A.: Organizing for innovation in the digitized world. *Organ. Sci.* **23**(5), 1398–1408 (2012)
40. Yoo, Y., Henfridsson, O., Lyytinen, K.: Research commentary. The new organizing logic of digital innovation: an agenda for information systems research. *Inf. Syst. Res.* **21**(4), 724–735 (2010)



# Scaling Across Functional Domains: A Case of Implementing an Electronic HIV Patient Information System in Sierra Leone

Eric Adu-Gyamfi<sup>1</sup>(✉), Petter Nielsen<sup>1</sup>, Johan Ivar Sæbø<sup>1</sup>,  
and Zeferino Saugene<sup>2</sup>

<sup>1</sup> Department of Informatics, University of Oslo, Ole Johan Dahls hus,  
Gaustadalléen 23 B, 0373 Oslo, Norway

{ericad, pnielsen, johansa}@ifi.uio.no

<sup>2</sup> Department of Mathematics and Informatics, Eduardo Mondlane University,  
Av Julius Nyerere, no. 3453, Campus Principal, C, Maputo, Mozambique  
zsaugene@gmail.com

**Abstract.** With adherence to treatment, HIV positives can live a normal life. Accordingly, investments are made and health systems are expanded to reach those at risk in developing countries, where HIV is reported to be most endemic. At the same time, many developing countries still rely heavily on paper-based tools which are found to be inefficient when large numbers of patients are involved and of limited use to support follow ups and assure adherence to treatment. In this paper, as we move from an existing paper base and to a digital and online information management system, we focus on improving our understanding of how to use an existing system made for collecting, aggregating and presenting population based routine data to support individual follow-up of HIV positives and their adherence to treatment. We approach this through an action research project in Sierra Leone where we have piloted a HIV patient information management system. We contribute insights on health information system scaling with emphasis on building on existing systems in developing new functionalities rather than introducing entirely new systems. Within this approach we observe the need for technological flexibility and organizational collaboration in utilizing existing resources for efficiency gains.

**Keywords:** HIV/AIDS · Patient information management system · UNAIDS 90-90-90 · Health information systems · Scaling · IS functionality · Electronic system implementation · DHIS2 · Flexibility · Organizational collaboration

## 1 Introduction

Essential components of HIV (human immunodeficiency virus) treatment are diagnosis, linkage to care, retention in care, adherence to antiretroviral therapy (ART), and viral suppression [1]. In line with this the Joint United Nations Programme on HIV/AIDS (UNAIDS) sets the 90-90-90 goal to help end the AIDS (Acquired Immune Deficiency Syndrome) epidemic by the year 2030 [2]. It outlines that by the year 2020,

90% of all people living with HIV will know their HIV status, 90% of all people with diagnosed HIV infection will receive sustained antiretroviral therapy and 90% of all people receiving antiretroviral therapy will have viral suppression. However, recent UNAIDS data [3] show that many developing countries are underperforming with respect to meeting these targets. Available data for Sierra Leone for example show only 35% of people living with HIV know their status and out of that only 26% are on treatment. No data was reported for patients on ART who are virally suppressed (ibid).

HIV care expansion strategies towards the UNAIDS 90-90-90 goal tend to pay attention to issues of availability of clinical resources, funding, and logistics supply such as antiretroviral (ARV) drugs (e.g. [4]) which are used in ART programs. But also of equal importance is the development and implementation of the appropriate information management systems for treating HIV as a chronic condition [5, 6]. Such systems potentially ensure correct patient identification during care encounters and linkage to care, and facilitate patient follow-up over time for retention and treatment adherence. From a health monitoring and planning point of view, information management systems are also required to produce the information needed for efficient resource allocation and for scale-up of treatment programs to cover more patients across wider geographical areas. Similarly, appropriate information systems (IS) can help substantiate more accurately the measurement of progress towards the 90-90-90 goals. Based on these and identified inefficiencies of paper systems especially when dealing with large number of patients [7], the World Health Organization (WHO) for example recommends a progressive transition from paper to electronic patient IS starting with high-burden sites [8]. Yet paper-based systems are heavily relied on in many developing countries including Sierra Leone. This is in spite of many information communication technology (ICT) based solutions previously explored in the literature [9]. A common approach in developing countries' setting is the use of electronic medical record (EMR) software, such as OpenMRS ([www.openmrs.org](http://www.openmrs.org)) [7, 10–12]. However, this approach too is found to be problematic due to architectural complexities, and high cost of adoption and maintenance of EMR systems [11, 13]. Thus within resource-limited settings, the continuous system adjustments needed for the changing dynamics of HIV treatment in particular becomes more challenging.

So to sum up, HIV treatment programs in developing countries are faced with resources availability challenges including lack of adequate funding, and human and material resources. This can also be seen in the lack of appropriate information management solutions. Prior attempts at implementing more efficient ICT-based IS solutions to support patient management too have largely failed to be sustained or be developed further due to resource limitations. Hence taking a different approach we explore in this study the application of an existing system made for collecting, aggregating and presenting population based routine data to also support individual level HIV case based management. With this approach we seek to utilize as much as possible resources already existing in the case context to minimize system implementation and subsequent maintenance costs, and thus potentially enhancing long-term system sustainability. Our conceptual framework is drawn from literature on health information systems (HIS) scaling in developing countries, where *scaling* involves expanding the size, scope, depth and functionality of an IS [14–16]. Combining this with functional architecting concepts and strategies for scaling functional architecture

of software systems [17] we introduce what we call *scaling across functional domains*. We define this as the building of new and differentiated functionalities for previously uncharted domains, starting from an existing install base. This is demonstrated through our case where we have scaled from aggregate health data management system functionality into individual level HIV client management functionality in Sierra Leone. Specific functions covered with the new system functionality are HIV counselling and testing (HCT), ART management and adherence monitoring.

While we find this proposed dimension to HIS functionality scaling to be particularly relevant within resource-limited contexts, how to approach this in practice is lacking in the literature. Therefore our research question is *how to scale functionality of HIS installed base to serve unmet functional need in an adjacent domain*. From this we contribute empirical insights on how to extend ICT-based IS functionality from one functional domain to another. At the same time we identify key enabling conditions to include technological flexibility and collaboration among the various domain organizations involved. The study follows an action research (AR) project covering designing, piloting, and evaluating an electronic HIV patient information management system. This paper gives an account of the first AR cycle reporting from a single pilot site about to be expanded to cover more health facilities. The solution, named HIV Patient Tracker, is built on the existing national health management information system (HMIS) and based on the DHIS2 software platform (see: [www.dhis2.org](http://www.dhis2.org)). In the remainder of the paper we describe details of the research project. First we introduce the conceptual framework. After this the research methods are described together with data collection and analysis strategies. This is followed by solution description, presentation of findings, discussions and concluding remarks.

## 2 The Conceptual Framework

Scaling of health information systems is analyzed in the literature on mainly horizontal and vertical dimensions [14–16]. Horizontal is in terms of size, coverage or scope, and functionality of the HIS in the same or different setting, and vertical in terms of penetration or depth of the HIS across the health system hierarchy. Within these dimensions, issues of complexity, learning, and adaptations are also analyzed against a backdrop of local and global contexts [18]. For example based on experience from implementing a HIS in primary health care in India, Sahay and Walsham [14] observe that IS scaling is an important issue in the context of globalization. They show how information systems expand within and across contexts and problematize what is scaled as complexity, and conceptualized complexity as a heterogeneous network of geography, numbers, technical systems, data and databases, system expertise, and socio-technical practices including politics (ibid).

With a more particular focus on software components, Nielsen and Sæbø [17] discuss how multiple actors are strategically configuring and re-configuring independent software components to serve functional needs when different systems are integrated. They conceptualize this as functional architecting and identify three different strategies; charting, encroaching and connecting. Charting is a strategy based on extending an existing software component with additional functionality to cover an

unmet functional need, in a new and typically adjacent domain. The encroaching strategy is also about extending into a new domain, but where a different system is already offering the functionality. Thus, encroaching is about grabbing the functional role of another software component by duplication, competition or substitution. Where encroaching is about competition, the connection strategy is about coordinating and negotiating the functional role and responsibility of complementary software based in different domains. Turning to the larger literature, scaling of systems functionalities is also seen to occur across dimensions and within local and global contexts. However the focus and approach has predominantly followed a ‘replication’ logic of sameness of functionalities within and across settings [18].

In this paper, we will use the concept of scaling as our lens to discuss our findings related to how the paper based information system was changed and how the new HIV-system was implemented as an extension of the existing HMIS infrastructure. We term this as scaling across functional domains, which is an attempt at expanding on the functional scaling dimension beyond just replicating same system functionality, to the building of new functionalities for different and typically adjacent domains starting from an existing install base. In our case this can also be viewed as moving an IS into a *new* domain where the move will also potentially strengthen the parts (i.e. the aggregate and population based functionality) that remain in the *old* domain. The installed base which currently serves the old domain and is our starting point consists of the HMIS software, surrounding socio-technical infrastructures, system expertise and other support structures.

### 3 Methods

Under a broader action research project of the Health Information Systems Program (HISP, see [www.hisp.uio.no](http://www.hisp.uio.no)) at the University of Oslo in Norway this study was initiated. HISP engages in health information systems design, development and implementation in developing countries [19]. The AR cycle [20] of *problem diagnosis*, *action planning*, *action taking*, *evaluating*, and *specifying learning* was followed. This approach was chosen as the research was prompted on a request by Global Fund ([www.theglobalfund.org/en/](http://www.theglobalfund.org/en/)) and the Ministry of Health and Sanitation (MOHS) of Sierra Leone to extend the functionality of the existing HMIS platform into a patient level information management system for the HIV program. This study also follows up the research project as earlier proposed in Adu-Gyamfi and Nielsen [21]. The project is funded by the Global Fund with the MOHS as the owner, and the University of Oslo (UiO) as the implementing partner. Other local stakeholders are the National HIV/AIDS Secretariat (NAS) in Sierra Leone, which has the strategic responsibility for the HIV/AIDS program in the country, the National HIV/AIDS Control Program (NACP) which is the program implementing agency and owner of the HIV patient information management system being implemented, and the Directorate for Planning Policy and Information (DPPI) which is responsible for the ministry’s entire information systems infrastructure including the HMIS system.

An interpretive paradigm of IS research is used in this study [22]. Research data was collected and analyzed through qualitative means [23]. Data collection methods

included participating in system conceptualization, setup and customization workshops, on-site visits, meetings, discussions, semi-structured interviews, email conversations, review of relevant documentations, and user training sessions. The empirical work spans a period of about 9 months between September 2017 and May 2018. All four authors were involved in the field work at various times but the first author stayed longer in the field (about 6 months in total) to collect more data while following up on the project implementation.

### 3.1 Data Collection and Analysis

The research team engaged with NAS, NACP and DPPI in meetings and discussions to understand and define the problem. The problem was defined as a lack of efficient, centralized and widely accessible information management system for the HIV program. Three selected HIV clinics were then visited to ascertain the problem scope. At all three clinics visited semi-structured interviews and discussions were conducted involving a total of 15 HIV counselors and ART nurses, 2 HIV medical doctors, and 1 electronic data entry clerk. Paper registers for HIV testing, ART, and aggregate reporting were also reviewed. These helped in identifying prevailing resource challenges, work processes and end-user requirements. After this, we held a weeklong system conceptualization workshop in Norway with DHIS2 developers and system consultants. Workshop activities included system design and customization planning, and learning from experts involved in similar ongoing projects in other developing countries. Later in the workshop we had a conference call with WHO representatives in Geneva for their feedback on the preliminary system design with respect to the WHO guideline recommendations [8]. This was also significant because our work informs early efforts to making a WHO reference configuration of DHIS2 for case based HIV information management (see e.g. [24]). We then embarked on a field trip to Sierra Leone to finalize the solution customization. Once on site, the HIV program personnel also reviewed the proposed solution and gave their inputs for further customization.

The next set of activities involved preparing training materials, developing system user guides, training of users and subsequently testing of the system at one clinic in the capital city. The test clinic has the highest case-load of ART patients in the country, which is about 4000 out of the 20000 registered patients countrywide. Challenges encountered during the system testing mainly related to internet service availability, which was resolved by the HIV program management. Two months into testing a first review meeting was held where we presented the system solution and progress on the implementation to 23 participants from NACP, NAS, DPPI and partner organizations. In May 2018, the system testing was ended and piloting with real-life patient data started. Program indicators were defined so the data entries could be supervised by the program management. We then conducted pilot expansion feasibility assessment for 8 more HIV clinics, and the findings together with preliminary results from the ongoing piloting were shared in a second project update meeting with 18 participants in attendance. This marked the end of the first AR cycle as we withdrew from the site to reflect on the results and prepare for the next cycle expected to focus on expanding the pilot to cover more HIV clinics. By end of September 2018 about 4200 HCT

registrations and close to 400 ART patient enrollments had been recorded on the new system for the pilot site.

Data collection and analysis strategies employed during this research included daily field notes compilation and reflection in the form of a research diary. Both the research problem and data were analyzed and tackled iteratively through consideration of *the interdependent meaning of parts and the whole that they form* [23]. This informed subsequent data collection and analysis by identifying emerging themes and patterns. Further analysis was also prompted against the extant research literature to foreground issues of HIS scaling in developing countries and help position our research contribution in the broader context of HIS research and practice. This was facilitated through the chosen conceptual framework.

### 4 System Description

The resulting HIV patient tracker solution infrastructure consists of a DHIS2 server instance deployed on cloud-based server which is accessible via internet. This is deployed as a separate DHIS2 server instance different from the existing HMIS instance, with own database, server address, and user access policies due to sensitivities associated with HIV patient data. A secured link is to be established for automatic aggregate data transfer to the HMIS server. The design of the HIV case based surveillance (CBS) system and how it connects with the national aggregate HMIS server is shown in Fig. 1. Two software modules of the DHIS2 platform namely Event Capture and Tracker Capture were customized for managing HIV client related services provided at HIV clinics which are HIV counselling and testing and ART services. The Event Capture is used for capturing data on counselling and testing including capturing Tuberculosis (TB) screening and testing information. The Tracker Capture module is

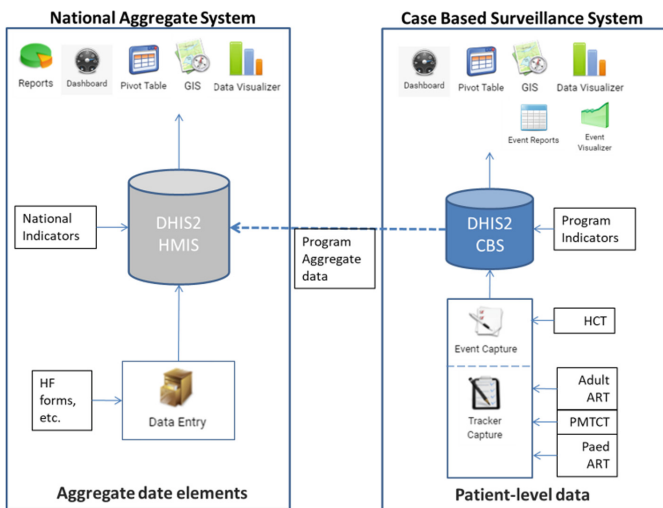
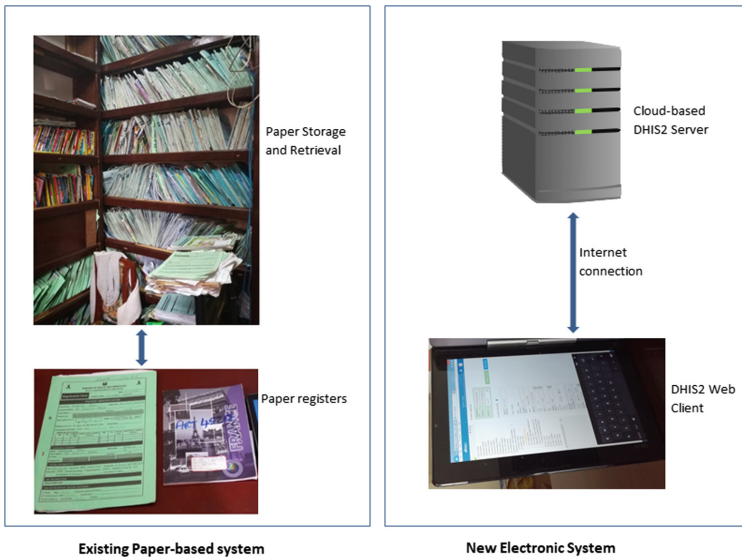


Fig. 1. Design of the existing national aggregate system and the new HIV system



used for managing adult ART, PMTCT, and Pediatric ART services. It consists of an *enrollment register* followed by four program stage registers in order of *initiation*, *visit*, *follow-up*, and *exit*. Additional features are included to enable scheduling of ART patient care events in advance, view events that are open, due, or in the future, and missed events which need to be followed up. All two modules were modelled according to local requirements and in line with WHO guideline recommendations on person-centered HIV patient monitoring and case surveillance [8]. The CBS system also inherits the reporting functionalities of the aggregate system plus its own individual events reporting functionalities.



**Fig. 2.** Paper vs. Electronic system for HCT and ART Management at the HIV clinic.

The new HIV patient tracker setup alongside the existing paper-based system is also shown above in Fig. 2. For now the two setups are running in parallel while the new electronic system is gradually integrated into the routine care delivery processes.

## 5 Findings

During the research we found the HIV service workflows across the clinics visited to be generally identical and adhering to WHO guidelines to a large extent. Testing for HIV is offered as a routine service, notably for tuberculosis patients (as co-infection is common) and all pregnant women, as well as in some other programs. If the test is positive, the patient is enrolled in ART. Treatment consists of a mix of various drugs, which may be changed over time due to adverse effects or less efficacy. Patients on ART thus regularly come to a health facility to measure the effect of treatment and to

get a new supply of medicines. CD4 count and degree of viral load suppression are also measured (CD4 count is used to monitor response to ART, and viral load is suppressed at a level where the disease is chronic but not deadly and risk of passing the virus on to others is limited). Special programs target pregnant women to prevent transmission to the unborn child, and there are also special child programs where nutritional status is included in addition to ART management. Due to these different treatment configurations, an information system needs to cater for both larger populations for irregular testing, and a smaller population on life-long treatment with scheduled visits. Key challenges relate to duplication of records and patients who default on ART. One area contributing is patient movements across facilities and service points without accompanying paper trail. This point was reiterated by the HIV program manager explaining that “*a client can default and even be reported as lost to follow up at one facility, while taking treatment in another facility*”. This also affects ART enrollment data credibility and has implications for efficient resource planning and allocation.

Gauging from the national list of facilities offering HIV services it can be said that care is reasonably well distributed across the country. However shortage of skilled health workers coupled with the inefficient paper-based information management system pose challenges for efficient service delivery. The paper systems by nature cannot support automation of tasks needed for effective patient monitoring, such as automatically scheduling patient visits and follow-ups with auto-reminders. The many associated manual processes also consume time and attention which should have been given to patient care. In addition, with increasing complexities and size of data, relying on paper tools alone makes it difficult to detect and correct data quality problems. In fact the ongoing system piloting has revealed discrepancies between data aggregates from the HIV patient tracker and that of the paper-based tools which feed into the HMIS. Furthermore as we plan to increase the coverage of the solution to include more health facilities the need for unique patient identification system has been expressed. This is required to facilitate ART patients’ follow-ups and also minimize incidence of multiple registrations.

Lastly, on the system implementation, we find team flexibility necessary in adapting plans and system choices, and aligning multiple stakeholder interests and resources towards project goals. The state of local infrastructure should also be taken into consideration. For example while it would have been possible to deploy the patient IS solution on a local server infrastructure, an existing offshore cloud server was used. Although this option was to guarantee higher system availability due to generally unstable electricity supply in the country, the downside is that without internet connectivity the system cannot be used. Hence an offline usability feature of the DHIS2 system should be explored further.

## 6 Discussions

Our discussion of the findings so far in our project relate to three main points; the characteristics of the technology that made this scaling possible, the benefits of the installed base related to the specific technology, and the need for organizational collaboration to grow in a sustainable way.

First, our case is one of proven, though limited, success. The DHIS2 was successfully scaled to cater for the recommended WHO guidelines on case based management [8], while allowing customization to suit current work practices in the Sierra Leone hospital. Preliminary results point to quick adoption by staff at the hospital, and potentially improved aggregate data quality compared to the paper-based reporting structure. On the technology side, this can be attributed to the design and architecture of the DHIS2 itself. Having gone through a decade of *generification* [25], it can now be applied for a wide range of use cases, especially applied to management of aggregate and patient data in the health sector. The generic nature of the software also means it needs to be customized and configured before it can be used, and can be considered as half-ready product [26]. The possibilities for customization are great, giving it the flexibility needed to first accommodate the WHO guidelines, and when there were requests for additional data to be collected in Sierra Leone, this could be added on the fly. While the tracker and event functionalities have been applied for HIV management in other countries, Sierra Leone was the first place it was adapted specifically building on the WHO guidelines [8].

Second, the intended approach was to build on the installed base to limit the amount of technologies needing support. In our case the answer to this is inconclusive, as there has been limited interaction so far between the owners of the HIV patient IS and the owners of the HMIS. However, there are also some obvious efficiency gains. There has been no introduction of new technology, and the cloud server used for the HMIS was partitioned to serve also the HIV system. There is an in-country person who can assist in maintaining both. There is also a strong base of local level staff in districts that routinely use DHIS2, which will provide a local support structure for future national roll out of the HIV system. Indeed an important aspect would be to grow the total user base, of both administrators and end-users, which will mitigate some of the known challenges of staff turnover and political changes. As the users of the different systems are different, the growing of both will limit the risk of losing key capacity related to the technology. Integration of information systems is another key challenge in the field [27], which has not been explicitly covered in this paper. However, using the same technology across two functional domains this integration is achieved by default. As the case based HIV system covers more health clinics, aggregate statistics derived from it can supplant the manual reporting of the same data to the HMIS. An added benefit of this will be fewer manual aggregation and data entry steps, improving data quality. Building on the installed base does not only have potential benefits for the new system introduced, but also strengthens the existing system it is built upon.

Thirdly, as the discussion above points to, while increasing the capacity of one technology to support several systems has potential benefits, it needs to be coupled with corresponding growth in organizational cooperation [28]. The benefits of increased user base, increased scope for specialization, and mutual support between user groups can only be achieved if the system owners (the organizations) enable and promote this. If this is not achieved, we have two organizations using the technology independently, building their own capacities irrespective of their complementarities, and independently facing the same challenges to implementation and sustainability. At the moment, there is only limited collaboration between DPPI and NACP. While DPPI have made available hardware for the pilot (tablets) and assigned their staff at the

hospital to support the entry of backlog data, a closer collaboration between DPPI and NACP needs to be fostered, so that they can pool resources for common requirements such as server maintenance, hardware procurement, and end-user training.

Theoretically, we have in this paper approached the complexity of scaling by focusing on functional architecting [17]. Our case is an illustrative example of charting, in terms of the HMIS system being extended with additional functionality to cover an unmet functional need related to HIV treatment. As shown, with the flexible DHIS2 software the WHO guidelines could be adopted and additional local requirements from Sierra Leone implemented. While Nielsen and Sæbø [17] primarily focus on different approaches to strategically positioning of different software components, we have in this paper highlighted how scaling functional architecture also depends on coordination and cooperation at the organizational level. We also emphasize building on the installed base so as to maximize efficient utilization of existing resources. But to release the full potential of this strategy the social, technical and political complexities of the context of scaling must also be taken into consideration [14, 15].

## 7 Conclusion

In our research we sought to investigate how we can scale an existing IS across two domains. We approached this through building on the existing Sierra Leone HMIS to cater for case based HIV management also. HMIS and case-based management represent different domains of care and information management. Where HMIS is routine reporting and analysis of aggregate data for general health management, the HIV system is focusing on continuous individual case-based management. We chose this approach because the alternative of introducing a new information system based on a different technology will require creating all the institutional and organizational structures needed for sustaining the solution. By instead building on a technology already present and supported in the MOHS, we aimed with this choice of architecture to reducing the costs and complexities related to the implementation and further development. Flexibility of the installed base technology enabled its functionality to be scaled for the different use case. Cooperation between the owners of the two systems (domains) though currently limited was vital. Additionally, implementation team flexibility helped achieved practicable and potentially more sustainable solution with the prevailing resource situation. In future research fostering of deeper collaboration between the owners of two systems for long-term project sustainability will be investigated further.

## References

1. Kay, E.S., Batey, D.S., Mugavero, M.J.: The HIV treatment cascade and care continuum: updates, goals, and recommendations for the future. *AIDS Res. Ther.* **13**(1), 35 (2016)
2. 90–90–90 - An ambitious treatment target to help end the AIDS epidemic. <http://www.unaids.org/en/resources/documents/2017/90-90-90>. Accessed 06 Oct 2018

3. UNAIDS DATA (2017). [http://www.unaids.org/en/resources/documents/2017/2017\\_data\\_book](http://www.unaids.org/en/resources/documents/2017/2017_data_book). Accessed 06 Oct 2018
4. Jamieson, D., Kellerman, S.E.: The 90 90 90 strategy to end the HIV Pandemic by 2030: can the supply chain handle it? *J. Int. AIDS Soc.* **19**(1), 20917 (2016)
5. Deeks, S.G., Lewin, S.R., Havlir, D.V.: The end of AIDS: HIV infection as a chronic disease. *Lancet* **382**(9903), 1525–1533 (2013)
6. Fraser, H.S., et al.: An information system and medical record to support HIV treatment in rural Haiti. *BMJ* **329**(7475), 1142–1146 (2004)
7. Douglas, G.P., et al.: Using touchscreen electronic medical record systems to support and monitor national scale-up of antiretroviral therapy in Malawi. *PLoS Med.* **7**(8), e1000319 (2010)
8. WHO—Consolidated guidelines on person-centred HIV patient monitoring and case surveillance. WHO. <http://www.who.int/hiv/pub/guidelines/person-centred-hiv-monitoring-guidelines/en/>. Accessed 06 Oct 2018
9. Jongbloed, K., Parmar, S., van der Kop, M., Spittal, P.M., Lester, R.T.: Recent evidence for emerging digital technologies to support global HIV engagement in care. *Curr. HIV/AIDS Rep.* **12**(4), 451–461 (2015)
10. Castelnovo, B., et al.: Implementation of provider-based electronic medical records and improvement of the quality of data in a large HIV program in Sub-Saharan Africa. *PLoS One* **7**(12), e51631 (2012)
11. Fraser, H., Biondich, P., Moodley, D., Choi, S., Mamlin, B., Szolovits, P.: Implementing electronic medical record systems in developing countries. *J. Innov. Health Inform.* **13**(2), 83–95 (2005)
12. Allen, C., et al.: Experience in implementing the OpenMRS medical record system to support HIV treatment in Rwanda. *Stud. Health Technol. Inform.* **129**(1), 382 (2007)
13. Fleming, N.S., Culler, S.D., McCorkle, R., Becker, E.R., Ballard, D.J.: The financial and nonfinancial costs of implementing electronic health records in primary care practices. *Health Aff. (Millwood)* **30**(3), 481–489 (2011)
14. Sahay, S., Walsham, G.: Scaling of health information systems in India: challenges and approaches. *Inf. Technol. Dev.* **12**(3), 185–200 (2006)
15. Shaw, V., Mengiste, S., Braa, J.: Scaling of health information systems in Nigeria and Ethiopia—Considering the options. Presented at the IFIP WG, vol. 9 (2007)
16. Braa, J., Hanseth, O., Heywood, A., Mohammed, W., Shaw, V.: Developing health information systems in developing countries: the flexible standards strategy. *Mis Q.* **31**(2), 381–402 (2007)
17. Nielsen, P., Sæbø, J.I.: Three strategies for functional architecting: cases from the health systems of developing countries. *Inf. Technol. Dev.* **22**(1), 134–151 (2016)
18. Sahay, S., Sæbø, J., Braa, J.: Scaling of HIS in a global context: same, same, but different. *Inf. Organ.* **23**(4), 294–323 (2013)
19. Braa, J., Monteiro, E., Sahay, S.: Networks of action: sustainable health information systems across developing countries. *MIS Q.* **28**(3), 337–362 (2004)
20. Davison, R., Martinsons, M.G., Kock, N.: Principles of canonical action research. *Inf. Syst. J.* **14**(1), 65–86 (2004)
21. Adu-Gyamfi, E., Nielsen, P.: Leveraging software platform capabilities to support HIV (ART) treatment adherence management: a case from Sierra Leone. In: Choudrie, J., Islam, M., Wahid, F., Bass, J., Priyatma, J. (eds.) *ICT4D 2017. IFIP Advances in Information and Communication Technology*, vol. 504, pp. 35–46. Springer, Heidelberg (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_4](https://doi.org/10.1007/978-3-319-59111-7_4)
22. Walsham, G.: *Interpreting Information Systems in Organizations*, vol. 19. Wiley, Chichester (1993)

23. Klein, H.K., Myers, M.D.: A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Q.* **23**(1), 67–93 (1999)
24. Poppe, O., Sæbø, J.I., Nielsen, P., Sanner, T.A.: *Standardising through software* (2017)
25. Gizaw, A.A., Bygstad, B., Nielsen, P.: Open generification. *Inf. Syst. J.* **27**(5), 619–642 (2016)
26. Dittrich, Y.: Software engineering beyond the project – sustaining software ecosystems. *Spec. Issue Softw. Ecosyst.* **56**(11), 1436–1456 (2014)
27. Braa, J., Sahay, S.: *Integrated Health Information Architecture: Power to the Users: Design, Development, and Use*. Matrix Publishers, New Delhi (2012)
28. Constantinides, P., Barrett, M.: Information infrastructure development and governance as collective action. *Inf. Syst. Res.* **26**(1), 40–56 (2014)



# Mobile Phone Use for Empowerment and Well-Being of the Physically Challenged in Nigeria

Abdulrashid Iliya<sup>(✉)</sup>, Chidi G. Ononiwu, Muhammadou M. O. Kah, and Ago K. M. Quaye

American University of Nigeria, Yola, Adamawa State, Nigeria  
Abdulrashid.iliya@aun.edu.ng

**Abstract.** National and economic benefits of mobile phone use in developing countries has been a well-articulated research domain over an extended period. This can be attributed to the ubiquitous nature of mobile phones and their increased penetration in developing nations. However, the potential benefits of mobile phones for empowerment and well-being of people with disability (PWD) has been ignored. This paper focuses on the well-being of the physically challenged in Nigeria and how mobile phones can be employed to empower them. The link between ICT and human development has been well researched, but minimal research has attempted to link ICT, mobile phone and disability using the Capability Approach as a theoretical lens. The critical realist ethnographic study approach is employed in this study to show how mobile phones can be used to empower and impact on the well-being of the physically challenged. Data were collected from the Adamawa skill acquisition center for persons with disability, Nigeria. It is argued that mobile phones have the capabilities to empower and impact on the well-being of the physically challenged. Thus, the findings illustrate that mobile phones play significant roles in the well-being and empowerment of the physically challenged.

**Keywords:** Mobile phones · Physically challenged · Critical realist ethnography · Capability approach

## 1 Introduction

Mobile phones are regarded as an important tool for national development and poverty reduction (Bhavnani, Chiu, Janakiram, Silarszky, and Bhatia 2008; Hoan, Chib, and Mahalingham 2016). The contributions of mobile phones have generated numerous studies in developing countries. As such, these studies are generally attributed to economic development (Shirazi 2012), gender empowerment (Hoan, Chib, and Mahalingham 2016), improvement of maternal health (Nyemba-Mudenda, and Chigona 2015) and poverty reduction (Islam and Slack 2016). Similarly, there are many studies on mobile phone use in developing countries (Donner 2008) that focus on marginalized populations. Most of these studies focus on marginalized women (Shirazi 2012), marginalized youth (Sam 2017) and well-being of blind micro-entrepreneurs (Anwar and Johanson 2015). However, in-depth and/or extensive studies on physically

challenged persons have not been carried out. Walsham (2017), indicate the need for more focused studies on disability in the ICT4D domain. The term ‘empowerment’ can mean different things to different people, but in this research, empowerment refers to the ability for people with disability to overcome their deficiencies in society. It is the ability to exhibit social, economic, political and cultural freedoms. Lately, technological advancements have been touted to enhance and empower People with disabilities (PWDs) especially in the provision of access to information and services, as well as, the physical environment (D’Aubin 2007). ICT has proven to play a vital role in the spheres of PwDs. It has removed barriers which prevent PwDs from participating in daily activities (D’Aubin 2007). Although, a number of studies have linked ICT with disability (e.g., Goggin 2011; Kane et al. 2009; Toboso 2011; Chaudhry 2005; Pal et al. 2009), there are no empirical evidences of studies on the use of mobile phones in empowering the physically challenged. Studies have categorized the PwDs into the virtually impaired (Hashemi, Khabazkhoob, Saatchi and Yekta 2018), hearing impaired (Qi and Mitchell 2011), mental health conditions (Kleinman 2009), intellectual disability (Lindsay 2002), autism spectrum disorder (Virnes, Karna and Vellonen 2015) and the physical disability or physically challenged (Miyahara and Piek 2006). To contextualize disability in this study, our focus is on the physically challenged (Wheelchair users). Therefore, we define the physically challenged people as those who have significant limitations in functioning and often experience exclusion from participation in their societies due to their impairments (Krahn, Walker, and Correa-De-Araujo 2015).

This research is part of a larger PhD work that is looking at how the use of mobile phones can empower the physically challenged in Nigeria. Our emphasis is on understanding how the use of mobile phones can empower the physically challenged. This is accomplished by understanding and framing technology use from the human development point of view. Human development stresses on a community where individual dreams can be actualized. This perspective is similar in view to that expressed in Amartya Sen’s work (1985a, b, 1999) on freedom of choice. Sen developed a framework for evaluating individual well-being called the Capability Approach (CA). The CA has been widely used by various researchers (Grunfeld, Hak, and Pin 2011; Zheng and Walsham 2008; Robeyns 2005; Nussbaum 2000, Dasuki et al. 2017) and organizations as published in the United Nations Development Programme (UNDP) report on human development. In this study, a number of concepts including empowerment, well-being, human development, the CA and ICT4D are employed with emphasis on disability. Consequently, the study’s focus is to explore the capabilities of mobile usage in empowering and improving the well-being of the physically challenged persons in Nigeria. Thus, the study asked the following question:

*What are the effects of mobile phone use in empowering and well-being of people with physical disabilities in Nigeria?*

The question suggests that the study is focusing on how mobile phone use support economic and social development, including its impact in contributing to some aspects of human well-being. Secondly, the study sets out to investigate how CA and ICT are linked to empowerment, especially, of the physical challenged.



The paper is structured as follows: the next section will discuss the research context of empowerment and mobile phones in developing countries, followed by the methodology. Preliminary results of the findings are presented. Finally, the study concludes with a discussion of how CA evaluates the contributions of mobile phones to empowerment and well-being of the physically challenged.

## **2 Research Context: Physically Challenged and Mobile Phones in Nigeria**

There are approximately 25 million people living with disabilities in Nigeria (Eleweke 2013; Obiakor and Eleweke 2014), of these, those using mobile phones for their daily activities is not known. The Nigerian government has provided support to the people with disability through services offered by the skill acquisition centers established in every state of the country. The skill acquisition centers are saddled with the responsibilities of empowering people with disabilities including the physically challenged. Skill training offered include making of shoes, bags and soaps. This initiative has no doubt empowered people with disability. Nonetheless, evidence have shown that PwDs continue to face widespread discrimination, barriers in accessing service and societal exclusion (Eleweke 2013; Obiakor and Eleweke 2014).

In Nigeria, the number of mobile phone subscribers have increased from 10.2 to 144 Million from 2005 to 2017 (NCC 2017). Mobile phones have become an integral part of the day-to-day activities in Nigeria. People engage their mobile phones in sending text messages, making calls and sometimes listening to music or FM radio. Due to its ubiquity, mobile phones have penetrated all of life including the poor, marginalized and the disabled. Mobile phone has become the IT artefact that seems to provide the social inclusion of people below the pyramid.

## **3 Research Methodology**

This study focus on understanding participants' experiences and views, using critical realist ethnographic approach. Critical realist ethnographic approach provides understandings of participants' perceptions, beliefs and experiences. Critical realism regards reality as objective and stratifies ontology into empirical, actual and real domains. The empirical domain includes what we see and observe, the actual domain comprises events that are generated by mechanism while the real domain contains mechanisms and structures with enduring properties (Mingers 2013). Critical realist ethnography is associated with reflexivity and has the prospects to be a dominant methodological framework about the nature of reality (Barron 2013). The adequacy and representation of the world of the empirical requires audio, visual and written representations. Writing of field notes and photographs are essential in capturing the world of the empirical without being intrusive (Barron 2013). For adequate representation, sharing of the field notes and photographs with participants will enhanced, challenge and provide additional empirical detail where necessary. At the 'actual' world, it is imperative to consider the events that may not have been experience and what had been experience

related to had not. This is where reflexivity plays a vital role in enabling the researcher challenge straightforward outcomes and consider “*as many events as possible in the world of the actual*”. This include the use of photography as a ‘text’.

### **3.1 Research Method**

The research approach (ethnography) constructs theory from the data obtained in the field through participants’ observation. Participant’s observation and in-depth interviews were used as the core data collection method. The field notes constituted the primary data, together with semi-structured interview were analyzed.

Various questions were developed to facilitate the semi-structured interviews. The investigations carried out in the field addressed questions on how mobile phones contribute to empowerment and well-being of the physically challenged.

We conducted our field work from February 2018 to September 2018 in the city of Yola, Nigeria. The location represents the northern part of Nigeria. A total of 10 participants were observed and interviewed. Been a critical realist ethnographic study, attention is given at the empirical domain for this study. Further work will focus on the actual and real domains. We envisage that the data collection will continue for about 2 years.

### **3.2 Semi-structured Interviews**

We conducted in-depth interviews with the members of the Adamawa skill acquisition center for persons with disabilities. Our focus was on the physically challenged. The interviews varied in duration but with an average length of 30 min. For the purpose of this study, 10 interviews were conducted. Each interview was intensively written (note taking).

### **3.3 Focus Group Interviews**

The focus group interview occurred in May 2018 where the 10 participants were brief about the 1<sup>st</sup> order categories of our findings. A unanimous agreement was reach about the about the first-order concepts (those important to the participants).

### **3.4 Participant Observations**

We were allowed access to the Adamawa skill acquisition center over the course of our field study. This has provided valuable understandings into the day-day activities of the physically challenged. Detailed notes were taken during the events to complement the semi-structured interviews and the focus group interviews. Discussion and note taking were conducted within the research team to arrive at the participants’ expressions. The names used in this study were given pseudonyms so as to protect the security and privacy of the research subjects.

### 3.5 Data Analysis

The data was deductively analyzed following the naturalistic inquiry method (Lincoln and Guba 1985) under the CA theoretical underpinnings. These methods of data analysis “provide rigor in analyzing qualitative data to simultaneously assist in determining the sampling and content foci of future data collection efforts” (Harrison et al. 2011).

Figure 2 at the appendix represent the data structure we analyzed. We began by analyzing the initial transcribed data to grouped them as the 1<sup>st</sup> order categories. Next, we examined the relationships among these categories where we arrived at the 2<sup>nd</sup> order themes. The similar themes were further reduced into the aggregate dimensions that led to the emergent of our model. Been a critical realist ethnographic study, the 1<sup>st</sup> categories, 2<sup>nd</sup> order themes and the aggregate dimensions has only focused on the empirical domain. This is where our study intends to contribute. A further study will focus on the underlying mechanism that must exist for empowerment and well-being to occur.

The figure shows the data structure, including first-order concepts (those important to the participants) and second-order themes (induced by the researchers), that led to the generation of the aggregate dimensions.

## 4 The Participants: Physically Challenged

### 4.1 Preliminary Findings

In this section, preliminary findings of the study are discussed, including the concept of well-being and empowerment as understood by the participants. How the physically challenged use mobile phones for personal and business activities is also discussed.

### 4.2 The Well-Being of the Physically Challenged

For the well-being of the physically challenged, it is necessary to understand their perceptions and what is vital to their well-being. Numerous concepts were advanced to explain what constitutes the term ‘well-being’ to the physically challenged. This is necessary to successfully define an accurate representation of well-being to the physically challenged. The empirical location where this study was conducted consists of participants’ mostly of the *Fulani* tribe, who are mostly Muslims. They speak Fulfulde and they view well-being as ‘*Nanugobeldum*’. *Nanugobeldum* meaning enjoyment, peace of mind and satisfaction. Clearly, this has no similar meaning in the English word well-being. Although, *Nanugobeldum* was interpreted differently between the participants, a common perception was achieved. *Nanugobeldum* was comprehended as a form of spiritual and physical fulfillments. Spiritual context here depicts freedom to practice their religion and physical fulfillment is linked to healthy lifestyle and wealth. Being valuable to family and society was also perceived as a form of *Nanugobeldum*. In summary, it is evident from the interviews that what matter to the well-being of the physically challenged can be categorized as follows: being healthy, family, peaceful co-existence and being independent.

#### 4.2.1 Being Healthy

Participants in this study believe that being healthy is an integral part of their well-being. In their context, being healthy means psychological ability to be able to provide for their family. Getting ill is an added disadvantage to their disability, as such they use mobile phone to contact their doctor or pharmacist whenever they feel sick.

*All I want in life is to be healthy so that I can be able to provide food for my children. I call my doctor whenever I feel sick (Amadu)*

#### 4.2.2 Family

The participants believe that the happiness of their family is paramount to their well-being. Family is important to them. In fact, some participants believe their well-being is not their own, but for their family. They use mobile phone to communicate to their family whenever it is necessary.

*My family is everything to me; I work hard every day to provide for them. I just called my wife to check on her and our new baby. (Moses)*

#### 4.2.3 Peaceful Co-existence

All the participants believe that societal peace is paramount to their well-being. They lament on the increase in-security cause by Boko-haram as a drawback to their well-being. Their mobile phone serves as a form of news channel.

*Boko-haram have crippled my business; I hardly make money for my upkeep. I am however, grateful to Allah. Thank God for my phone, it has help me follow the news on boko haram crisis. (Adamu)*

#### 4.2.4 Being Independent

The physically challenged perceived being independent as an important aspect to their well-being. They see dependency as a form of inferiority and as such they prefer to do everything by themselves if they can. Mobile phone provide support for the physically challenged though physical mobility.

*My husband died in 2012 during the Boko-haram crisis. He left me with 4 children and I have to come out here every day to sell my products so that I can be able to feed my children. If I am not feeling too good, I call on my sister to take me to the hospital. But I don't like troubling her all the time (Asabe).*

### 4.3 The Business and Personal Use of Mobile Phones

The other categories that emerged from the interview data are the use of mobile phones for business and personal use. These can be categorized into the following themes: mobile phone use for business networking, maintaining kingship amongst family members and mobile phones for sales/customers' relationships. These are discussed below.

### 4.3.1 Mobile Phone Use for Business Networking

Participants agreed to use mobile phones to communicate amongst themselves. They used mobile phones to schedule for business meetings between themselves.

*Before, it is difficult to have everybody participate in a meeting. But now that we all have a mobile phone, I called everyone on the phone whenever we are having a meeting. For example, I called everyone to let them know you (researcher) are coming to interview them. (Sera)*

It also helps the participant to agree on a collective price for their products

*Due to the recent recession, we all receive a message from our coordinator to review our prices so as to be in line with each other. (Shuaibu)*

### 4.3.2 Maintaining Kingship Amongst Family Members

Mobile phone is an integral artifact in the life of the physically challenged. As a ubiquitous device, it has facilitated communication amongst relatives, family and friends. The participants believe that the mobile phone is important in maintaining relationships amongst them.

*Mobile phone has helped me communicate with my son who is a soldier. He is at the battle grounds fighting with boko-haram. I am always happy when he calls me. (umma)*

However, other participants believe maintaining a mobile phone is very expensive. For example,

*I always call my wife in the village to find out how she is doing with our children. She doesn't have a phone; I always call my neighbor to help me take the phone to her so that I can talk to her. I want to buy her a phone but it is expensive. I will buy her a phone soon. In sha Allah. (Idris)*

### 4.3.3 Mobile Phones for Sales and Customer Relationships

All the participants have access to mobile phones. They agreed that mobile phone help them maintain relationship with their customers.

*In fact, since I started using a mobile phone, my customers have increased dramatically. They can now call to order for their type of bags and shoes. I am very happy to use my mobile phone all the time. (Ibrahim)*

The mobile phone also help them to showcase their products:

*I have been using my phone for almost three years now. However, I was recently introduced to WhatsApp messenger which has made my business so easy. I can now snap pictures of my products and send it to my customers. But the data price is very high. (Saleh)*

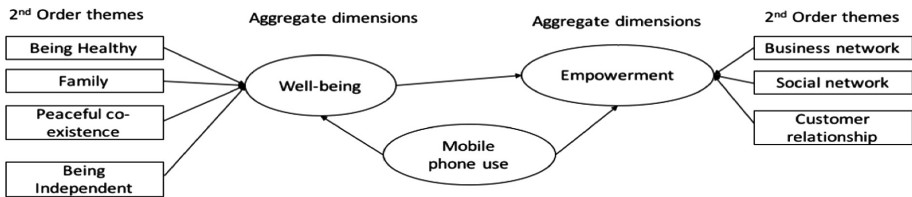
## 5 Discussion

### 5.1 How Mobile Phones Impact on Well-Being and Empowerment

As described in the findings, mobile phones assist the physically challenged in communicating with their friends, family and improving their business strategies and

network. But most importantly, it helps them to be independent and brings them to be an inclusive part of the society. The ubiquity of mobile phones which provide information sharing and connectedness offer opportunities that may have been challenging to realized. The effective use of mobile phones for business activities has resulted in increased income, more customers thereby improving the livelihood of the physically challenged. It also facilitated freedom and independence in conducting business and personal activities. In the case of the physically challenged, mobile phones are seen as the more preferred tool for communication amongst the group. The lack of assistance and flexibility from government agencies promotes networking within the group. These virtual interaction benefits the physically challenged by offering efficient and more effective avenues for business interaction thereby leading to empowerment. However, this comes with its own disadvantage as mobile phones and their services are very expensive to maintain. The ability to contact family members at any given time enhanced their social empowerment. Being able to convey their feelings freely through the mobile phones have surely given them a sense of self-expression among one another. All these can be attributed to the participants' goals in achieving well-being and empowerment. The findings indicate that the physically challenged often experience inferiority around able people. Certainly, this has led people with disability to be culturally, economically and socially marginalized. In the case of the physically challenged, dependency is being attributed to a form of inferiority. Removing dependency and improving the physically challenged independence proves vital in achieving a better life and empowerment. Despite the barriers of costs involved in the maintenance of mobile phones, participants still utilized the capability of mobile phones for their empowerment.

Drawing from the concept of the CA, a theoretical framework is proposed as shown in Fig. 1. The framework is illustrated in the form of a diagram that depicts the relationships between well-being, mobile phone use and empowerment. It shows that mobile phone use has an impact on the well-being and can empower the physically challenged. The framework also shows that well-being lead to empowerment of the physically challenged.



**Fig. 1.** A theoretical framework for theorizing mobile phone use for and empowerment. Source: Author's own explanation based on the integration of Sen's CA

## 6 Conclusion and Future Work

This paper has demonstrated that the primary effects of mobile phones to the well-being and empowerment of the physically challenged include their family, being healthy, peaceful co-existence and being independent. The paper has also shown how mobile phone is used for personal and business purposes of the physically challenged. It can be concluded that mobile phones use has expanded the capabilities of the physically challenged to live the type of life they value. Although, the results from the study has depict the positive effects of mobile phones to the physically challenged, there might be negative elements that may affect the well-being of the physically challenged.

The findings have shown that there is a strong relationship between well-being and empowerment. For the physically challenged, the categories of well-being such as being healthy, family, being independent and peaceful co-existence as discovered from this research has the capability to empower the physically challenged. And as such, well-being leads to empowerment to the physically challenged.

Additionally, the paper has contributed to the ignored topic of disability and mobile phone in the ICT4D domain. As a timely contribution, it has given insights into how mobile phone can be linked to human development frameworks, particularly, the capability approach. It has reported with empirical evidence how mobile phones have the capabilities of expanding the well-being and empower the physically challenged in a developing country. The findings from the study is significant to policy and policy makers in addressing the challenges faced by disabled in Nigeria.

Future work needed in this research domain is to understand the underlying mechanisms that affect disabled people from using mobile phones to achieve empowerment. Mechanisms such as these can then be addressed to enhance the well-being of the physically challenged. The research could be important to a wider social domain, as findings from the research can be used to address social marginalization and inequalities among people living with disability.

To this end, the prevailing notion of technology in the CA has not been harmonized empirically. A further work which this study intends to continue with is how to explicitly justify the inclusion of technology (mobile phone) and disabilism into the CA, thus, contribute to the theoretical development of the CA. We believe that our contribution will fill an important theoretical gap in the CA and add to the current contribution by Haenssger and Ariana (2017), who examines the concept of technology in the CA with the aim of understanding the technical objects, social structures and individuals. By putting disabilism within the CA, we are not adding another framework. Instead, our goal is to contribute to the harmonizing discussion on technology and disabilism in the CA.

## Appendix

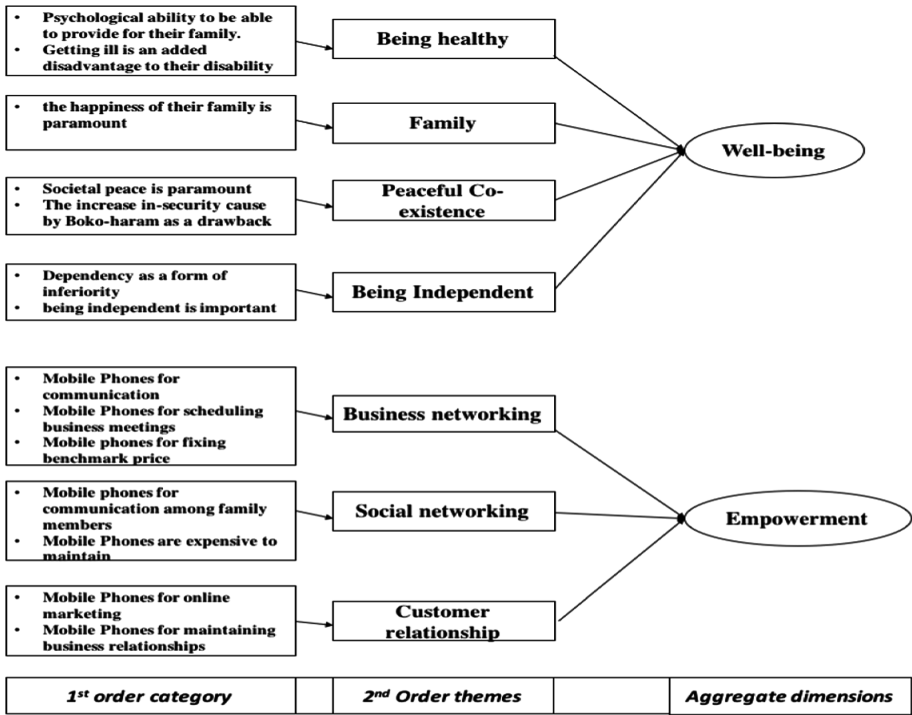


Fig. 2. Data structure

## References

- Anwar, M., Johanson, G.: Mobile phones and the well-being of blind micro-entrepreneurs in Indonesia. *EJISDC* **67**(3), 1–18 (2015)
- Bhavnani, A., Chiu, R.W.-W., Janakiram, S., Silarszky, P., Bhatia, D.: The role of mobile phones in sustainable rural poverty reduction (2008). Accessed 22 Nov 2008
- Chaudhry, V.: Rethinking the digital divide in relation to visual disability in India and the United States: towards a paradigm of “information inequity”. *Disability Studies Quarterly* **25**(2) (2005). <http://dsq-sds.org/article/view/553/730>
- D’Aubin, A.: Working for barrier removal in the ICT area: creating a more accessible and inclusive Canada: a position statement by the council of Canadians with disabilities. *Inf. Soc.* **23**(3), 193–201 (2007). <https://doi.org/10.1080/01972240701323622>
- Dasuki, S.I., Quaye, A.M., Abubakar, N.H.: An evaluation of information systems students internship programs in Nigeria: a capability perspective. *Electron. J. Inf. Syst. Dev. Ctries.* **83** (1), 1–19 (2017). <https://doi.org/10.1002/j.1681-4835.2017.tb00614.x>



- Donner, J.: Research approaches to mobile use in the developing world: a review of the literature. *Inf. Soc.* **24**(3), 140–159 (2008)
- Eleweke, C.J.: A review of the challenges of achieving the goals of the African plan of action for people with disabilities in Nigeria. *Disabil. Soc.* **28**(3), 313–323 (2013)
- Goggin, G.: Disability, mobiles, and social policy: new modes of communication and governance. In: Katz, J.E. (ed.) *Mobile Communication: Dimensions of Social Policy*, pp. 259–272. Transaction Publishers (2011)
- Grunfeld, H., Hak, S., Pin, T.: Understanding benefits realisation of iREACH from a capability approach perspective. *Ethics Inf. Technol.* **13**(2), 151–172 (2011)
- Hashemi, H., Khabazkhoob, M., Saatchi, M., Ostadimoghaddam, H., Yekta, A.: Visual impairment and blindness in a population-based study of Mashhad, Iran. *J. Curr. Ophthalmol.* **30**(2), 161–168 (2018). <https://doi.org/10.1016/j.joco.2017.01.003>
- Harrison, S.H., Corley, K.G.: Clean climbing, carabiners, and cultural cultivation: developing an open-systems perspective of culture. *Organ. Sci.* **22**(2), 391–412 (2011). <https://doi.org/10.1287/orsc.1100.0538>
- Hoan, N.T., Chib, A., Mahalingam, R.: Mobile phones and gender empowerment: enactment of “restricted agency”, pp. 1–10. ACM Press (2016). <https://doi.org/10.1145/2909609.2909671>
- Barron, I.: The potential and challenges of critical realist ethnography. *Int. J. Res. Method Educ.* **36**(2), 117–130 (2013). <https://doi.org/10.1080/1743727X.2012.683634>
- Islam, M.K., Slack, F.: Women in rural Bangladesh: empowered by access to mobile phones. In: *Proceedings of the 9th International Conference on Theory and Practice of Electronic Governance*, pp. 75–84. ACM (2016)
- ICT and Development - Research Voices from Africa: International Federation for Information Processing (IFIP), Technical Commission 9 – Relationship Between Computers and Society. Workshop at Makerere University, Uganda, 22–23 March 2010
- Kane, S.K., Jayant, C., Wobbrock, J.O., Ladner, R.E.: Freedom to roam: a study of mobile device adoption and accessibility for people with visual and motor disabilities. Paper Presented at the *Proceedings of the 11th International ACM SIGACCESS Conference on Computers and Accessibility* (2009)
- Kleinman, A.: Global mental health: a failure of humanity. *Lancet* **374**, 603–604 (2009)
- Krahn, G.L., Walker, D.K., Correa-De-Araujo, R.: Persons with disabilities as an unrecognized health disparity population. *Am. J. Public Health* **105**(S2), S198–S206 (2015)
- Lincoln, Y., Guba, E.: *Naturalistic Inquiry*. Sage, Beverly Hills (1985)
- Lindsay, W.R.: Research and literature on sex offenders with intellectual and developmental disabilities. *J. Intellect. Disabil. Res.* **46**(s1), 74–85 (2002). <https://doi.org/10.1046/j.1365-2788.2002.00006.x>
- Haenssger, M.J., Ariana, P.: The place of technology in the Capability Approach. *Oxford Dev. Stud.* (2017). <https://doi.org/10.1080/13600818.2017.1325456>
- Mingers, J., Mutch, A., Willcocks, L.: Introduction [special issue: critical realism in information systems research]. *MIS Q.* **37**(3), 795–802 (2013)
- Miyahara, M., Piek, J.: Self-esteem of children and adolescents with physical disabilities: quantitative evidence from meta-analysis. *J. Dev. Phys. Disabil.* **18**(3), 219–234 (2006). <https://doi.org/10.1007/s10882-006-9014-8>
- NCC: Nigeria Communications Commission (2017). <https://www.ncc.gov.ng/stakeholder/statistics-reports/subscriber-data>. Accessed 2 Feb 2018
- Nussbaum, M.: Women’s capabilities and social justice. *J. Hum. Dev.* **1**(2), 219–247 (2000)
- Nyemba-Mudenda, M., Chigona, W.: mHealth drivers for maternal health outcomes in developing countries: a systematic review. In: *Proceedings of the 13th International Conference on Social Implications of Computers in Developing Countries*, Negombo, Sri Lanka, May 2015. [http://ifipwg.org/files/IFIPWG94\\_2015\\_PROCEEDINGS.pdf](http://ifipwg.org/files/IFIPWG94_2015_PROCEEDINGS.pdf)

- Obiakor, F.E., Eleweke, C.J.: Special education in Nigeria today. In: Rotatori, A., Bakken, J., Obiakor, F., Sharma, U. (eds.) *Advances in Special Education: International Perspectives*, vol. 28, pp. 379–397. Emerald, London (2014)
- Pal, J., Freistadt, J., Frix, M., Neff, P.: Technology for employability in Latin America: research with at-risk youth and people with disabilities (2009). <https://digital.lib.washington.edu/researchworks/handle/1773/16297?show=full>
- Robeyns, I.: The capability approach: a theoretical survey. *J. Hum. Dev.* **6**(1), 93–114 (2005)
- Sam, S.: Towards an empowerment framework for evaluating mobile phone use and impact in developing countries. *Telemat. Inform.* **34**(1), 359–369 (2017). <https://doi.org/10.1016/j.tele.2016.06.003>
- Sen, A.: *Commodities and Capabilities*. Oxford University Press, Delhi (1985a)
- Sen, A.: Well-being, agency and freedom: the dewey lectures 1984. *J. Philos.* **82**(4), 169–221 (1985b)
- Sen, A.: *Development as Freedom*. Knopf, New York (1999)
- Shirazi, F.: Information and communication technology and women empowerment in Iran. *Telemat. Inform.* **29**(1), 45–55 (2012). <https://doi.org/10.1016/j.tele.2011.02.001>
- Qi, S., Mitchell, R.: Large scale academic achievement testing of deaf and hard of hearing students: past, present and future. *J. Deaf Stud. Deaf Educ.* **17**(1), 1–18 (2011). <https://doi.org/10.1093/deafed/enr028PMid:21712463>
- Toboso, M.: Rethinking disability in Amartya Sen’s approach: ICT and equality of opportunity. *Ethics Inf. Technol.* **13**, 107–118 (2011)
- Virnes, M., Kärnä, E., Vellonen, V.: Review of research on children with autism spectrum disorder and the use of technology. *J. Spec. Educ. Technol.* **30**(1), 13–27 (2015). <https://doi.org/10.1177/016264341503000102>
- Walsham, G.: ICT4D research: reflections on history and future agenda. *Inf. Technol. Dev.* **23**(1), 18–41 (2017). <https://doi.org/10.1080/02681102.2016.1246406>
- Zheng, Y., Walsham, G.: Inequality of what? Social exclusion in the e-society as capability deprivation. *Inf. Technol. People* **21**(3), 222–243 (2008)



# Agile Software Development Practices in Egypt SMEs: A Grounded Theory Investigation

Amr A. Mohallel<sup>(✉)</sup>  and Julian M. Bass<sup>(✉)</sup> 

University of Salford, Manchester M5 4WT, UK  
a.hamed@edu.salford.ac.uk, j.bass@salford.ac.uk

**Abstract.** Agile information system development methods have been adopted by most software development organizations due to their proven benefits in terms of flexibility, reliability, and responsiveness. However, companies face significant challenges in adopting these approaches. Specifically, this research investigates challenges faced by software development companies in Egypt while transitioning to Agile. As little previous research is available targeting their concerns, we have conducted a grounded theory investigation. Key problem areas were found including lack of cadence in sprints planning, inadequate use of effort estimation and product quality issues.

The developed grounded theory reflects on the key problem areas found with SMEs adopting agile practices and can be used by software development practitioners adopting agile methods in Egypt or similar developing countries as an outline for the common problem areas they are expected to find.

**Keywords:** Agile methods · Egypt · Agile methods adoption

## 1 Introduction

Agile methods are based on an iterative and incremental approach where projects are divided into smaller analyze, implement, integrate, and test cycles. They have been shown to be more effective for software development than traditional waterfall models for small and large-scale projects [1].

Although Agile methods have been adopted by the software industry for more than a decade and started to rise with the Agile Manifesto in 2001 [9], it only started to gain popularity in Egypt a decade later. Based on the first author's previous experience of the Egyptian software development sector, we were aware that agile practitioners in Egypt are struggling to make the transition from traditional development models to Agile.

After conducting research interviews with Egyptian agile practitioners, we have learnt about their struggle with adopting agile development practices. Little previous research is available to study or investigate their problem areas, therefore, we are conducting this exploratory research to identify, evaluate, and potentially mitigate their problems.

We approached the problem using grounded theory which is based on interviewing agile practitioners and identifying their key problem areas. Findings from data collection were analyzed and evaluated in comparison to the current literature.

The aim of this research is to get an in-depth understanding of the agile software development practices and help Egyptian practitioners overcome their problem areas. This was achieved by interviewing 9 agile software development practitioners using Scrum (the most popular method for agile project management [2]), in 7 companies, in the north of Egypt. The findings showed mixed results in terms of agile adoption.

Although the interviews did show clear motivation from practitioners to adopt agile methods, four key common problem areas were found:

- Scrum is based on *Sprints* i.e. repeatable time-boxes during which a potentially shippable product is delivered. Sprints ideally vary from 1–4 weeks [2]. The reason why these time-boxes are fixed is that they help teams calculate their *Velocity*. Velocity is one of the key outcomes of applying Scrum to software development. It is a metric for work done by a team in a sprint. Scrum teams use velocity for effort estimation before a project starts and for forecasting the amount of time needed to complete a given project [16]. We discovered that companies tend to change the length of sprints based on the workload they put in each.
- Unlike traditional software development methods that calculate the time needed to complete a given task by looking at how big it is, Scrum uses story points which takes priority, size and complexity into consideration. We discovered that companies have insufficient use of story points which leads to a dramatic failure in sprints planning.
- As Scrum promotes constant deliverables in short periods of time to enhance, practitioners experience higher levels of stress which negatively affect the quality of products.
- Teams have difficulties handling task switching and handoffs.

The contribution of this research is a grounded theory that can be used by software developers adopting agile methods in Egypt or similar developing countries that sets an outline of the common problem they are expected to find and how to mitigate them.

## 2 Related Work

Software development models have been produced to help organize, scope and keep software projects on time and within budget. Agile software development methodologies were developed to help solve the problems aroused by traditional development methodologies [3]. The main goal of applying Agile methods is having a more adaptable, flexible and responsive development lifecycle.

It has been shown that agile methods improve both product quality and development productivity [21], they enhanced customer involvement, adaptability and incremental delivery of software projects [22].

The Agile manifesto defined a set of values and principles for developing software projects [20]. Since then, several methods (e.g. Lean [23], Extreme Programming [9])

and Scrum [23]) were defined to provide guidelines and clear up the application of the Agile values in the development of software projects.

Agile development is based on self-organizing teams [26] who collaborate to adjust to customers' changing requirements [24]. Several practices are adopted in Agile methods, however, daily stand-ups, sprint planning and retrospectives are the most commonly used, with a percentage of 90%, 88% and 85% respectively [6].

Although guidelines and practices are defined for applying Agile methods in software development, companies, especially SMEs tend to 'cherry-pick' selected Scrum and XP practices from the full constellation of practices available [19].

Agile software development has been an active area of research ever since the agile manifesto was published in 2001, however, the research literature fails to reflect specific challenges faced by Egyptian practitioners. By 2012, from a sum of 1,427 papers on agile methodologies, only one paper was based on Egyptian experience [25].

Some research did focus on investigating software development challenges faced by practitioners in smaller software companies in specific regions e.g. sub-Saharan Africa where contributions were to literature in areas such as agile awareness and adoption challenges [8]. It was concluded that further research is required on how agile methodologies can be tailored for use in a developing country context.

### 3 Research Methods

#### 3.1 Research Sites

We were curious about exploring the transition process and whether agile is adding value to the practitioners or not. There is a lot of focus in literature on studying agile practices in European/western countries, while little research focused on studying agile practices in Egypt [25]. In that sense, we do believe that this study is ground-breaking.

#### 3.2 Data Collection

As presented in [4], this study is to follow a grounded theory approach to gather and analyse data from agile practitioners in Egypt. Grounded theory is a qualitative research method that seeks to discover emerging patterns in data. Data collection was based on reviewing agile practices in literature, artefact modelling and interviewing agile practitioners.

**Sampling.** The sample identified in this study is composed of 9 agile practitioners including 3 project managers, 1 business analyst (ex-developer), 1 quality assurance engineer, 1 senior software engineer and 3 junior software developers. The selected companies have 5–25 employees with businesses offering custom web-based software solutions. All 7 companies have been using Scrum for less than 5 years.

After engaging 9 interviewees, the data collection process did reach a saturation level as no new data is being revealed by collecting more data if more interviewees are to be made. Qualitative research should not be concerned about how many people contributed to a study as long as the interviews did discover new constructs and values [5].

Although minor data will always be revealed from conducting more interviews, the main issues raised as a result from the interviews were pretty much the same (as explained further). For this reason, the chosen individuals who contributed to the study were chosen carefully to represent different points of views and aspects depending on their various specialties and experiences dealing with practicing agile development.

**Coding Scheme.** Companies were coded from Comp1 to Comp7, while participants were coded as follows:

- Project managers: PM1, PM2, and PM3
- Business analysts: BA1
- Senior software engineers: SSE1
- Quality assurance engineers: QA1
- Junior software developers: JD1, JD2, and JD3

**Creating the Interview Guides.** As Scrum was initially based on principles from Lean manufacturing [7], and since the fact that the main idea behind Lean is to provoke the customer-focused value idea while mitigating waste as is the case for all the agile approaches, the interviews were built to help rate each company on how Lean they are. The interview guide was developed to cover each individual's implementation of agile practices and artefacts along with their use of Lean software development.

### 3.3 Data Analysis

The data is to be extracted from the interview scripts following a content analysis approach [27]. In content analysis, responses are coded based on patterns or themes found in the interview scripts.

*Selective Coding* (also known as *Open Coding*) is the first step of data analysis where it starts by noting down *Key Points* during and post every interview, then coding these points to summarize findings [27].

While conducting the interviews, memos were written down to summarize the main issues faced by each interviewee. Then the constant comparison method [27] was followed where the memos were constantly edited and enhanced. By the end of the interviewing process, the core issues raised were categorized into core categories based on the generated memos.

## 4 Findings and Data Analysis

While conducting the interviews, key points were noted along with a memo for each interview reflecting on the key problem areas faced by each individual. The constant comparison method [26] was used to enhance and develop the resulting memos. After having all the memos written, three of them were chosen to represent three core categories. The resulting core categories are:

### 4.1 Lack of Cadence in Sprints Planning

The conducted interviews did investigate the efficiency of the teams’ planning for their sprints and backlog items. The first interesting topic raised was the dynamic duration of the sprints. 4 out of the 7 companies involved in the study did plan for dynamic sprints where a sprint duration is decided mostly upon the amount of work that needs to be done in the given sprint.

All participants were asked about their default sprint length and whether they change it or not. Table 1 summarizes their answers.

**Table 1.** A table showing for each company, the sprints duration and if they’re dynamic or not

Companies	Comp1	Comp2	Comp3	Comp4	Comp5	Comp6	Comp7
Participants	PM1 & BA1	SSE1	JD1 & JD2	JD3	PM2	PM3	QA1
Duration (weeks)	2–4	1.5	4	2	3	1–4	2–3
Dynamic?	Yes	Yes	Yes	Yes	No	Yes	No

As presented in Table 1, we had different opinions on the lengths and dynamic nature of the sprints. *“Some sprints were 2 weeks, others were 3, and sometimes it could take a bit longer to a month. Sometimes we have very short sprints, as for those made to fix bugs”* -PM3; *“Sprints length changes. The first two sprints were 3 weeks. The current sprint is four”* -PM1; *“95–98% of our sprints are fixed to 3 weeks. Under some circumstances, we could have a hotfix, or we find that a group of story points can better be completed in the same sprint together, so we could have a 1–2 weeks sprint to get them all done then.”* -PM1.

So it appeared that most of the companies do change the duration of their sprints depending on the workload in each sprint. This has been described by using terms such as *“Well, it depends on what are we working on”* -JD1; *“So you decide a sprint length depending on the amount of user stories you want to accomplish in it?”*-Interviewer, *“Basically, yes”*-PM1.

Comp2 seemed to have shorter sprints to get faster feedback; *“We ‘tend’ not to exceed one and a half weeks. Just not to redo a lot of work if the feedback wasn’t positive”* -SSE1.

### 4.2 The Inadequate Use of Effort Estimations

After investigating the sprints durations, all participants were asked to rate their sprint planning from their own point of view as follows:

*“How much would you rate your sprint planning in a scale from 0–10? Where 0 reflects very bad planning, and 10 reflects perfect planning.”* -Interviewer

As presented in Table 2 below, the interviewees gave an average rate of 4.5 to the sprints planning of their current or last completed projects.

**Table 2.** Interviewee’s individual rating on their company’s sprints planning efficiency

Interviewee	PM1	PM2	PM3	BA1	SSE1	QA1	JD1	JD2	JD3
Rating	7	8	7-8	0	3	7	3-4	-	5

Most participants mentioned that the lack of efficiency of sprints planning is mostly related to weak effort estimation. This was clear to us from answers like “[Planning fails] Mainly due to the bad estimation of time”-JD1; “[Sprint planning is] Very bad mostly due to bad estimates” –BA1; “Mainly due to the bad estimation of time”-JD1; “I believe estimation is the most painful part”-PM2.

While the inaccurate effort estimation problem started being a key point, we started investigating the estimation criteria in each company. To begin with, the interviewees were asked about the units they use for measuring their estimates. Five companies were using points-based estimation as their used effort estimation unit, while 2 were using hours.

Participants who used hourly-based estimation agreed on its unreliability; “I believe time-based estimations always give false numbers” -BA1; “I believe estimating tasks in hours just makes everything stressful. It doesn’t usually count time for testing, validation, documentation, etc.” -JD2.

However, those some of those who used story points mentioned that they struggle with applying it. “I wasn’t comfortable using it. Neither me, nor my teams.”-PM3; “see it beneficial when it comes to performance tracking” -QA1. PM2 stated that story points were “easy to understand, but definitely hard to master”. Four out of the five companies using story points clearly shown the teams misunderstanding of how points estimation works. “Developers always tend to use time-based system. They normally calculate how much time would it take them to finish a given task, then convert the hours to points” -BA1. SSE1 explained how they estimate points as “We use points where each point represents two hours.

Although PM1 did mention how he does not encourage developers to use time as a main factor when deciding how many points they need to complete a given task, his opinion was still somehow unclear. So he was asked if a developer has a min or max number of points to burn in a given period of time. He answered “Typically, a developer should burn an average of 2 story points per day. A working day has 7 working hours; therefore, a story point should take an average of 3.5 working hours.” –PM1.

PM2 made a point on the connection between time and points showing how important the time factor is as this is what the client wants to hear at the end (similar to PM3). He also added how he does intrude the estimation process when he finds out that his development teams are giving estimations that would not fit with budget. Seems like it was the case with JD2, she stated that she gets assigned to a task with an estimated time to finish it. Same with BA1 where he said that “Team leaders make a point estimation and pass it to developers.” –BA1. PM2 does the same with his team, and when asked for the reason, he said “When you give a certain team the full responsibility to make their own estimations, they always tend to over-estimate story points just to feel more relaxed and less tensed while developing the given project.” –PM2



### 4.3 The Pressure Factor and Code Quality

While the constant pressure on software development teams was being mentioned by more participants, a direct connection started to rise between the pressure and the overall product quality.

As claimed by PM2 in the quote above, teams do tend to over-estimate the efforts they need to finish a given job. He claimed that the reason behind their tendency to over-estimate is “just to feel more relaxed and less tensed”.

JD1 and 2 did show their concern with agile being stressful; “[Scrum] is generally more stressful”; she later added “it stresses me out having to attend a meeting every day to report my progress” -JD1. PM3 also made the same point on stress stating:

“Instead of dividing a given system into phases and get feedback on each phase, we had to develop fully-functional releases that the customer can actually use and start inputting data into. This caused more much stress on the development team due to the small intervals of time needed to produce functional releases, however, the teams produced better outputs” -PM3.

QA1 approved the point stating that he has issues with Scrum rushing their work; “We always have pressure and deadlines where we have to submit tasks and so on, sometimes there are too many stories are assigned to a two weeks sprint. Sometimes we don’t have time to finish them while maintaining testing and so on.” -QA1.

JD2 mentioned that her main cause of stress is that “..They [the team leaders who estimate the tasks for her] normally do not count the time needed for testing, validation, documentation, etc. So, when I have a short period of time, I find myself skipping everything but actual coding.” -JD2

Those participants how mentioned that Scrum makes them to be in a constant rush, they were asked about how they think rushing the project affect the quality of their work.

Some participants mentioned this affects documenting their code; “We have no time to document the code.” -SSE1; “I never really have time [for documentation]”-JD2; “As the nature of work in the company being in a continuous rush; documentation is often done.” -QA1.

Others mentioned problems with testing; “I believe it causes a lot of pressure on us. Rushing always prevents us from having enough time to conduct complete regression testing to discover problems or bugs.” -QA1; “Due to the fact that he [the manager] is always in a rush, we couldn’t make any test-driven development or unit testing, etc.” -JD3.

## 5 Discussions and Evaluation

The data collection did show how the participants were motivated to adopt the agile project management methodologies, more precisely Scrum. All the participants did show decent understanding of the agile practices and how they could be applied.

## 5.1 Key Problem Areas

**Inadequate Use of Effort Estimation.** The accuracy of effort estimation can indeed determine the success or failure of any given software development project [10]. As presented in the data analysis, participants did manage to find the connection between weak effort estimation and weak sprints planning. In fact, some practitioners did mention how effort estimation is their biggest problem since they made the transition to adopting the agile methodologies.

While analyzing the collected data, we found out that five out of the seven companies that participated in the study did use the Scrum point-based estimation system which is the recommended effort estimation system in Scrum [11] and is the most used estimation system by Scrum practitioners worldwide [12], nevertheless, practitioners did find difficulties using it.

The estimation accuracy for teams do increase remarkably when planning poker is used for planning releases [13]. Two studies were conducted to compare a given group's estimation accuracy using planning poker to traditional individual-expert-based estimations. The results did show how the group's estimations using planning poker were much less optimistic and much more realistic [14].

The story points estimations does rely on three factors i.e. priority (= urgency\*business value), size, and complexity factors [15], however, as presented in the analysis above, teams always tend to use time as the only factor when estimating their efforts. Although some research does not include time as a factor at all [15], PM2 did mention how his teams realized that time is at least becoming a less important factor by time. When he was asked about his teams' accuracy with estimating efforts using points, he did mention how their accuracy was raised from 60% to 70% in one year. QA1 also mentioned how the more his team work together, the more accurate estimations they make.

Estimating points using planning poker can be difficult, but our findings and literature does prove how teams show constant improvement as they do more work together. In case the teams are given tasks with pre-estimated points, there will be no chance of getting the estimation accuracy increasing.

**The Lack of Cadence in Sprint Planning.** Although the teams' commitment to their sprint duration is a crucial pillar of Scrum [18], Our findings along with cases in literature [18] did show how development teams struggle to stay committed to their sprint length decisions, so they end up extending it to fit the required user stories. In fact, some participants did build the whole plan on a dynamic sprints basis.

Calculating the velocity, which is the key metric of Scrum [16], is based on having the sprints duration fixed. Without velocity, it is impossible for a product owner to estimate how many sprints a team needs to burndown a given number of stories. However, this didn't seem to be a problem for most of the participants. We had interesting opinions about the reason why they do not worry about velocity; "each developer/team builds a reputation by time that indicates whether he/they can finish the assigned task in the given story points they estimated. I don't believe team velocity

should be calculated as a quantitative number.” –PM1; “I don’t bother [calculating velocity]. I don’t find it [burndown charts] very beneficial if the team is going smooth with the estimates” -PM3.

**Constant Pressure and Code Quality.** As presented in the findings about, all the participants -apart from project managers- did state that they either do minimal testing and almost no documentation for their code. The findings did explain how the main reason was the constant pressure and lack of time availability.

Many reasons can cause pressure on the team; that is why it is the scrum master’s responsibility to be constantly observing his team’s social/psychological aspects. Product owners or the management can also indicate whether the team is under pressure or not.

The findings did show the constant problem between project managers not relying completely on a team to make his estimations because they are expected to over-estimate their effort to be more relaxed, and on the other hand, developers do need time to make sure they get their job done right.

In Scrum, although the development teams can make use of some experienced guidance, they must estimate the story points for each backlog item, and they should be responsible for choosing how much work they can do in each sprint [17]. However, in some investigated cases, the development teams were not trusted to give their own estimations. They were either given a task with pre-estimated duration or given a certain amount of tasks to complete in a given sprint.

**Agile and Flexibility.** Sprints in Scrum should range from one to four weeks having the same length during the project [2]. The term “suggested” was intentionally used in the above sentence. In fact, most of the Scrum practices are not standardized. There are no rules or guidelines that can walk you through some steps or practices that can guide you to make the best use out of agile. It is seen more like a framework. It is based on some set of principles providing the foundation to which a team will add its own approaches and practices. The result of applying Scrum will always be a unique version for each development team.

However, practitioners did seem to confuse the difference between customizing a practice and ignoring it. Scrum does offer some foundational practices where the more you ignore them, the less benefits you are getting from the whole approach.

The term “suggested” did not refer to the sprint length being fixed. It was proven that the companies using dynamic sprints are totally losing the benefits of calculating velocity, hence not being able to make accurate forecasting, hence making the burndown chart lose its indication capabilities.

Although the more teams collaborate, the more they realize that burndown charts are getting more and more accurate, and the velocity is stabilizing over time. Scrum is not about steadily improving the velocity, it’s about making the velocity measures more accurate, so that you can more reliably predict how much you can develop in an iteration. Scrum teams work more on driving predictability in the process more than they work on productivity.

## 6 Conclusions

The participants in our research mentioned how adopting agile had a positive reflection on both their software development process and the overall satisfaction of their customers. However, since their migration to agile, many challenges were faced to implement Scrum, the most commonly used method for agile project management.

This paper presents a grounded theory investigation that was conducted with agile practitioners in Egypt regarding the challenges they face with adopting agile methods. Memos were written to reflect on the main problems faced by practitioners. Using the constant comparison methods, core categories were written to represent the common key problem areas found during the memoing process. These problem areas are (a) lack of cadence and insufficient planning of sprints, (b) constant pressure on development teams and (c) inadequate use of effort estimation.

## 7 Future Work

The next stage of our research will be to explore lean principles e.g. eliminating waste, amplifying learning, team empowerment, and building integrity in. We expected to find companies using Lean principles, so we built our interviews to reflect on how *Lean* companies are. However, our approach did not fit very well as what we found the challenges to be more fundamental with applying agile development which made the whole assessment process in terms of Leanness not practical.

## References

1. Brhel, M., Meth, H., Maedche, A., Werder, K.: Exploring principles of user-centered agile software development. *Inf. Softw. Technol.* **61**(C), 163–181 (2015)
2. Rubin, K.: *Essential Scrum: A Practical Guide to the Most Popular Agile Process*, 1st edn. Addison-Wesley Professional, Boston (2012)
3. Pikkarainen, M., Haikara, J., Salo, O., Abrahamsson, P., Still, J.: The impact of agile practices on communication in software development. *Empir. Softw. Eng.* **13**(3), 303–337 (2008)
4. Walker, D., Myrick, F.: Grounded theory: an exploration of process and procedure. *Qual. Health Res.* **16**(4), 547–559 (2006)
5. Steinberg, W., Price, M.: *Statistics Alive!*, 2nd edn. Sage Publications, Los Angeles (2011)
6. Rahy, S., Bass, J.: Information flows at inter-team boundaries in agile information systems development. In: Themistocleous, M., Rupino da Cunha, P. (eds.) *EMCIS 2018. LNBP*, vol. 341, pp. 489–502. Springer, Cham (2019). [https://doi.org/10.1007/978-3-030-11395-7\\_38](https://doi.org/10.1007/978-3-030-11395-7_38)
7. Janes, A.: A guide to lean software development in action. In: 2015 IEEE Eighth International Conference Software Testing, Verification and Validation Workshops (ICSTW) (2015)
8. Regassa, Z., Bass, Julian M., Midekso, D.: Agile methods in Ethiopia: an empirical study. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017. IAICT*, vol. 504, pp. 367–378. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_31](https://doi.org/10.1007/978-3-319-59111-7_31)

9. Beck, K.: *Extreme Programming Explained: Embrace Change*. Addison-Wesley Professional/Addison-Wesley Longman Publishing Co., Inc., Boston (1999)
10. Akhtar, N., Ghafir, S., Tripathi, S.: Effort estimation of the scrum based software projects using particle swarm optimization. *Adv. Comput. Sci. Inf. Technol. (ACSIT)* **2**(7), 24–26 (2015)
11. Gandomani, T., Wei, K., Binhamid, A.: A case study research on software cost estimation using experts' estimates, wideband delphi, and planning poker technique. *Int. J. Softw. Eng. Appl.* **8**(11), 73–182 (2014)
12. Mahnic, V.: A case study on agile estimating and planning using scrum. *Elektronika* **111**(5), 123–128 (2011)
13. Méndez Fernández, D., Penzenstadler, B., Kuhrmann, M., Broy, M.: A meta model for artefact-orientation: fundamentals and lessons learned in requirements engineering. In: Petriu, Dorina C., Rouquette, N., Haugen, Ø. (eds.) *MODELS 2010. LNCS*, vol. 6395, pp. 183–197. Springer, Heidelberg (2010). [https://doi.org/10.1007/978-3-642-16129-2\\_14](https://doi.org/10.1007/978-3-642-16129-2_14)
14. Usman, M., Mendes, E., Britto, R., Weidt, F.: Effort estimation in agile software development. In: *Proceedings of the 10th International Conference on Predictive Models in Software Engineering - PROMISE* (2014)
15. Zahraoui, H., Idrissi, M.: Adjusting story points calculation in scrum effort & time estimation. In: *2015 10th International Conference Intelligent Systems: Theories and Applications (SITA)* (2015)
16. Downey, S., Sutherland, J.: Scrum metrics for hyperproductive teams: how they fly like fighter aircraft. In: *46th Hawaii International Conference on System Sciences*. IEEE, Wailea (2013)
17. Viscardi, S.: *The Professional Scrum Master's Handbook*. Packt Publishing, Birmingham (2013)
18. Sutherland, J., Schwaber, K.: *The Scrum Guide*. O'reilly, Sebastopol (2013)
19. Clutterbuck, P., Rowlands, T., Seamons, O.: A case study of SME web application development effectiveness via agile methods. *Electron. J. Inf. Syst. Eval.* **12**(1), 13–26 (2009)
20. Agilemanifesto. <http://agilemanifesto.org/>. Accessed 10 Oct 2018
21. Dyba, T., Dingsøyr, T.: What do we know about agile software development? *IEEE Softw.* **26**(5), 6–9 (2009)
22. Dingsøyr, T., Nerur, S., Balijepally, V., Moe, N.B.: A decade of agile methodologies: towards explaining agile software development (2012)
23. Poppendieck, M.B.: *Lean Software Development: An Agile Toolkit*. Addison-Wesley, Boston (2003)
24. Santos, V., Goldman, A., Desouza, C.: Fostering effective inter-team knowledge sharing in agile software development. *Empir. Softw. Eng.* **20**(4), 1006–1051 (2015)
25. Dingsøyr, T., Nerur, S., Balijepally, V., Moe, N.B.: A decade of agile methodologies: towards explaining agile software development. *J. Syst. Softw.* **85**(6), 1213–1221 (2012)
26. Hoda, R., Noble, J., Marshall, S.: Supporting self-organizing agile teams. In: Sillitti, A., Hazzan, O., Bache, E., Albaladejo, X. (eds.) *XP 2011. LNBP*, vol. 77, pp. 73–87. Springer, Heidelberg (2011). [https://doi.org/10.1007/978-3-642-20677-1\\_6](https://doi.org/10.1007/978-3-642-20677-1_6)
27. Georgieva, S., Allan, G.: Best practices in project management through a grounded theory lens. *Electron. J. Bus. Res. Methods* (2008)



# Experiences from a Development Project in Kenya – Baselines for Future Climate Information Systems

Jaakko Helminen<sup>1</sup>(✉), Balozi Bekuta Kirongo<sup>2</sup>, Silvia Gaiani<sup>1</sup>,  
Ezra Misaki<sup>3</sup>, Mikko Apiola<sup>1</sup>, and Erkki Sutinen<sup>1</sup>

<sup>1</sup> Department of Future Technologies, University of Turku, Turku, Finland  
{jaakko.a.helminen,mvapio,erkki.sutinen}@utu.fi,  
silviagaiani@yahoo.it

<sup>2</sup> Department of Forestry and Wood Science,  
University of Eldoret, Eldoret, Kenya  
balozibk@hotmail.com

<sup>3</sup> College of Business Education,  
Dar es Salaam Campus, Dar es Salaam, Tanzania  
e.misaki@cbe.ac.tz

**Abstract.** This paper explains our efforts in regards of hybrid climate services.

As one part of our research efforts and exploration in Africa, we have worked with the Marigat District in Baringo County, Kenya, where we first intended to help the farmers to replace the invasive *Prosopis juliflora* deep-root species by another deep-root species easier to keep under control. Data was collected through questionnaires with open-ended and closed-ended questions to find a baseline of community challenges and technology use. The lessons learned in the project inspired us to analyze the data by using the lens of Heeks' [3] design theories. The main outcome of this study is a hybrid evaluation and its discussion with future implications for future climate services.

**Keywords:** Climate information systems · Agriculture · Developing countries

## 1 Introduction

During the recent decades, climate has started to change and so its variability as well. Hence the variety of climate impacts affecting everyday life especially in developing countries has changed and led to a growing need for hybrid and locally pertinent climate services. In line with this we started from the design research framework [1] as well as critical systems heuristics [11] and proceeded with local partners in a participatory way to imagine and co-create climate services for end-users in Kenya. In this article we focus on understanding the baseline situation and related technology usage for crucial farming and other decisions with using the method of Heeks [2] as one of our lens and tool, as well as with future needs for improved climate information systems in mind.

Another kick-off to our start came from the design-thinking paradigm [3, 4]. We encountered *empathy* as its first stage of the inspiration space. According to Brown [3] the objective of the empathy stage is to experience a problem or an opportunity, which sets the relevant participants in motion. We joined a pre-negotiated program and adapted our sub-project, described in this paper, to its larger objectives without losing our freedom to study problems and opportunities, which were pertinent for this project as well as its information systems, and included also the evaluation of our sub-project. Our preliminary data collection started by studying available local climate services and related general baselines in Marigat District, Kenya, with recommendations for actionable climate knowledge [5] in mind.

In the following sections we briefly describe the situations at the time of our field trip to Eldoret and Marigat District, Kenya. Then we cover the processing of parts of the interview material and introduce next the method, by which we evaluate the silvicultural information systems and the baseline data [2]. Thereafter we show pertinent results of the interviews as well as our evaluations of the baseline data and associated forestry information systems. In the context of the discussion and conclusions we mention the stalemate we encountered in Eldoret and Marigat District. The lessons learned inspired us to further apply and extend the evaluation method of Heeks [2] in the context of developing appropriate hybrid grass-root mobile climate services for local farmers in Kenya. Our suggestions include extending observations by Heeks [2] with suggestions that are based on co-creation and participatory design [3, 4]. Finally to conclude we share our inspirations with the readers.

## 2 The Project and Related Consortium

In the context of the umbrella project on “Building further capacity in Kenya: Strengthening practical & ICT aspects towards multidisciplinary and community-engaged forestry education” (SFEK) we established a joint project “Holistic grass-root mobile climate services” (HGMCS) with the School of Forestry of the University of Eldoret, Kenya (SF/UOE) and Marigat Research Sub Centre of Kenyan Forest Research Institute (MRSC/KEFRI) as our local hosts, the School of Forestry of the University of Eastern Finland (SF/UEF) and the School of Computing of the University of Eastern Finland (SC/UEF). The Centre for International Mobility, Helsinki, Finland (CIMO) funded SFEK.

Based on the declaration of the Kenyan minister of agriculture *Prosopis juliflora* to be a noxious weed [6] we agreed unanimously with the local colleagues to focus on attempts to replace the invasive *Prosopis juliflora* deep-root species by another deep-root species, which could be kept easier under control in Marigat District, which is located 100 km east-northeast of Eldoret on the opposite side of the Rift Valley. From this point we started our preparations to keep an MSc (Forestry) course on “Forest Management in a Varying and Changing Climate (FMVCC)” with the deep-root species problem in mind. FMVCC took place under mission 2 of SFEK - “Improvement of forest education curricula at MSc and PhD levels”.

As noted, *Prosopis juliflora* is a recent invasive deep-root species in Lake Baringo area and has been discussed by [7]. By considering both its positive and negative effects to the local environment, people have preferred it to be controlled or eradicated [7]. It became clear that actions to eradicate *Prosopis juliflora* species and to replace it by another less invasive deep-root species were needed.

### 3 Crucial Need for Climate Information

Climate change and changes in climate variability are among the most serious problems of the world today. Climate change may cause a number of uncontrolled sequences of fatal harms, and as is well known by recent reports by IPCC<sup>1</sup> it directly threatens the future existence of humankind. The negative effects of climate change are already being experienced globally, particularly in the Global South, mainly by the most vulnerable groups of people, and the situation is getting worse as time passes. Therefore, urgent actions are needed in order to adapt to changing climate conditions. Our observations confirm that climate change and the changes in its variability are pertinent factors in this semi-arid region, too, and it has become clear that local people, typically smallholder farmers and nomads need appropriately tailored climate services.

A number of new climate service projects are underway in Tanzania, Kenya, and Uganda, to name a few examples. A number of projects are still in their developmental stages. However, some evidence of successes have been reported for example by [8]. In their research in Kenya, it was shown that farmers, who received climate information were better in crop management and got higher yields, as compared to farmers in a control group [8]. Thus, while many projects are still in their beginning stages, and many mobile services for agriculture have failed or disappeared, evidence of benefits from new technologies is also starting to emerge, which is encouraging and gives motivation for future efforts.

## 4 Data and Methods

### 4.1 Research Questions

Based on our objectives to develop future hybrid climate services, our preliminary data collection was set to understand the available local climate information systems and practices to gain general baselines of the context in Marigat District, Kenya. In regards of understanding the baseline situation, our research questions were set as follows.

- (1) What are the current baselines for crucial information needs, current strengths, infrastructure, skillsets, climate information, and mobile usage patterns in Marigat District, Kenya?
- (2) How can the baselines for current information and development processes for climate and weather information systems be evaluated from the viewpoint of Heeks' [2] design-reality theories?

<sup>1</sup> <http://www.ipcc.ch>.



## 4.2 Data Collection Protocol and Informants

The data collection protocol was designed to explore the strengths and gaps in baseline and behavior items that are pertinent to hybrid climate services. During data collection, we encouraged the local farmers and nomads to adopt a participatory and co-creative attitude. In order to collect data about the general baselines, a questionnaire was developed. The questionnaire contained both quantitative items with scales such as “good”, “fair”, “poor”, as well as open-ended questions. The questionnaire contained six themes, which were: *community life, personal skills and expectations, local climate impacts and demands for pertinent climate services, ICT and its role in the daily life, livestock related items* as well as *first motivation for nomadism and collaboration to develop relevant local climate services* and finally *trust on other community members*.

The data was collected from the Marigat district in Kenya, from two communities: the Tugen-community and the Njemps-community. In addition to data collection, the visits included a two-week intensive course on climate services in Eldoret. In regards of numbers of respondents, there were a total of 27 respondents (10 females, 17 males). 15 respondents were from Tugen, and 12 respondents were from Njemps.

## 4.3 Data Analysis

First, the questionnaire data was analyzed in the following way. In regards of closed-ended questions, the number of responses per each item were calculated, and modes (Mo) were counted. In regards of open-ended questions, the related qualitative responses were coded so that each item or category was first collected, and then the total number of mentions of that specific issue was calculated. Per each item reported in the results, it is clearly stated if the item was an open-ended or a closed-ended question. This analysis is presented in Sects. 5.1–5.5.

Second, this baseline data was analyzed and evaluated from the viewpoint of the framework presented by Heeks [2], which is introduced in Sect. 4.4. The results of this evaluation are presented in Sects. 5.6–5.12. The analysis of results proceeds following the Heeks’ [2] model, dimension by dimension, i.e. information, technology, processes, objectives and values, staffing and skills, management systems and structures and other resources.

## 4.4 The Evaluation Method of Heeks [3]

In order to evaluate forestry information systems of our interview sites in Marigat District Kenya, we applied the method of Heeks [2]. In our explorations we focused on the existing design-actuality gaps by recognizing as elements of design:

- components from the designer’s own context and
- conceived assumptions about the situation of the end-user.

Our evaluations followed Heeks [2]. We applied his dimensions of relevance:

- information (data store, data flows, etc.),
- technology (both hardware and software),
- processes (the activities of end-users and others),

- objectives and values (the key dimension, through which factors such as culture and politics are manifested),
- staffing and skills (both the quantitative and qualitative aspects of competencies),
- management systems and structures, and
- other resources (particularly time and money).

With pertinent parts of the conducted surveys and interviews as well as related discussions as input we evaluated these seven dimensions separately for the design, represented by the designer, and the actuality, represented by the end-users, by rating on the scale low – medium – high and by taking into account the discussion and ideas of [2]. We considered also the relevant findings from related work [2, 6, 8–11].

## 5 Results

### 5.1 Community Life

In regards of *quality of life*, on a scale of “Good”, “Fair”, “Poor”, and “Can’t assess”, the following responses were given by interviewees. A total of 7 interviewees (4 males, 3 females) considered their life to be “Good”, 11 interviewees considered their life to be “Fair” (7 males, 4 females), 6 interviewees considered their life to be “Poor.” One interviewee responded with the “Can’t assess” option. Thus, the mode (Mo) was “Fair”.

The interviewees’ perceptions in regards of the *prominent main needs* were investigated by using an open-ended question “*At present, what do you think are the main needs/requirements/demands of the community?*” From the answers, the following main needs were found. The most often mentioned *prominent main need* was *access to clean water* (n = 18), followed by *education for children* (n = 11) and *tree plantation* (n = 3). In addition, *medical services*, *good roads*, *electricity*, and *irrigation and seeds* were each mentioned for one or two times in the data. Caretaking of handicapped or the lack of it was found also to be an issue.

The informants’ perceptions in regards of the *main strengths in their communities* were investigated by using an open-ended question. The data shows that among the mentioned strengths, *farming* (n = 17) was the most often mentioned, followed by *keeping livestock* (n = 15). The following strengths of the community were mentioned once or twice in the data: *charcoal burning*, *beekeeping*, *locally available resources*, *teamworking skills*, *fruit business* and *poultry rearing*. The community members were rather unanimous in regards of the main strengths.

In regards of the informants’ perceptions as to the *weaknesses in the communities*, this was also investigated by using an open-ended question. The results show that the most often mentioned weaknesses were *lack of water* (n = 4) and *preparedness against drought* (n = 4). In addition, the following issues were mentioned once, twice or three times: *preparedness against floods*, *poor poverty reduction*, *infrastructure*, *education level*, *business skills*, *communication skills*, *access to markets*, *knowledge of people and leadership*, *lack of food*, *medicine*, *information*, *means of transportation*, *grass*, *electricity*, *technology*, *land possible to cultivate*, *skills*, *resources and livestock*,

*financial constraints, reliance on sole traditional knowledge, exposure on cattle rustling, illiteracy, people afraid, slow change, alcoholism and laziness.* Thus, the informants' perceptions to the weaknesses differed quite much with each other, and the answers seemed not to be too unanimous.

## 5.2 Infrastructure

In regards of *infrastructure items*, the questionnaire asked the informants to classify the following items: *roads, means of transportation, health centers, housing, and support for nomadism* on a scale of “*excellent*”, “*good*”, “*acceptable*”, and “*poor*”. In regards of *roads*, eight respondents ( $n = 8$ ) considered the roads to be “*acceptable*”, while nineteen ( $n = 19$ ) considered the roads to be “*poor*”. No-one considered the roads to be either “*excellent*” or “*good*”. In regards of *means of transportation*, three ( $n = 3$ ) respondents chose “*excellent*”, six ( $n = 6$ ) “*good*”, four ( $n = 4$ ) “*acceptable*”, and fourteen ( $n = 14$ ) “*poor*”. Thus, in regards of roads and means of transportation, the modes (Mo) to both two questions were “*poor*.”

In regards of *health centers*, the responses were as follows: “*excellent*” ( $n = 2$ ), “*good*” ( $n = 0$ ), “*acceptable*” ( $n = 10$ ), “*poor*” ( $n = 15$ ). In regards of *housing*, the responses were as follows: “*excellent*” ( $n = 0$ ), “*good*” ( $n = 2$ ), “*acceptable*” ( $n = 7$ ), “*poor*” ( $n = 15$ ). In regards of *support for nomadism*, the respondents gave the following answers. No-one considered this issue to be “*excellent*”, three ( $n = 3$ ) considered it to be “*good*”, four ( $n = 4$ ) considered it “*acceptable*”, and twenty ( $n = 20$ ) considered it to be “*poor*.” Hence, in regards of all three questions in regards of health centers, housing, and support for nomadism, the modes (Mo) for the questions were “*poor*.”

In regards of the interviewees' *willingness to settle down*, this was queried with a scale of “*yes*”, “*no*”, “*conditionally yes*” or “*conditionally no*.” Of all the respondents, eleven ( $n = 11$ ) answered *yes*, and no-one answered “*no*”. Seven ( $n = 7$ ) answered “*conditionally yes*”, and five ( $n = 5$ ) answered “*conditionally no*.” For those who selected “*conditionally yes*”, an open-ended question was presented. The answers to that question were: *improved services to access water, grass, more land and trees around the village*. Other aspects mentioned included *harsh conditions, willingness to settle down, and demarcation of land*. In regards of suggested changes to the community, in the open-ended answers, the most suggestions centered around *land demarcation* ( $n = 6$ ), *access to clean water* ( $n = 7$ ), *quality education for children* ( $n = 8$ ), and *tree planting* ( $n = 3$ ).

## 5.3 Personal Skills and Expectations

In regards of *skills that the interviewees would like to learn in order to improve their livelihood*, this was queried with an open-ended question. 21 out of 27 interviewees said that they wanted to learn new skills. The answers indicated the following. Improved farming skills were mentioned five times ( $n = 4$ ), bookkeeping skills were mentioned three times ( $n = 3$ ), driving was mentioned four times ( $n = 4$ ), ICT skills was mentioned once ( $n = 1$ ). Quite much other things were mentioned, too. These included: *skills in building irrigation canals, saloon hairdressing, cooking skills,*

*charcoal burning skills, learning to sell, drip irrigation, buying and selling livestock, improving education level, masonry, animal breeding, and food planning.*

In regards of *expectations for the future*, the answers emphasized *electricity and water, improved infrastructure, and self-reliance*. In regards of past and present climate hazards the interviewees listed the following: *droughts (n = 18), floods (n = 13), diseases (n = 7), people displacement because of floods (n = 4)*. In addition, ‘*hunger and poverty*’ was mentioned several times.

In regards of *suggestions to improve actions of local authorities*, this was asked with an open-ended question. The suggestions included *fast responses to needs (n = 3), improved collaboration (n = 4), help in tree planting (n = 3), early warning system (n = 3), basic climate education (n = 3), and improved education (n = 1)*. Other suggestions were (each were mentioned once or twice): *access to clean water, change of river course, move livestock to grassland, getting subsidies, improved infrastructure, plant grass, access to health centers, access to medicine, assistance in selling livestock, assistance in farming, rebuilding houses, materials for new houses, increased government help, and donations and food*. Point of note is that responses to this question were spread on a wide scale, and no single issue was mentioned more than four times.

#### **5.4 Local Climate Impacts and Demands for Pertinent Climate Services**

In regards of *current access to climate and weather information*, the following was observed. For the questionnaire item “current access to climate and weather information”, the interviewees responded *yes* for six times ( $n = 6$ ) and *no* for twenty-one ( $n = 21$ ) times. In regards of *devices used to access climate and weather information*, radio was mentioned seven ( $n = 7$ ) times, television once ( $n = 1$ ), and indigenous knowledge fourteen ( $n = 14$ ) times. In regards of the *main need for climate and weather information*, the following items were mentioned: *information from mobile, radio and community meeting (barasa) (n = 14), rain information (n = 7)*. In regards of the *willingness of the interviewees’ to settle down in case that weather and climate information needs would be met*, the responses were *yes (n = 26)*, and *no (n = 0)*.

#### **5.5 Mobile Technologies**

In regards of *owned ICT technologies*, the following was found. Twenty-six ( $n = 26$ ) persons owned mobiles, twenty-four ( $n = 24$ ) a radio, eleven ( $n = 11$ ) a television, and four ( $n = 4$ ) a personal computer. The most often used ICT technologies were found to be mobiles ( $n = 24$ ), followed by radio ( $n = 4$ ), television ( $n = 1$ ), and personal computer ( $n = 0$ ). In regards of *usage patterns of mobiles*, the following was found. *Making and receiving voice calls (n = 26), sending and receiving short messages (n = 21), taking photographs (n = 13), accessing the internet (n = 11), sending and receiving money (n = 7), and listening to music (n = 1)*. All but one of the interviewees were of the opinion that ICT supported nomadism.

In regards of *communication patterns*, the following issues were mentioned: *communication on proper pastures (n = 11), communication about access to drinking water (n = 6), communication on need for help (n = 6), communication on security*

issues ( $n = 7$ ), communication with veterinarian ( $n = 5$ ). In addition, the following single issues were mentioned: *informing on animal conditions, business and marketing issues, cattle rustling danger, livestock auction dates, and livestock new breeds.*

In regards of *willingness to receive improved climate information*, the following was found. The responses to category “yes” were ( $n = 24$ ), and to category no ( $n = 3$ ). In regards of suggestions on how improved climate information would help in the future, the answers included the following: preparing land in advance ( $n = 7$ ), preparations against hazards ( $n = 3$ ), warnings for impending drought ( $n = 1$ ), and possibility to preserve food ( $n = 1$ ). In regards of the biggest risks for keeping livestock, the following were mentioned: *diseases ( $n = 11$ ), cattle rustling ( $n = 9$ ), droughts ( $n = 20$ ), *prosopis juliflora pads* ( $n = 2$ ), lack of water ( $n = 5$ ). In regards of benefits of improved climate information to livestock production, the following were suggested: *proper timing for selling and buying livestock* ( $n = 15$ ). In addition, one interviewee pointed out the possibility for better timing in preparing tree planting. All interviewees indicated improved climate information would be beneficial to agricultural activities in the community.*

In regards of *trust on other members of the community*, an almost unanimous trust was found. There were 23 of those who trusted everyone, and three ( $n = 3$ ) of those who trusted only a part of other members.

## 5.6 Heeks’ Design Reality Gap: Information

In the context of assessing the quality of community life, as noted in Sect. 5.1, the mode (Mo) of answers was “Fair”. One qualitative comment in the data also read “*people are more informed.*” However, weaknesses in other responses in regards of lack of information, illiteracy, poor communication skills and poor knowledge, it was found that the informants were eager to utilize climate and weather information and related ICT solutions. The willingness to search for information was growing.

One important observation in regards of information was that in regards of some questions, such as *strengths, main needs, and infrastructure*, the respondents were quite unanimous in their responses. However, in regards of some other questions, such as *weaknesses, skills that the interviewees would like to learn in order to improve their livelihood, and suggestions to improve actions of local authorities*, the answers were not unanimous, but almost all participants had their individual views as to the most relevant issues. Thus, community members share quite strong common views into some important questions, while not to some others. For example, in regards of important skills for the future, almost each member had their own ideas.

In regards of climate information, the current access was assessed as “No” by most ( $n = 21$ ) of the interviewees, while “Yes” was selected considerably less ( $n = 6$ ). In regards of *willingness to receive improved climate information*, “Yes” was selected ( $n = 24$ ) times, while “No” was chosen ( $n = 3$ ) times. This indicates that in regards of current weather and climate information, there is a design-reality-gap [2]. In regards of weather and climate information, the respondents were unanimous. In regards of information flow between officials and community people, there were some hints that the information flow was not optimal.

### 5.7 Heeks' Design Reality Gap: Technology

While current access to ordinary mobiles was found to be good, access to other technologies came up mostly as needs or lacks, as seen in Sects. 5.3 and 5.5. There were signs of growing interest in terms of willingness to learn ICT skills. However, the current technology-usage patterns were found to be basic, and modern technology usage was at a very modest level. It must be noted that evidence of climate information systems with evidence of benefits to small scale farmers does not yet exist. Therefore, it is not a matter of *access* or *skills*, but a matter of future co-creation. In regards of future technologies for climate information, this project is at the inspiration stage with empathy as one of its primary tools, where problems and opportunities are first being experienced [3], before it becomes possible to build and test prototypes and later to implement fully operational technologies. The preliminary results indicate that future breakthroughs in technology will most likely happen through co-creation at the grass-root level.

### 5.8 Heeks' Design Reality Gap: Processes

One of the hard processes in our original and agreed plan was the replacement of *Prosopis juliflora* with another deep-root species. According to [7], the eradication of *Prosopis juliflora* from its originally planted area in Baringo County would had cost some one million euros, which the local communities would not have been able to afford. Both this action and to get the expansion of *Prosopis juliflora* under control would have required financial support and specific policies from the authorities.

On one of our first visits to Eldoret and Marigat, we found that in line with the findings by [7, 9, 10], the majority of people in Marigat argued that life would be better without the *Prosopis juliflora* species. For a long time prior to our visit there was no policy guiding the management of the plant but in effect from the end of 2008, when the minister for agriculture declared *Prosopis juliflora* as a noxious weed [6].

With this background in mind it was interesting to see both from our interviews and our surveys that in early 2015 almost nobody told any more of eradication of *Prosopis juliflora* in any of the questionnaires or other related talks. Instead, the local soft processes had been improvised to utilize it in handcrafts and also as raw material for a tuned power station. From our point of view a fast change of process had occurred, which was in complete conflict as to what had been agreed. Therefore, we conclude that lack of trust and commitment in agreed processes constituted a design-reality-gap.

### 5.9 Heeks' Design Reality Gap: Objectives and Values

We came with the hybrid objectives of our hard process and with values, expectations, and biases rooted in all of the local cultures where the authors of this paper originate from. Hence the soft objectives of local people were not always understood. This convinced us about the need for participatory co-creation in technology projects. We found self-reliance as one important wish for the future. Motivation to nomadism was based both on financial gains by selling livestock and on tending a flock while searching for water and pasture. Trust on community members was almost unanimous

and different from some other cultures. On the other hand, while trust was unanimous in regards of the objectives of some issues, such as the most important skills for the future, each community member had their own views. On other issues, such as important needs, the groups views were unanimous. In addition to trust between members, other important attributes in groups were the tolerance for differing view-points, and social-psychological issues of leadership.

### **5.10 Heeks' Design Reality Gap: Staffing and Skills**

Based on our interviews of community weaknesses, lack of skills and poor leadership were mentioned. On the other hand, bookkeeping appeared as a skill some community members wanted to learn ( $n = 3$ ). However, as seen in Sect. 5.3, a number of other skills were mentioned too, including driving, hairdressing, cooking, charcoal burning, selling, masonry, breeding, food planning.

### **5.11 Heeks' Design Reality Gap: Management Systems and Structures**

The interviewees asked us to list current inadequacies in the community baselines. However, management systems and structures were issues that our data did not deal in a great depth.

### **5.12 Heeks' Design Reality Gap: Other Resources**

In other resources we came up with education, poverty, hunger and financial constraints. The interviewees emphasized the need of education for children, even though it was mentioned also as a strength. The mentioned weaknesses included poverty reduction and financial constraints. Impacts of past and present climate hazards having affected livelihood had caused hunger and poverty. Local important responses included the demand for basic climate education and improved education. A general lack of almost all possible resources was permanent, which was in conflict to the answers to general ratings of *quality of life*, which participants assessed as “Fair” (Sect. 5.1). It calls into question the reliability of answers to the question and possibly the tendency to give socially acceptable answers to questionnaires by outsiders. This observation contributes as one sort of design-reality-gap when future technologies or other interventions are planned.

## **6 Discussion and Conclusions**

From this project we were left with some successes, some failures, and lessons learned. In regards of *Prosopis juliflora*, the problem still remains unresolved. It is obvious that our original hard process needed to be revised to become softer and to allow for improvisations. On the other hand, in line with the design-thinking paradigm [3, 4], we were able to experience local challenges, problems, and opportunities and collect reliable baseline data about the pertinent issues. This helped in building trust and

connections in order to continue with possible future activities and initiatives. In discussing our results, we turn now to the specific research questions.

Research question 1 asked “*What are the current baselines for crucial information needs, current strengths, infrastructure, skillsets, climate information, and mobile usage patterns in Marigat District, Kenya?*” Our results showed the following.

First, the baseline data revealed a number of crucial needs in regards of equipment, access to resources, to medical care and to clean water, needs for educational resources, and demands for a variety of skill development opportunities. In regards of technology usage, the current usage patterns were mostly non-agriculture and non-climate related. The need for improved climate and farming information and services became clear, and this was one of the issues, where the locals were unanimous. In regards of some issues, the participants were unanimous. However, in regards of some other issues, such as the most important skills for the future, their opinions in regards of the most important lines of action differed quite much.

Our recommendations included the need to focus on areas where the collected information showed largest diversity and to think carefully, which parts of the data are crucial. As changes in current strengths, infrastructure and skillsets can occur even in a short time, follow-up studies are needed for these items. The awareness and access of climate information demanded strengthening in order to enhance the use and the learning of climate knowledge [5]. The use of mobile technology seemed to be wide and the leading way for communication. This provides a platform for future climate services. In regards of designing those services, co-creation and participatory design are recommended. In one way or the other, a number of stakeholders, who may not otherwise communicate very well with each other, need to be included in the design processes. Building commitment and trust is a crucial factor here. Projects that start with good intentions end too often when commitments and priorities change.

Research question 2 asked “*How can the baselines for current information and development processes for climate and weather information systems be evaluated from the viewpoint of Heeks’ [2] design-reality theories?*” Our results show the following.

Our answers show that the dimensions of information, technology, processes, staffing and skills as well as management systems and structures are closely related to the operational aspects of climate and weather services. In addition, these dimensions overlap with the objectives and values as well as some other resources when we build hybrid climate services. For us, it was crucial to update our understanding with the interviews in regards of the local current baseline. First, we could see that a part of the responses were reasonable coherent, whereas some others were quite diverse. We may ask, how we could achieve a reasonable consensus. Should we encourage people for co-creative cooperation and take first steps to absorb, not just climate information, but to process it to climate knowledge in their minds.

Second, we face the challenge to narrow the design-reality gaps in terms of Heek’s [2] model. Beside climate knowledge, this is another life-long exercise. Third, we see improvisation (Heeks [2]) as a vital tool for narrowing design-reality gaps. Fourth, with the ever-hectic changes in our environment we need agility in our responses. Hence, we would like to see agility to be extracted as an explicit new dimension from other resources in Heek’s [2] model. Last but not least, we would recommend that evaluation would become an inseparable part of any development project.



## References

1. Hevner, A.R., March, S.T., Park, J., Ram, S.: Design science in information systems research. *MIS Q.* **28**(1), 75–105 (2004)
2. Heeks, R.: Information systems and developing countries: failure, success, and local improvisations. *Inf. Soc.* **18**(2), 101–112 (2002)
3. Brown, T.: *Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation*. Harper Collins, New York (2009)
4. Both, T.: Design project scoping guide. Hasso Plattner Institute of Design at Stanford, Stanford University, Palo Alto, California, USA (2016). <https://dschool.stanford.edu/resources/design-project-guide-1>
5. Meinke, H., Nelson, R., Kokic, P., Stone, R., Selvaraju, R., Baethgen, W.: Actionable climate knowledge – from analysis to synthesis. *Clim. Res.* **33**, 101–110 (2006). [http://www.int-res.com/articles/cr\\_0a/c033p101.pdf](http://www.int-res.com/articles/cr_0a/c033p101.pdf)
6. GoK [Government of Kenya]: The Kenya Gazette of 9th January 2009, vol. CXI, no. 2 (2009)
7. Maundu, P., Kibet, S., Morimoto, Y., Imbumi, M., Adeka, R.: Impact of *Prosopis juliflora* on Kenya's semi-arid and arid ecosystems and local livelihoods. *Biodiversity* **10**(2–3), 33–50 (2009). <https://doi.org/10.1080/14888386.2009.9712842>
8. Rao, K., Hansen, J., Njiru, E., Githungo, W., Oyoo, A.: Impacts of seasonal climate communication strategies on farm management and livelihoods in Wote, Kenya. In: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)/CCAFS Working Paper no 137 (2015)
9. Kipchirchir, K.O., Ngugi, K.R., Wahome, R.G.: Use of dry land tree species (*Prosopis juliflora*) seed pods as supplement feed for goats in the arid and semi arid lands of Kenya. *Environ. Res. J.* **5**(2), 66–73 (2011)
10. Mwangi, E., Swallow, B.: *Prosopis juliflora* invasion and rural livelihoods in the Lake Baringo area, Kenya. *Conserv. Soc.* **6**(2), 130–140 (2008)
11. Ulrich, W., Reynolds, M.: Critical systems heuristics. In: Reynolds, M., Holwell, S. (eds.) *Systems Approaches to Managing Change: A Practical Guide*, pp. 243–292. Springer, London (2010). [https://doi.org/10.1007/978-1-84882-809-4\\_6](https://doi.org/10.1007/978-1-84882-809-4_6). <http://oro.open.ac.uk/21299/1/systems-approaches>



# How South African University Information Systems Students Are Using Social Media

Yazeed Seedat<sup>(✉)</sup>, Sumarie Roodt<sup>(✉)</sup>,  
and Samwel Dick Mwapwele<sup>(✉)</sup>

The University of Cape Town, Cape Town 7700, South Africa  
{sdtiaz002,mwpsam001}@myuct.ac.za,  
sumarie.roodt@uct.ac.za

**Abstract.** Social media is a term used to combine social networking, media sharing and microblogging systems. Social media assists students to improve their academic studies, allows collaboration and sharing of information with each other, and affords students to know what is happening in the world, acquire pictures and videos in support of such information. Information Systems (IS) students are the next generation of technology experts and their exposure to using social media as an alternative source of information and for collaboration might affect features included in systems.

This research was conducted following a positivist approach which used a quantitative method to investigate the usage of social media in higher education. An online questionnaire was distributed to undergraduate Information Systems students via email with a link to the questions provided. Statistical inference was performed to test the usage of social media in higher education through the Unified Theory of Acceptance and Use of Technology (UTAUT).

As a result, students viewed social media as a learning tool since it allowed them to enhance their academic performance and ability to explore knowledge. Social media also allowed students to communicate, share and collaborate. Research model confirmed that there's a positive relationship between social media and the behaviours of undergraduate students and regarded social media as a learning tool.

**Keywords:** Generation Z and use of social media ·  
Use of social media in higher education ·  
Undergraduate students and use of social media ·  
Undergraduate students in South Africa and use of social media ·  
Operationalization of UTAUT

## 1 Introduction

Social media is one of the most common and important communications networks used by individuals and groups. Social media is defined as “the collection of Internet websites, services, and practices that support collaboration, community building, participation, and sharing” [1, p. 2]. Social media allows a user to “share information, files, pictures and videos, create blogs, send messages, and conduct real-time conversations” [2, p. 2].

Students attending higher education institutions are considered digital natives since they are part of Generation Z. Generation Z refers to individuals born after 1996 and have not experienced life without the Internet [3]. Students from Generation Z are familiar with interacting and communicating in a world that is always connected to the Internet which includes social media.

Information systems (IS) students in higher education are expected to join organizations in different roles upon graduating. The roles include systems analysts, data analysts, system testers, systems developers, database administrators and business analyst [4]. These roles afford them the link to businesses and organizations with technology where students can advise on what features should be included in upcoming systems based on their skills, exposure and prior knowledge. It is a crucial role as most organizations in the world are adopting systems that enhance efficiency and effectiveness in conducting businesses [5].

Social media has been argued as one of the systems that employees use to waste time and reduces efficiency [6]. One way to taste this claim is to engage with people who interact with businesses and advice on systems for companies to adapt and in this case, IS students [4]. Thus, the research poses the question, *what is the usage of social media by information systems undergraduate students in higher education in South Africa?* The research provides empirical evidence from South African information systems undergraduate students in the quest of describing their actual use of social media and thus validating UTAUT.

This empirical research begins with a summary of the literature in relation to key concepts leading to the use of UTAUT, thereafter research methodology is provided which explains how the research was conducted. Findings and discussion are presented and related to literature. The research concludes by explaining the contributions of the study.

## 2 Literature Review

### 2.1 Undergraduate Students and the Presence of Generation Z

Undergraduate students that are currently studying in higher education are part of Generation Z and considered as digital natives. The Generation Z students were born from 1996 or later and are also known as iGen or Centennials [3]. According to [7], digital natives are used to receiving information at the real-time and are good at multitasking.

Within higher education, not all students have the same learning style. The different learning styles consist of visual, auditory and kinaesthetic [8]. Visual students prefer to use graphical images such as graphs, diagram and/or pictures, auditory students prefer to make use of voice sounds which includes speaking out loud, listening and involving discussion with other people and lastly, kinaesthetic students prefer to learn using a sensor which includes physical activities, problem-solving and being active. The effort that undergraduate students place on using social media for learning is dependent on their preference for learning style.

## 2.2 Social Media Applications and Their Use

Using social media, users share their personal diaries, post images or videos, express opinions, meet new people and establish communities based on common interests or/and background [2]. Users have an option to choose whether to send private or public messages, post on other user's timeline, organise social events, and getting informed of other user's daily activities [9]. Social media is inexpensive and free to use which allows individuals to access any social media platforms. There are different types of social media tools that one can use; social networking, microblogging and media sharing.

Social networking sites are online communication tools that allow users to set up their personal profile before establishing connections with friends or other users who have similar interests or/and background [10]. Social networking site contains user's details such as biological information, likes and dislikes, and education that he/she attended. According to [3], students prefer to use social networking sites to create their own groups that include all students in the class. Social networking is used as a form of instant messaging for communication purposes. The two most popular social networking sites that are widely used are Facebook and LinkedIn [10].

Microblogging is a combination of social networking and blogging but has a set limit of characters [10]. Microblogging is mainly used by participants to talk about their daily activities and share or seek information at the real-time [11]. Twitter is one of the most popular microblogging sites. Twitter allows users to send and read posts with a set limit of 140 characters [12]. A user follows other users, even if the user being followed does not necessarily follow back and this is considered being a "follower" instead of a friend [11, 12]. Students use microblogging sites to acquire information on current events including market shares, news and content shared by friends.

Media sharing sites allow "users to upload and share media such as videos and photos as well as allowing users to comment and tag other media" [10]. Examples of media sharing systems are YouTube and Instagram [13]. The main purpose of students using the media sharing sites is to view or download a podcast, pictures or videos that they have missed, want to view it to gain a better understanding or explore new learning experiences.

## 2.3 Use of Social Media in Higher Education

The study by [14] found that social media are mainly used for, social interaction, sharing videos and pictures, meeting people, information seeking and watching the news. [15] reported that 93% of social media users focus on communication as the primary purpose. Even though social media is developed for communication, it is used as a learning tool to enhance teaching and learning through online social networking activities [14].

In higher education, students use different technologies other than learning management system (LMS) such as Vula, Sakai and Blackboard as learning tools. Many students regard social media such as Facebook, Twitter and YouTube as learning tools that enhance academic performances [16]. Higher education tends to rely on traditional teaching method without realising that students are using social media to get a better

understanding of lecture content and collaborating with classmates outside the lectures [14].

According to [2] and [10], social media has a positive effect on student’s academic performances, but if students control and manage their time on the use of social media excessively and effectively. While [17] study found that the higher the student’s use of social media is, the higher is the negative effect on students’ academic performances.

### 2.4 The Use of the Unified Theory of Acceptance and Use of Technology (UTAUT)

While the literature outlined the usage of social media in higher education, this study will employ Unified Theory of Acceptance and Use of Technology (UTAUT) framework as a lens to determine behaviour intention and define the relationship between the actual usage of social media and students in higher education institutions. According to [18], recent studies have used UTAUT to investigate how the relationship between the variables (depicted in Fig. 1) adapt to each other.

In the South African context, UTAUT is as an ideal theory to use as it assists in describing the actual behaviour of higher education students. Internet use in South Africa in 2016 was at 49% with 24% of the population using social media for almost 3 h a day [19]. The social media that were ranked as the most used in South Africa were; WhatsApp (33%), Facebook (30%) and Twitter (12%) [19]. Previous studies that have used empirical evidence from South African higher education institutions have identified that the actual use of social media by higher education students includes the use of YouTube, Facebook and Twitter [20–22]. Thus, the student’s actual behaviour is that of using social media during and outside lectures.

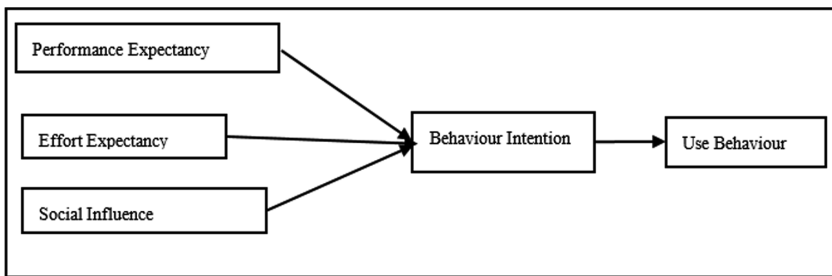


Fig. 1. The unified theory of acceptance and use of technology

As shown in Fig. 1, there are three main factors that influence the intention of acceptance and usage of social media technology, namely performance expectancy, effort expectancy and social influence [23] that relate to a students’ behaviour to adopt a technology and use it for learning.

Performance expectancy is “the degree to which an individual believes that using the system will help him or her to attain gains in job performance” [23]. [24] reported

that students use social media to offer social support and manage their academic studies leading to collaborating with colleagues for learning.

Effort expectancy is “the degree of ease associated with the use of the system” [23]. [25] provides statistics in 2015 that 76% of the users who are higher education students were using social media.

Social influence is “the degree to which an individual perceives that important others believe he or she should use the new system” [23]. Social media provides opportunities for students to participate and collaborate which increases their learning experience [26]. Further, [26] argues that the use of social media sites for education purposes increases academic performance, interaction with the lecturers, opportunities to share opinions, develop creativity and provide feedback if it is used wisely.

Students intending to use social media represents a behaviour intention and is affected by performance expectancy, effort expectancy and social influence. The behaviour intention, in turn, affects the actual behaviour that a student has in applying social media to learning. The research uses four hypotheses to explain students use of social media based on the three constructs and the behaviour intention.

**Table 1.** Hypothesis used to validate UTAUT.

#	Hypothesis
H <sub>1</sub>	Performance expectancy (PE) of using social media is positively related to students' behaviour intention (BI)
H <sub>2</sub>	Effort expectancy (EE) of using social media is positively related to students' behaviour intention (BI)
H <sub>3</sub>	Social influence (SI) of using social media is positively related to students' behaviour intention (BI)
H <sub>4</sub>	Behaviour intention (BI) of using social media is positively related to students' use behaviour (BU)

### 3 Methodology

The purpose of this research was to offer an explanatory contribution [27] using positivist philosophy and a deductive approach through the use of UTAUT. The researchers wanted to investigate which social media platform affects student's behaviour on its usage and whether it could be used as a learning tool in higher education institutions.

The research used the quantitative method of data collection by employing questionnaires that were posted online using Qualtrics as the tool for data collection. The use of questionnaires was favoured as the intention was to collect data from the population of undergraduate IS students.

The questionnaire consisted of 16 closed-ended questions which include dichotomous, multiple-choices and checklists that were used to structure the questions. Dichotomous and multiple-choices were used to support the constructs of UTAUT; performance expectancy, effort expectancy, social influence, gender, age, behaviour

intention and use behaviour. While checklists were used to determine the usage of social media.

This research uses a single case study of the first ranked university in Africa for data collection as it represents a unique and peculiar set of students. Cluster sampling was used to gather data. The target sample was the information systems (IS) undergraduate students at the university as the main source of data since the students represent a diverse population from different countries, cultural background, level of educational preparation, personality and they have a different style of learning. The university also uses social media to inform students of developments around campus. For example, in the years 2016 and 2017 the university used Facebook and Twitter to share information to students during discussions, demonstrations and closures that were unfolding as part of the #RhodesMustFall and #FeesMustFall movements.

During the practical classes and workshops, students were observed using social media when the researcher would take breaks to attend to students who did not understand the content being taught. When asked, some of the students would explain using social media to communicate with relatives or organizing a braai and others were organizing academic discussions using Facebook.

Cape Town is a diverse city in South Africa as it is home to individuals from all continents who own businesses and are employed in different sectors. Several Information Technology (IT) multinational companies such as Amazon operate from Cape Town and thus offer not only job opportunities but also prospects for an internship in big firms. Some IS graduates from the university have gone to start their own companies such as GetSmarter and Silulo Ulutho technologies that use social media to brand and advertise their products. During university vacations, some students undertake internships in IT companies which gives them exposure and knowledge of what IT companies require. In return, they share such knowledge with peers and assist their understanding of what the industry wants.

By using the university database which stored student records, an online questionnaire was sent to the students' email account with a request to complete the survey and was accompanied by a cover letter that explained the aim of the study, confidentiality and anonymity of respondents' personal information. Out of a total of about 150 undergraduate IS students, 64 respondents completed the online questionnaire that was available for seven weeks from July to September 2017. Five questionnaires were removed as respondents were either postgraduate or did not complete the survey. Data were analysed using statistical inference. In preparation for data analysis, data was imported from Qualtrics to Excel. Excel was used to summarise data using frequency tables and graphs (to show the parameters). Another tool, WARPLS, was used to test the four hypotheses from data loaded in Excel.

## 4 Findings and Discussion

Of the 59 respondents that were analysed, 54% are females and 46% males. 88% of the respondents were aged 18 to 21 years old and only 12% were older than 21. Data collection was conducted in 2017 which means undergraduate students in South Africa are from generation Z. Further, 96% of the students responded to having Internet access

most of the time to always. The university offers access to Edu roam Internet connectivity using Wi-Fi services that are available at any time on campus and at university residence facilities. Furthermore, 97% of the students have access to social media with the majority of the use being on mobile phones (44%) followed by laptops (33%) and tablets (15%). Personal computers contributed only 8% on access to social media. Many of the students used mobiles and laptops to access social media which contradicts [3] as students in higher education institution in South Africa tend to have more than one device.

Participants were asked which social media platform they used daily. WhatsApp had the most daily use with 26% followed by YouTube with 21%. Facebook was used by 18% of participants. Only 5% accounted for LinkedIn where students seek job opportunities. When aggregated, 48% of respondents used social networking (Facebook and WhatsApp), 12% microblogging (Twitter) and 40% employed media sharing (YouTube and Instagram).

#### 4.1 Performance Expectancy of Undergraduate Students on Using Social Media

Using checklists, Students were asked of factors contributing to daily use of social media and responded by ranking keeping in touch with family and friends as the first factor with 92% followed closely at 88% with checking what is happening around the world which support [28] and [29] report. Finding information for personal and academic needs was ranked third with 71%. Further probing on finding information is depicted in Fig. 2.

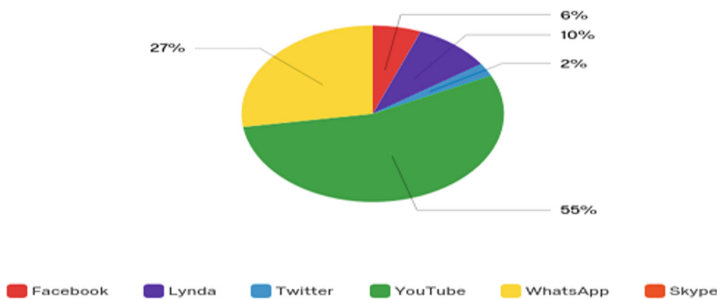


Fig. 2. Distribution of social media platforms used in higher education institutions.

Figure 2 shows the distribution of social media used in higher education institutions to assist with finding academic information. YouTube is regarded as a popular social media (55%) followed by WhatsApp with 27%. Facebook and Twitter have a slight contribution with 6% and 2% respectively. Whereas [30] indicated that 91% of the students used Facebook for educational purposes followed by YouTube with 27%. Therefore, this study contradicts [30] as students prefer to use media sharing sites than social networking sites.

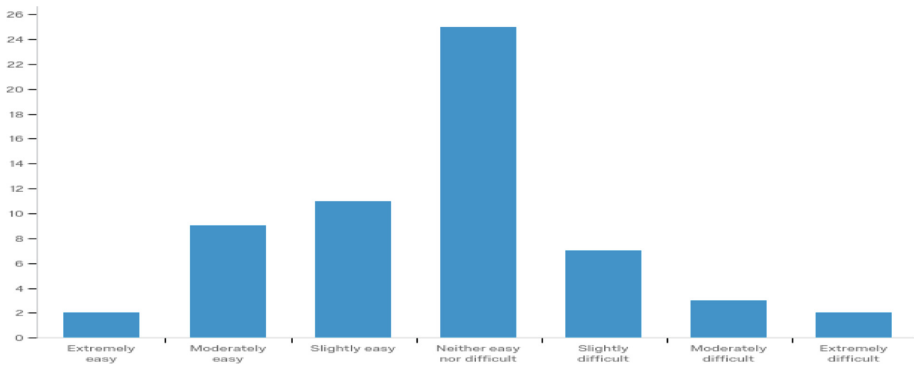


Media sharing platforms (YouTube, Lynda) accumulated 65% and are used to assist with students’ academic studies which include videos, audios and visual. Lynda is a learning website offering access to massive open online courses (MOOCs) through the use of videos and is the official social media platform the university endorses for its students.

**4.2 Effort Expectancy in Using Social Media for Academic Studies by Undergraduate Students**

In terms of effort, 45% of the respondents stated spending between most of the time and always on social media to access academic content. 17% of the students quantified using ‘about half the time’ on social media to assist with academic studies while 32% of the respondents accounted for sometimes which means these students only use social media when there is need to acquire information. The frequency of accessing social media in higher education was not so often which indicates the students have managed their access to social media effectively and corresponds to studies by [2, 10, 17].

Students were further asked on their perception that in comparison to using official university learning management systems like Vula, Sakai and Blackboard, do they view social media as easier platforms and 55% responded by stating they somewhat agree to strongly agree. 10% of the students were neutral with 35% of the respondents ranging from somewhat disagree to strongly disagree.

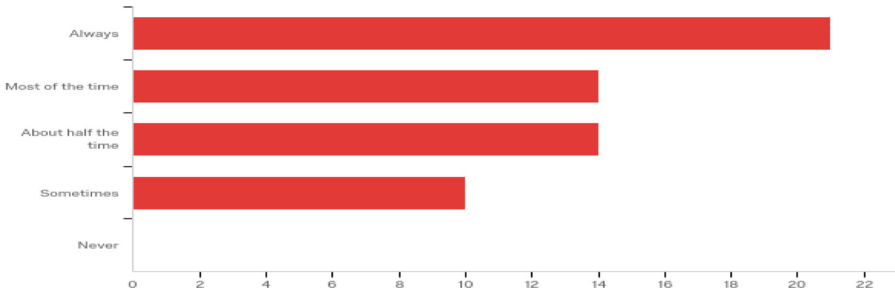


**Fig. 3.** Distribution of how social media influences participants’ academic studies.

Participants were asked whether social media influenced their academic studies in higher education and hence making it easier for learning. About 42% of the respondents chose it was “Neither easy nor difficult” and this is explained as subjective to the nature of the work that students are currently focused on. The skewness of Fig. 3 is 0.895 which indicated a positive skewness. As a result, participants believed social media does influence their academic studies.

### 4.3 The Social Influence of Colleagues in Using Social Media for Academic Studies

Higher education students work in groups to complete assignments and projects. Further, students assist one another during the preparation of test and examinations. Figure 4 provides information on students' response to being influenced by colleagues to use social media.



**Fig. 4.** Distribution of social media collaboration in a higher education institution.

Figure 4 depicts a positive skewness as most of the participants used social media, 50%, communicate with other fellow colleagues for academic purposes. This is parallel to [26] that social media could be used for educational purposes that allowed the student to increase their learning experience such as discussion, sharing opinions, interaction as well as collaboration.

### 4.4 Construct Reliability and Validity

To test the reliability of each construct, the Alpha Cronbach and composite reliability were used to determine the reliability of the data in each of the constructs. For a construct to be reliable, the results needed to be at least 0.7. The results for each of the constructs shows that Cronbach Alpha and Composite Reliability are all equal to 1.00. There is no need to remove any question and it is considered acceptable since there is only one question assigned to each construct.

The validity of each construct was tested using the Average Variance Extracted (AVE) in each of the constructs. For a construct to be valid, the results need to be at least 0.7. The results for each of the constructs on the average variance extracted of each construct are all equal to 1.00. Therefore, there is no need to remove any question and it is considered valid.

### 4.5 Hypotheses Testing

To determine the acceptance of the usage of social media in higher education institutions, a significance level test was performed between each construct. The p-value indicates a probability of accepting the hypothesis. Thus, a significance level should be

less than 0.05 for the hypothesis to be accepted. The list of hypotheses that were outlined in Table 1 was tested according to the analytics using WARPLS. Table 2 summarises the results of the hypothesis testing.

**Table 2.** Tested hypothesis results.

#	Relationship	p-value	Outcome
H <sub>1</sub>	PE – BI	<b>&lt;0.001</b>	Accept
H <sub>2</sub>	EE – BI	<i>0.081</i>	Reject
H <sub>3</sub>	SI – BI	<b>0.049</b>	Accept
H <sub>4</sub>	BI – UB	<b>0.004</b>	Accept

The hypotheses that failed to produce the significance level of less than 0.05 is marked in italic while bold indicates there is a significance. The only hypothesis that was rejected was the relationship between the EE and BI (H<sub>2</sub>) with the significance level of 0.081 while other hypotheses (H<sub>1</sub>, H<sub>3</sub> and H<sub>4</sub>) are accepted.

The amount of effort spent on social media does not impact on student’s behavioural intention. H<sub>2</sub> indicates there’s no significance, therefore this hypothesis has been rejected even though 80% of participants have access to social media in higher education. [25] statistics indicated that 76% of the students used social media in higher education. These two figures are related but the effort of having access to social media does not relate to the behaviour intention to use social media in higher education.

Performance Expectancy has a high level of significance (< 0.001) towards Behaviour Intention (H<sub>1</sub>) where students mostly spend time using social media to find information or communicate to enhance their academic performances which are supported by Fig. 2. The findings of the research correlate to [31] that students integrate social media with their academic studies to improve work performance. While [24] was contradicted since social media improves students’ performances in higher education.

Social influence also has a high level of significance with 0.004 towards Behaviour Intention (H<sub>3</sub>) where students believed that social media influences their academic studies in higher education and allows them to explore new knowledge and information as presented in Fig. 4. This is parallel to [26] that social media could be used for educational purposes and allowed the student to increase their learning experience such as discussion, sharing opinions, interaction as well as collaboration.

Overall, the students perceived the behaviour intention of the usage of social media in higher education as a learning platform with a high level of significance of 0.004 to use behaviour (H<sub>4</sub>). Students showed the significance of H<sub>4</sub> since they found social media easy to obtain information and affords an ability to understand the topic than using academic materials. As [14] observed, social media is used as a learning tool to enhance teaching and learning within higher education.

This research is limited by size and time. Failure to acquire more participants is due to lack of interest from IS students and an effort to complete the survey. The amount of time the survey was kept online, seven weeks, is shorter than the researcher’s expectation of at least three months and this was caused by delays in ethical clearance.

## 5 Conclusion

The purpose of this research was to investigate the usage of social media in information systems undergraduate students in higher education institutions. Social media is considered the most common communication and media sharing platform. Internal validity was acquired by linking themes with the theoretical framework and research protocol. The discussion is guided by the UTAUT.

The main research findings are that students are using social media to acquire academic content which assists in their studies. Students do not use much effort as generation Z knows how to use technology. Peers assist in acquiring academic assistance using social media. Media sharing is the most accessed social media tools for learning purposes.

This research contributes to the body of knowledge on adoption and use of social media as tools that foster collaboration and teamwork to students in higher education institutions and hence extend formal learning across the boundaries of the lecture venue. Universities could make good use of case studies from companies that are within the country and where possible, those CEOs or founders that are their alumni.

The research provides a contribution to UTAUT theory by providing empirical evidence from the highest ranked university in Africa by explaining how social media is used in higher education institutions. By so doing, the research extends the use of the theory to the usage of social media with a focus on more than one platform for learning. Further, the theory assists to explain how social media assists students in their academic work and how social influence from peer's fosters learning.


## References

1. Junco, R., Heiberger, G., Loken, E.: The effect of Twitter on college student engagement and grades. *J. Comput. Assist. Learn.* **27**(2), 119–132 (2011)
2. Rahman, N.S.A., Othman, M.S., Al-Rahmi, W.: Exploring the use of social media tools among students for teaching and learning purpose. *J. Theor. Appl. Inf. Technol.* **91**(1), 49–60 (2016)
3. Turner, A.: Generation Z: Technology and social interest. *J. Individ. Psychol.* **71**(2), 103–113 (2015)
4. Brown, I., Moola, I., Mugjenkar, A., Sands, M.: Impediments on the path to academic success in an IS degree programme: a South African perspective. *S. Afr. Comput. J.* **41**, 64–74 (2008)
5. Rivard, S., Lapointe, L.: Information technology implementers' responses to user resistance: nature and effects. *MIS Q.* **36**(3), 897–920 (2012)
6. Karim, A.K.M.R., Nigar, N.: The internet addiction test: assessing its psychometric properties in Bangladeshi culture. *Asian J. Psychiatr.* **10**, 75–83 (2014)
7. Prensky, M.: Digital natives, digital immigrants. *Horizon* **9**(5), 1–6 (2001)
8. Constantinidou, F., Baker, S.: Stimulus modality and verbal learning performance in normal aging. *Brain Lang.* **82**, 296–311 (2002)
9. Sponcil, M., Gitimu, P.: Use of social media by college students: relationship to communication and self-concept. *J. Technol. Res.* **4**, 1–13 (2014)
10. Alwagait, E., Shahzad, B., Alim, S.: Impact of social media usage on students' academic performance in Saudi Arabia. *Comput. Human Behav.* **51**, 1092–1097 (2015)

11. Java, A., Song, X., Finin, T., Tseng, B.: Why we Twitter: understanding microblogging usage and communities. In: 9th WebKDD and 1st SNA-KDD 2007 Workshop on Web Mining and Social Network Analysis, pp. 56–65 (2007)
12. Stieglitz, S., Dang-Xuan, L.: Emotions and information diffusion in social media—sentiment of microblogs and sharing behavior. *J. Manag. Inf. Syst.* **29**(4), 217–248 (2013)
13. Ngai, E.W.T., Moon, K.L.K., Lam, S.S., Chin, E.S.K., Tao, S.S.C.: Social media models, technologies, and applications: an academic review and case study. *Ind. Manag. Data Syst.* **115**(5), 769–802 (2015)
14. Sobaih, A.E.E., Moustafa, M.A., Ghandforoush, P., Khan, M.: To use or not to use? Social media in higher education in developing countries. *Comput. Human Behav.* **58**, 296–305 (2016)
15. Correa, T., Hinsley, A.W., de Zúñiga, H.G.: Who interacts on the Web?: the intersection of users’ personality and social media use. *Comput. Human Behav.* **26**, 247–253 (2010)
16. Lai, K., Hong, K.: Technology use and learning characteristics of students in higher education: do generational differences exist? *Br. J. Educ. Technol.* **46**(4), 725–738 (2015)
17. Ainin, S., Naqshbandi, S., Moghavvemi, M.M., Jaafar, N.I.: Facebook usage, socialization and academic performance. *Comput. Educ.* **83**, 64–73 (2015)
18. Gruzd, A., Staves, K., Wilk, A.: Connected scholars: examining the role of social media in research practices of faculty using the UTAUT model. *Comput. Human Behav.* **28**, 2340–2350 (2012)
19. Kemp, S., We Are Social: Digital in 2016: we are social’s compendium of global digital, social, and mobile data, trends, and statistics (2016). <http://wearesocial.com/sg/special-reports/digital-2016%5Cnhttp://www.slideshare.net/wearesocialsg/digital-in-2016>. Accessed 11 Apr 2017
20. Cloete, S., de Villiers, C., Roodt, S.: Facebook as an academic tool for ICT lecturers. In: Proceedings of the 2009 Annual Conference of the Southern African Computer Lecturers’ Association, pp. 16–22 (2009)
21. Krutka, D.G., Bergman, D.J., Flores, R., Mason, K., Jack, A.R.: Microblogging about teaching: Nurturing participatory cultures through collaborative online reflection with pre-service teachers. *Teach. Teach. Educ.* **40**, 83–93 (2014)
22. Roodt, S., Peier, D.: Using Youtube© in the classroom for the net generation of students. *Issues Informing Sci. Inf. Technol.* **10**, 473–488 (2013)
23. Venkatesh, V., Zhang, X.: Unified theory of acceptance and use of technology: U.S. vs. China. *J. Glob. Inf. Technol. Manag.* **13**(1), 5–27 (2010)
24. Selwyn, N.: Social media in higher education. *Eur. world Learn.* **1**, 1–10 (2012)
25. Perrin, A.: Social media usage: 2005-2015 (2015)
26. Firat, M., Altınpulluk, H., Kılınç, H., Büyüç, K.: Determining open education related social media usage trends in Turkey using a holistic social network analysis. *Educ. Sci. Pract.* **17**(4), 1361–1382 (2017)
27. Saunders, M., Lewis, P., Thornhill, A.: *Research Methods for Business Students*. Pearson education, London (2009)
28. Arteaga Sánchez, R., Cortijo, V., Javed, U.: Students’ perceptions of Facebook for academic purposes. *Comput. Educ.* **70**, 138–149 (2014)
29. Hamid, S., Waycott, J., Kurnia, S., Chang, S.: Understanding students’ perceptions of the benefits of online social networking use for teaching and learning. *Internet High. Educ.* **26**, 1–9 (2015)
30. Saw, G., Abbott, W., Donaghey, J., Mcdonald, C.: Social media for international students – it’s not all about Facebook. *Libr. Manag.* **34**(3), 156–174 (2013)
31. Dabbagh, N., Kitsantas, A.: Personal learning environments, social media and self-regulated learning: a natural formula for connecting formal and informal learning. *Internet High. Educ.* **15**(1), 3–8 (2012)



# Convergence of Technical and Policy Processes: A Study of Indonesia's Health Information Systems

Taufiq Sitompul<sup>1</sup>(✉), Wilfred Senyoni<sup>1</sup> , Jørn Braa<sup>1</sup>, and Yudianto<sup>2</sup>

<sup>1</sup> University of Oslo, Oslo, Norway  
{taufiqhs, jbraa}@if.uio.no,  
senyoni@gmail.com

<sup>2</sup> Data and Information Centre of Ministry of Health, Jakarta, Indonesia

**Abstract.** This paper discusses the process of implementing a district dashboard as the means for integrating health information systems (HIS) in Indonesia. The project involved two processes: a bottom-up one with iterative design and implementation process and a top-down one involving data policies. Using moments of translation, we discuss the complex processes of aligning actors' interests necessary for the implementation of HIS in developing countries. The paper contributes to the existing discussions of HIS integration and information sharing in developing countries by providing a better understanding of translation processes and thereby of ways to handle fragmented HISs.

**Keywords:** Integration · Translation · Health information system · Dashboard · Information policy · Developing countries · Indonesia

## 1 Introduction

This article addresses the issue of developing integrated Health Information Systems (HIS) in Indonesia through what is labelled a dashboard strategy, which is seen by the local actors as enabling integration without disturbing the underlying systems. The development started as a small bottom up project working on extracting data from national databases to present in dashboards at national level and in a pilot province [1]. Gradually, however, the dashboard process increased its importance and organisational anchoring and in 2018 it converged with a top-down national initiative called One Data to integrate data from different governmental sectors to be made accessible in one portal. This process is being analysed using Callon's concept of translation [2].

The process of HIS development in Indonesia is unfolding in a context shared with other developing countries; poor infrastructure in parts of the country, inadequate capacity, fragmentation of reporting systems, suboptimal HISs and limited funds [3–5]. The health sector is heterogeneous, consisting of multiple subsystems such as health programs (for example, HIV, TB and Malaria), and multiple administrative hierarchy levels. Indonesia has adopted a federal government structure where provinces and districts are relatively independent from the national administration, which add to the fragmentation and complexities of the HIS. The HIS is fairly typical with multiple

vertical health program-specific systems with own platforms working in ‘silos’ with little data sharing. For example, health programmes such as TB, HIV/AIDS and Malaria have their own reporting systems running in silos with minimum information sharing. The Data and Information Health unit in the Ministry of Health (MoH) in Indonesia called Pusdatin, is responsible for developing and supervising health information regulation across the country and in charge of the project described in this article. Therefore, our study positioned itself to understand how diverse actor’s interests can be aligned to develop an integrated information system. Specifically, we aim to answer the research question, how can diverse actors in a heterogeneous environment be aligned in the development of an integrated dashboard information system? Using the concept of translation, we identify and analyse the different stages involved in aligning diverse actor’s interests. The dashboard strategy is shown to be useful in aligning stakeholders in pursuing integration in a context of fragmented HISs. We illustrate this by showing how the bottom-up dashboard process and a top-down policy processes got more aligned and started to converge despite starting out independently.

The article is organised as follows; in the next section is a literature review outlining the concept of translation used in the analysis; then follows a section on methods before the analysis section where the case is analysed according to four moments of translation. The final section provides a discussion and conclusion.

## 2 Literature Review: Translation

The paper uses the concept of translation from the Actor Network Theory (ANT) to understand the complex social processes involved in the implementation of health information system. The ANT theory highlights the heterogeneous nature of actors within a network, their association and interactions; and importance of balancing both social and technical aspect [6–8]. Translation is seen as a process which generates ordering effects and aligns interests of heterogeneous actors within a network into a common one [9]. “Translation occurs as actors enrol allies in the actor network and align their interests in a continuous process of renegotiation where claims become well-established facts and prototypes are turned into routinely used pieces of equipment” [10]. According to Callon, the translation process is described to have four phases (problematisation, intersement, enrolment and mobilisation) which may overlap one another as one goes through them [2]. In general, the first two phases describe how one can start by identifying actors and their problem nature while establishing the possibility of interaction among them. The strategy for negotiation and manoeuvre and assigning actor roles while strengthening the network is more elaborated by the latter two phases of the concept.

## 3 Method

The empirical material is gathered through a longitudinal process from January 2015 to February 2019 in Indonesia. The study took place within a HIS strengthening implementation project including national, province, district and facility levels. The project

has followed an action research approach [11] including prototyping and participation from users and researchers in planning, implementation, evaluation and dissemination activities [12, 13]. During an intensive period over 18 months 2016–2017 the authors were engaged in implementation in 10 pilot districts in 5 provinces where the districts were visited one week each in a sequence over three cycles. While the sequential approach allowed learning from one district to be shared with and applied in the following districts, the cyclic approach allowed for learning from one cycle to be analysed and used in the next cycle.

In addition to the fieldwork, the authors gathered empirical data from multiple information sources at national and regional level, such as strategic documents, project reports, minutes from meetings (monthly technical meeting with local and national level), interviews, strategic documents, training materials and supervision and technical assistance reports, training materials and participation in trainings at national and regional level. During field activities, an analysis part of data took place through a continuous process of data collection in the field to identify important themes and relate them to the theory. While initially, the focus was on understanding and documenting the health information data sources, data flows and routines for data use, later the focus was more on participatory design and implementation of dashboards and other aspects of the DHIS2 dashboard system. We discussed with people in all positions and at all levels of the health system both in formal and informal settings, about our and their views on the current situation and strategies. The analysis continued to evolve through an ongoing review of relevant research literature and theories, thus representing an evolving “conversation” between data and method.

All authors are part of health information system strengthening implementation in Indonesia. The first author has been in HIS development and implementation, and one author has been part of formulating regulations at the national level. The other two authors have extensive experiences in HIS implementation in developing countries as part of Health Information Systems Programme (HISP) [1, 14].

## 4 HIS Implementation: Indonesia’s Journey

In this section, we will give a chronology sequence of events prior to and leading to the implementation of district dashboards in Indonesia and its designation as the official platform for integrated health information within the Ministry of Health. We categorise these chain of events into three phases as illustrated in the below section.

### 4.1 Initial HIS Efforts

In 2010, Indonesia’s government through the President’s work unit for development supervision and control or commonly known as “Unit Kerja Presiden Bidang Pengawasan dan Pengendalian Pembangunan (UKP4)” initiated the “Satu Data” policy, meaning One Data and created a national portal (<https://data.go.id>). The Satu Data policy was formulated to address the observed challenges in relation to quality and use



of governmental data [15]. Data collected were in diverse formats and not following standardised mechanism making it difficult to analyse and use both within and across the different government agencies [16].

In the health sector, the Satu Data policy is labelled “Satu Data Kesehatan”, meaning One Health Data, with the principle of having one standard, one metadata, and one portal for information dissemination. The Satu Data Kesehatan policy has been developed by Pusdatin with the aim of providing accurate, integrated and up-to-date information, accessible through integrated information systems using standard meta-data services [17, 18]. Indonesia has a federal structure where provinces and districts are relatively independent from the national ministry of Health. The adoption of information systems at provincial and district levels follows local regulations with little involvement from the ministry of health. At the national level, health programmes have their own systems with some using web-based systems such as TB and HIV/AIDS and others using Excel based systems, such as Malaria and immunisation. Realising the HIS fragmentation within the health sector, Pusdatin implemented a nation-wide system named KOMDAT collecting data for about 130 national health indicators, based on data aggregated by district. The KOMDAT design however, limited the district data managers to enter data until they have received a complete set of data from all reporting puskesmas (health centres) in their districts.

## 4.2 District Dashboard as a Strategy

The DHIS2 dashboard process in Indonesia started with a demonstration at the AeHIN conference in Manila, December 2014, which was attended by top level Ministry of Health managers from Indonesia. The leader of Pusdatin, now secretary general of MoH, was impressed and, as he saw it, ‘dashboards can be used to integrate data without disturbing the underlying systems - too much’. Following this, the University of Oslo (UiO) team was invited to Indonesia and Pusdatin, UiO and Gadjah Mada University (UGM) formed a joint project, funded by Global Fund, to develop an integrated dashboard system, starting in 2015. See [1] for an account of this early part of the project.

In November 2016, the second phase of the project started when the dashboard approach and the UiO became part of a large pilot project to implement dashboards in 10 districts, also funded by Global Fund [17]. The initial strategy for data capture was to enable interoperability by extracting data from existing national and local systems and four national applications were selected as priority data sources for routine data extraction to the DHIS2. These were HIV (SIHA), TB (SITT), malaria (eSismal) and KOMDAT, which included key data elements collected as district aggregates. Ten districts were selected from five provinces across Indonesia as pilot sites to test the district dashboard concept [17].

In a first round visiting all 10 districts, the focus was on system advocacy, socialisation, training and a rapid situation analysis to identify data sources and routines for data use in the districts. Through socialisation meeting and mini-workshops in all districts, the DHIS2 dashboards and concepts were demonstrated and participants trained on the use of DHIS2 and analytic features, such as maps, pivot tables, charts, and dashboards. Feedback from the training as well as findings from the situation

analysis reveal that in order to be relevant, the scope of data captured in the dashboards needed to be extended from the initial TB, HIV and Malaria programs to included data on the main activities in the health centres, such as Mother and Child Healthcare and Immunisation. Key data from these programs are included in the KOMDAT system, but only as district aggregates, which are not useful at the health centre level. Furthermore, the situation analysis found that all health centres conducted routine monthly meetings called ‘Lokakarya Mini (Lokmin)’ with great potential for use of facility dashboards, provided that relevant datasets were included. These findings led to a revision of the strategy to include data capture at facility level and the promotion of facility dashboards to be used at Lokmin meetings. These facility dashboards became very popular in the pilot districts and this strategy is now becoming national policy. The initial plan and mandate from Pusdatin were to only import data from existing electronic systems. The main problem with this strategy was that local data were captured in more or less un-standard Excel sheets, which made systematic monthly import of these data impossible. DHIS2 capacity building for the central core team on issues such as metadata management, DHIS2 and server maintenance, customisation, data interoperability and managing user roles was another initiative going on in parallel with work in pilot districts. The core DHIS2 team consisted of the UiO team, Pusdatin and the UGM team. Metadata for the selected health programmes were designed and implemented in the DHIS2 allowing for their indicators to be visualised using DHIS2 analytics tools and dashboard. Feedback gathered during the system advocacy and socialisation sessions were feed back to the dashboard design as well as the overall integration approach used for other programmes. In this process, local capacity was strengthened, a team composing of members from national level, Technical Assistance (TA) assisting the districts, local universities, local data managers and stakeholders from province and district level were trained in the administration of DHIS2, as well as designing dashboard for local information utilisation. This allowed transfer of knowledge and technology from UiO team to DHIS2 Indonesia team.

A sequential implementation approach was adopted to introduce and support the district dashboards in the 5 provinces and 10 districts. The sequential approach was useful in directly comparing the perspectives at province level with how different aspects of the HIS were regarded at district level. Lessons learned from one district were incorporated in the subsequent one, enabling accumulation of knowledge as the implementation progressed. Supervision visits followed immediately after the deployment of the district dashboards. During supervision, the team was engaged with activities focused on data dissemination using analytic tools on mobile and desktop/laptop, troubleshooting and technical assistance. The visits enabled the Pusdatin and UiO team to conduct several formal as well as in-formal meeting with local government officials, re-training end user and updating data import mechanism based on the feedback received. The activities were carried out routinely, one in each quarter, collected feedback from the end user as well as strengthening the use of information at the local level. DHIS2 became popular at both local and national levels attracting other health programmes to integrate their information with it. One data manager at the national level revealed that *“DHIS2 is the best application, and dreams come true because since past, the national level has daydreamed to provide data were integrated for facilities and district levels”*. Dashboards customised for each health program

visualising their key indicators became popular tools for data analysis and dissemination and became an important drawcard attracting new programs to join the process [19]. Dashboards were promoted used in routine monthly and quarterly meetings at health facility and district levels and which were already including data verification, validation, and dissemination. This approach enabled the dashboards to be a reference point and used in regular routine activity at different levels.

### 4.3 Convergences of HIS Processes

Following the implementation of DHIS2 dashboards, Pusdatin felt the need to get further support from the senior levels. They started to use routinely, data extracted from the DHIS2 dashboards and introduced the web portal for public information dissemination. Earlier, the use of DHIS2 dashboards had been challenged and competed with another software named Tableau. The senior level managers were more in favour of using dashboard generated by Tableau due to their ability to illustrate the indicator performance for high-level staffs with less technical knowledge. However, as DHIS2 already included the integrated data from multiple sources used to power the dashboards and as more powerful dashboard features were added in new version of DHIS2, customised dashboards in DHIS2 became increasingly popular among senior managers for analysis and public data dissemination [20] (Fig. 1).

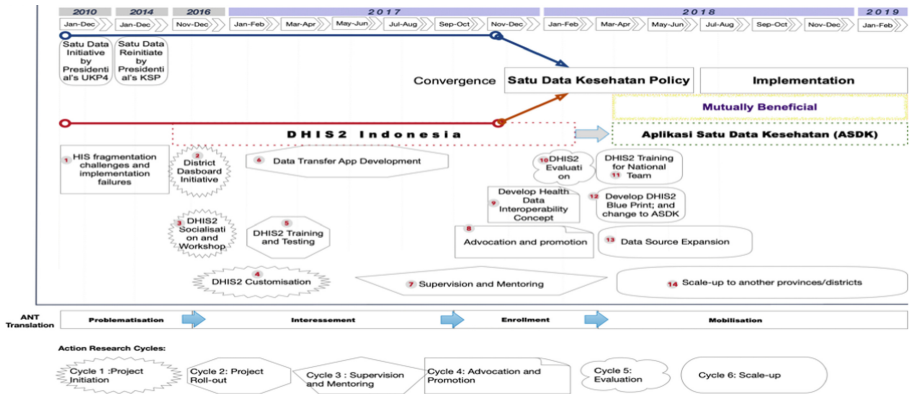


Fig. 1. Series of events for the implementation of DHIS2 dashboards in Indonesia

In order to strengthen and sustain the DHIS2 dashboard momentum, regular training and support sessions were conducted in collaboration with local universities at province, district and health centre levels, including taking part in local HIS conferences to establish more alliances. In the pilot project budget, ten health facilities in each of the ten districts were funded as pilot sites. However, as the project progressed, in many cases local government provided funds from their budget to enable expansion of the project to the remaining health facilities in their district and to the remaining districts in their province. At the national level, Pusdatin and its stakeholders

demonstrated DHIS2 functions and dashboards to the minister and other top-level managers, leading to approval for the system to be utilised nationally. Ten universities selected as ‘Centre of Excellence’ based on their academic programs in HIS, have been enrolled in the project and have been active in providing support in their regions [17].

In mid-2018, the district dashboard implementation was evaluated to provide insight on results and achievements. The evaluation concluded that the results in the pilot districts were good and recommended DHIS2 to be used also in other districts and provinces. Following this, a DHIS2 Implementation blueprint was developed to shape the scaling approach and to provide technical guidelines. The guidelines targeted provincial and districts managers to enable them to expand the project within their administrative boundaries. The implementation guidelines included issues such as team formation and training, expansion of data sources, end-user training, advocacy and promotion, funding sources, training material and troubleshooting. In the development of the guideline, DHIS2 were renamed to “Aplikasi Satu Data Kesehatan (ASDK)”, meaning One Health Data Application. This renaming reflects the official buy-in and solid organisational anchoring of the ASDK process, which we label the third phase of the DHIS2 dashboard project.

Pusdatin has continued to include new datasets from existing priority data sources as well as from new data sources, such as on human resources, stunting, national indicators, health equipment, and facility profiles. The process of scaling the process to new provinces and districts and expanding data sources are led by Pusdatin and is consisting of multiple activities including training for old and new system users and staff from provinces and district levels; engaging with national level health programs and organisations for enrolling them in the process and engaging the universities participate in training and support in their regions [21]. An online DHIS2 certified course using the Indonesian database for training has been developed by UGM and had 350 registered learners in their first batch (late 2018).

## 5 Analysis

In this section, we analyse the dashboard implementation process in Indonesia and its convergence to the Satu Data policy using the four moments of the general process of translation as a framework [2]. In our case, these moments depict cyclic and overlapping stages in the evolving project as it increases in scope (health programs, user groups and data sets to include) and scale (new provinces and new districts).

### 5.1 Problematisation Moment

Callon and Latour identified problematisation as the moment when an actor defines an ‘Obligatory Passage Point’ (OPP) as points of consensus, or in our context agreements on design or specifications of the system to be developed [2, 10]. Callon & Law define this point as a connection between ‘two sides’ of the actor network, the local network and the global network [9]. While in our case the local network consists of those involved in development and negotiations at the technical development and

implementation levels, the global network consists of actors at the higher level of policy funding and decision making.

KOMDAT was the first effort of integrating national key indicators but proved early on to be a sub-optimum solution. The integration strategy then became to go for an all-encompassing electronic patient record (EPR) system called SIKDA Generik. With all data in one system, there would be no more fragmentation and all data would be available, was the thinking. However, the EPR process met technical problems and dragged out. At the same time, instructions from the central government to implement the Satu Data policy loomed over Pusdatin, increasing the pressure for standardisation and health information integration.

The solution, as discovered by the director of Pusdatin in a conference in Manila 2014, was a district dashboard, a programmatic strategy for integration, which does not disturb the underlying systems and political structures, creating a ‘win without losing’ situation. This provided support from the top, which was important, but there were other already planned applications with their own stakeholders, who did not necessarily agree in changing the strategy. Unfortunately for the DHIS2 project, the supporting director was transferred to another position just a few months later. One important negotiation process was with the group working to implement SIKDA Generik in all health centres, who didn’t want DHIS2 to go into their scope of work, i.e. patient data. The first perception and agreement from a week position, was that DHIS2 should only operate at district level as ‘district dashboard’, then, after arguing the case for ‘health centre dashboards’ and demonstrating the usefulness of this strategy in the pilot districts, the agreement reached was that also health centres should use dashboards, based on data extracted from other systems. In the pilot districts, however, health centre data were captured. In 2018, when the dashboard became the official Satu data project, and after a survey of all the then 9,993 registered public health centres had documented that only 28% had EPR systems, i.e. no electronic sources for the bulk of health centre data, it was agreed that essential aggregate data should be captured directly in the DHIS2.

Given this narrative of the evolution of the negotiations and decisions regarding the core data use and data input part of the DHIS2, promoted and ‘allowed’ activities in the health centres, we see that the process has cycled through three distinct OPPs; (1) Dashboards only at district level, no data entry; (2) Dashboards also at facility level, a priority; (3) DHIS2 also used for data capture of essential facility data. Building on Callon and Law, we see that the local network started out as being very heterogeneous and weak and not very strongly attached to the global (policy level) network, which has also become gradually stronger [9], as illustrated by now being supported even by the president’s office.

## 5.2 Interestement Moment

Whitley described the interestement as the moment when ‘actors try to impede alliances that may challenge the legitimacy of the OPP’ or formulating the alliances to support the OPP [22]. In our case, we see that the OPP has been gradually strengthened through the three phases described above as the various actors saw how their interests could be served as becoming custodians of the increasingly more important project. For the users of dashboards and data, interestement means formulating strategies enabling them to

pursue their interest regarding the data. In new districts, the provinces managers and data & IT staff were the first to get engaged in a complementary way. While district and program managers were genuinely interested in dashboards displaying their own key data, the data and IT folks were similarly eager to be capacitated to manage data and dashboards in the new system. Identification of key players and champions and building their capacity as trainers of trainers were key part of the strategy and the involvement of the Centre of Excellence (CoE) universities was important in this regard.

In order to foster interest for the dashboards among data users in the health centres, it was necessary to expand the data scope beyond TB and HIV/AIDS and to include the health programs data being used at local level as well as to identify important areas of use. Through the initial situation analysis, the project identified the monthly routine meetings (Lokmin) in the health centres as the key area for data use and the creation of facility dashboards to support these meetings became a priority. Since local data on the key programs were not available through import from national systems, these data had to be captured locally, an option that was not yet 'allowed' as discussed in the above section. However, in the pilot districts, the KOMDAT data set was included in the DHIS2 for data capture at facility level from 2017 enabling the creation of very popular local health centre dashboards. When a delegation from national level including the WHO visited Ambon district in 2017 the person responsible for data in a meeting became so emotional that she started to cry when she told the audience how good it felt to 'own your own data and be able to make graphs and dashboards by yourself'. The WHO got so impressed by this account of success that they suggested making a film to document the project in Ambon.

To conclude: availability of facility-based data and capacity are key to the creation of interest and a sense of ownership to the dashboard system at local level.

### **5.3 Enrolment Moment**

Bargaining and reaching concession are major elements observed in the enrolment moment [22]. The process of enrolling actors passed through several phases at different levels with the initial ones including key stakeholders in MoH, universities and key health programmes such as TB and HIV. In later phases, other stakeholders such as for example human resource department and health worker registers and district and province level actors were enrolled in the project through negotiations and discussions. The inclusion of facility level data in the district dashboards enabled the scaling of dashboards to all facilities within the pilot districts to be used in their routine monthly meetings. The example of the emotional presentation of the facility data-based district dashboard in Ambon, illustrates the enrolment process at local level, but also how success at local level enhances enrolment at the global levels. With WHO on board, also other global actors were enrolled. The World Bank, for example, is holding back 11% of the funding for the building of 3 new hospitals in the poorer eastern part of Indonesia, until all districts have implemented the dashboards including some key indicators they have identified.

The enrolment of health programs for data integration has however met several challenges. While the HIV programme, for example, has been actively participating in the process, other programs like TB and human resources required detailed and

continuous negotiations involving senior level managers. Some system owners were reluctant to join the network fearing to lose control with a tighter integration. However, continuous negotiations and application of dashboards to visualise their data provide a solution to reduce some of the challenges faced.

#### 5.4 Mobilisation Moment

Mobilisation moment may be seen as occurring when, as Latour argues, other actors (Pusdatin in our case) have their needs and interests met and are speaking on behalf of the focal actor [23], i.e. the initial university actors in our case. The project has gone through 3 phases; (1) the early phase before the pilot project, (2) the 10 districts pilot project, and (3) the expansion to 50 new districts, a plan for countrywide coverage and the official status as “Aplikasi Satu Data Kesehatan” (ASDK). Studying this project trajectory, we see that Pusdatin’s role has moved from being a bit reluctant and unsure about consequences for other projects (1), to being involved (2) and finally to be fully committed and the ‘project owner’ and leader. The current expansion phase started in September 2018 with regional training for the Eastern, Central and Western part of the country with 5 participants from each of the 50 districts; one person from data manager, and four persons from the programs. After the regional training two or three days ‘post training’ is planned for in each of the 50 districts, which started in November 2018. This training scheme is planned for and carried out by Pusdatin. What started as a university project in the first phase is now a full ‘mobilised’ and organisationally anchored dashboard project in the MoH. As one manager at national level commented;

*“DHIS2 is the best application with full features. Previously, we have bought expensive software, and all of that had failed. With this DHIS2 Platform, it is easy to use, it is free, Pusdatin chose the right solution now.”*

The final revision of this paper is written in February 2019 while participating in one of the post trainings organised by Pusdatin in Jayapura city and Jayapura regency, Papua province, the extreme eastern – and poorest - part of Indonesia. As according to the plan, Pusdatin was running the training and five from each of these two districts had participated in regional training November 2018. Discussion during the training focused on how to reach the remote areas with no Internet and mobile connectivity and how to ensure offline data capture and analysis. One health centre in the district, we were told, is 45 min away - with aeroplane (!). This only to underline that, while the dashboard project is well mobilised and organisationally anchored, there are organisational and technical challenges not yet addressed.

## 6 Discussion and Conclusion

We have used translation moments to analyse the project and its 3 phases; (1) the early phase before the pilot project, (2) the 10 districts pilot project, and (3) the expansion to 50 new districts and the official status as ASDK. Studying this project trajectory, we see that Pusdatin’s role has moved from being a bit reluctant and unsure about consequences for other projects (1), to being involved (2) and finally to be fully committed as

‘project owner’ and leader. The problematisation moment has been particularly important, as the OPP has been gradually strengthened through each phase of the project, as a result of the alignment processes between and within the translation moments and in particular the problematisation and interessement moments.

An earlier study of the Indonesia project used the concept of attractor for change to analyse how the DHIS2 dashboard helped to develop a strategy for integration of HIS despite high degrees of complexity [1]. The various actors could imagine that integration was feasible ‘because the dashboard was not closely embedded in complicated business processes and could stand above it’. Using the translation moments, we see that, while the dashboard has been the attractor aligning actors at policy and data use levels in the interessement moment, interessement among technical actors in the local network has been concerned with internal positioning around the OPP and relations to the global policy network. The stronger the OPP and the alignment in the local network are, the stronger the convergence of policy and technical elements in the project. In this way, the analysis based on the translation moments has provided new insight.

The Indonesia case underscores the importance of continuous negotiations and translating diverse stakeholder’s interests in the implementation of health information systems in volatile environments. Kimaro & Nhampossa argued that, stakeholder’s interests should be translated into the solution to address the long-term organisational needs [4]. Thus, the solution which meets the interests of different actors in the network will ultimately become the de-facto solution. While several contested interests emerged, the emergent of the district dashboard to the policy level depended on the result of contested interests reached by actors linked together in complex networks. The transition of the project to policy, as identified in this study, is caused by increased organisational ownership, local capability and strong collaboration and alignment among participating actors. The easiness with which new health programmes could be included and the flexibility of DHIS2 to accommodate new features and requirements prompted Pusdatin to design it as the ASDK. As one high level manager said: “The ministry could not continue to pay more money to new systems, DHIS2 provides affordable solution, yet flexible to accommodate our needs”.

The use of the four moments of translation in the analysis of the dashboard process has provided new insight into how diverse groups are translating and aligning their interests into the network to achieve the project goal. It has been important to understand the strong position of the OPP, also called ‘project goal’ [9], in our case the agreed system specification as negotiated between the local and global network. Furthermore, it has been equally important to understand how the OPP is developing through stages caused by a process of overlapping and repeated cycles through the four moments of translation.

## References

1. Braa, J., Sahay, S., Lewis, J., Senyoni, W.: Health information systems in indonesia: understanding and addressing complexity. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017*. IAICT, vol. 504, pp. 59–70. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_6](https://doi.org/10.1007/978-3-319-59111-7_6)



2. Callon, M.: Some elements of sociology of translation: domestication of the scallops and the fisherment of St Brieuc Bay. *Sociol. Rev.* **32**, 196–233 (1984)
3. Heeks, R.: *Reinventing Government in the Information Age: International Practice in Public Sector Reform*. Routledge, Abingdon (1999)
4. Kimaro, H.C., Nhampossa, J.L.: Analyzing the problem of unsustainable health information systems in less-developed economies: case studies from Tanzania and Mozambique. *Inf. Technol. Dev.* **11**(3), 273–298 (2010)
5. Sanner, T.A. et al.: Paying per diems for ICT4D project participation: a sustainability challenge. Summer 2014 IFIP Spec. Issue **10**(2), 33–47 (2014)
6. Latour, B.: On recalling ant. *Sociol. Rev.* **47**(1\_suppl), 15–25 (1999)
7. McBride, N.: Actor-network theory and the adoption of mobile communications. *Geography* **88**(4), 266–276 (2003)
8. Tilson, D., Lyytinen, K.: *Making Broadband Wireless Services: An Actor-Network Study of the US Wireless Industry Standard Adoption* (2005)
9. Law, J., Callon, M.: The life and death of an aircraft: a network analysis of technical change. In: Bijker, W.E., Law, J. (eds.) *Shaping Technology/Building Society. Studies in sociotechnical change*, pp. 21–52. MIT Press, Cambridge (1992)
10. Latour, B.: *Science in Action: How to Follow Scientists and Engineers Through Society*. Harvard University Press, Cambridge (1987)
11. Winter, R., Munn-Giddings, C.: *A Handbook for Action Research in Health and Social Care*-Routledge. Routledge, Abingdon (2001)
12. Baskerville, R.L.: Distinguishing action research from participative case studies. *J. Syst. Inf. Technol.* **1**(1), 24–43 (1997)
13. Checkland, P., Holwell, S.: Action research: Its nature and validity. *Syst. Pract. Action Res.* **11**(1), 9–21 (1998)
14. Sahay, S., et al.: *Public health informatics: Designing for Change, A Developing Country Perspective*. Oxford University Press, Oxford (2017)
15. The Presidential Work Unit for Development Monitoring and Control, M. of N.D.P.: *Satu Data Blueprint for Sustainable Development*. Unit Kerja Presiden Bidang Pengawasan dan Pengendalian Pembangunan, Jakarta (2014)
16. Hovy, E.: *Data and Knowledge Integration for e-Government* (2008)
17. Pusdatin: *Final Report of HIS Implementation*. Jakarta, Indonesia (2018)
18. Pusdatin: *Guideline of Satu Data Kesehatan* (2018)
19. Pusdatin: *Best Practice dan Lessons Learned*. Jakarta, Indonesia (2018)
20. Walsham, G., Sahay, S.: GIS for district-level administration in india: problems and opportunities. *MIS Q.* **23**(1), 33–65 (1999)
21. Costa, C.C., da Cunha, P.R.: *Business Model Design from an ANT Perspective: Contributions and Insights of an Open and Living Theory* (2009)
22. Whitley, E.A., Pouloudi, A.: Studying the translations of NHSnet. *J. Organ. End User Comput.* **13**(3), 30–40 (2001)
23. Latour, B.: *Reassembling the Social: An Introduction to Actor-Network-Theory*. Oxford university press, Oxford (2005)



# IT and Government Corruption in Developing Countries: A Literature Review and Reframing

Atta Addo 

London School of Economics and Political Science, London, UK  
a. a. addo@lse.ac.uk

**Abstract.** Corruption is a significant challenge confronting government administration in developing countries with adverse implications for information technologies implemented to stamp it out. ICT4D, information systems and related studies of government corruption continue to shed light on the phenomena but have an undertheorized view of corruption, its relationship with IT, as well as the role of IT in curbing corruption. Research underemphasizes the socially embedded nature of corruption by treating corruption as a problem of individuals who act corruptly out of rational self-interest or internalized social structures. Drawing on a review of relevant literature, this article suggests a reframing to better align research on IT and government corruption with a socially embedded perspective that considers the formative organizational and broader contexts of developing countries to improve explanations of the complex and seemingly intractable phenomena.

**Keywords:** Government corruption · Information technology · ICT4D · Literature review · Social embeddedness · Contextualist research

## 1 Introduction

Government corruption—defined as the misuse of public office for private gain [1–4]—has been suggested to be more prevalent in developing countries [5]. Corrupt practices at the government-citizen and government-business interface in developing countries have been associated with structural and operational deficiencies [6–10], as well as poor developmental outcomes [1, 11]. Given such nexus of government corruption with an inefficient and ineffective administrative apparatus, attempts at controlling the former often involve efforts to reform the latter [12, 13]. IT implementations have been carried out in developing country governments to improve services and to stamp out corruption [14–16]. But despite extensive computerization [16–19], their interplay with corruption remains unclear as diverse literature report mixed and contradictory findings.

While corruption is universal, its endemic and widespread nature in developing countries calls for consideration of context and its implications for IT in the fight against corruption. For example, the historical, political and broader social context of developing countries have been suggested to entrench government administrations where officials routinely control public office for private gain [20–22]. Yet, many corruption studies ignore context by assuming endemic corruption as a behavior by opportunistic, or perhaps immoral people – a view that might lead to the problematic

conclusion that people in developing countries must be particularly opportunistic or immoral.

Through a review of the extant literature we discuss understandings of the role of IT in the fight against corruption. We suggest that extant research on IT and government corruption in developing countries undertheorize IT and corruption. The implication of such undertheorization is examined through a theoretical lens of social embeddedness [23], which allows equal consideration of both social structures and actors in explanations of (corrupt) action. Consistent with understandings of theorizing in ICT4D that stress the significance of the developing country context in explanations [24–27], we propose a reframing that considers the nature of corruption as socially embedded within the peculiar historical and broader context of developing countries—that is, as neither *undersocialized* (actor focused) or *oversocialized* (social structures focused).

The rest of the article proceeds as follows: first, we outline the perspective of social embeddedness and its relevance for studies of information technology in developing countries. We then describe our methodology and present findings of our literature review. The literature is discussed, and the article concluded.

## 2 IT and Government Corruption in Developing Countries

Early empirical studies of the organizational effects of IT explored government administration reform contexts [28, 29, 30]. These studies reported limited, and questionable outcomes despite expectations of IT’s potential for organizational change. IT was shown to reinforce existing values, interests and power structures, rather than transforming [28]. Scepticism remains regarding the capacity of IT to reform malpractices like corruption rather than “amplifying” them [31–33]. The challenge in public reform appears to be not so much one of technology, but rather, how heterogenous actors with entrenched interests enact IT [34]. An overarching view is that IT does not deterministically reform or stamp out corruption; social forces constrain or enable effects of IT. However, this is not to suggest that IT plays no role. The salient questions are why, how and under what conditions IT and government corruption interplay for specific outcomes.

To answer these questions, an ICT4D-oriented theorization of IT’s interplay with, or effects on government corruption in developing countries might involve some conceptualization, implicit or explicit, of government corruption, IT, and the nature of their relationship in given organizational or social settings [35]. To the extent that researchers pursue these aspects differently or not at all, findings of various studies of IT and government corruption vary and tend towards incongruence. Hence, while methodological and conceptual pluralism are beneficial for understanding complexities of IT and government corruption [36], it is important to clarify assumptions about government corruption, IT, their relationship, and the significance of context; and as needed, points of departure from relevant contradictory findings.

Next, we present general understandings of corruption in the social sciences (Sect. 2.1), then review three views of social action that might frame conceptualizations of government corruption in the extant literature (Sect. 2.2). In our review of the

literature (Sect. 4), we discuss the implication of technology in relation to these alternative views of action (*qua* government corruption).

## 2.1 What Is Corruption?

Corruption is universal and has a long tradition of work in the social sciences [37]. However, definitions are contested and consensus elusive [4, 38–40]. Earlier moral, ethical and legal definitions lacked scope across place and time [37, 41], and economic perspectives of corruption that view it as a form of rent-seeking or as a variant of the principal-agent problem are based on narrow assumptions of individual rational agents, devoid of contextual influences [42, 43]. Such assumptions of rational self-seeking have been shown to be untenable and lacking universal merit because other intrinsic motivations lower corruptibility [44].

Most definitions derive from corruption among ‘standalone’ economic agents and view corruption as happening with one party (e.g., embezzlement, fraud, abuse of government property) or two (e.g., bribery, ‘speed money’, kickback, collusion). Another approach is to view corruption in socialized terms, for example, by considering the implication of social networks and relations [45]. By admitting corruption among multiple parties in a social system, the role of social norms and institutional conditions (beyond individual rationality) emerge. Social norms appear to underpin complex corrupt practices such as patronage, clientelism, cronyism, money laundering etc., that might be less explicable by economic assumptions of rational self-seeking agents.

Corruption has also been understood by looking at specific forms it takes e.g. grand versus petty/street-level corruption related to the hierarchy of officials or the amounts involved [2, 3]; systematic versus venal related to whether corruption is for political ends or for private economic interests [31, 46]; base versus permeated, related to whether corruption occurs in national institutions or stakeholder service systems [47]; and a host of practices related to whether a corrupt individual acts alone, in interaction with another or multiple parties [45, 48].

## 2.2 Alternative Views of (Corrupt) Action

Foundational to theorizations of the link between IT and corruption is the way in which corruption is conceptualized, that is, the nature of corruption as a particular kind of action or behavior. In general, views on the nature of action and behavior vary across the social sciences with two, economic and sociological—common in IS, ICT4D and related fields. The economic view conceives action/behavior as the result of rational choice by self-seeking, utility-maximizing agents with perfect information, whereas sociological views ascribe action to a configuration of social structures and agency (e.g. either through agents internalizing structures or structural association [49, 50]).

In his seminal work on economic action and social structures, Granovetter [23] presents three contrasting perspectives on the nature of action. He identifies two extreme views—undersocialized and oversocialized action—and a middle perspective of socially embedded action. The undersocialized view, common with economic assumptions of action, take the actor as a rational, self-seeking utility maximizer with

perfect information (*homo economicus*), whose calculative decisions are their own, independent of society. The oversocialized view, common with sociological assumptions of action, take actors as chiefly guided by internalized social norms and structures (*homo sociologicus*).

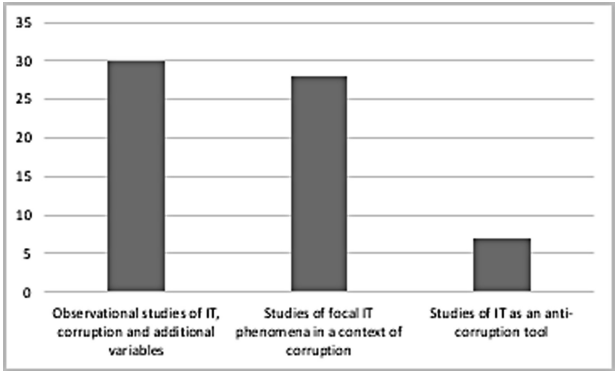
A critique of both views is that they ‘atomize’ action and behavior by focusing on the individual. A socially embedded view acknowledges this limitation in the under-socialized and oversocialized views and considers action as intertwined with complex, dynamic systems of ongoing social relations that occurs within specific contexts. Such view of embedded action echoes elements of structuration theory [49, 51] in that in explanations of action and behavior they both advocate due consideration of the individual and the social (agency and social structures). Furthermore, an embedded view of action enables exploration of the significance of formative organizational and broader contexts on particular phenomena involving IT [52, 53] —an important concern in ICT4D research [24, 35, 54].

### 3 Methods

Using an initial structured protocol and search strategy we systematically select and review relevant literature from an initial list of leading ICT4D, IS, as well as related Management, Public Administration, and Development journals. From an initial hit of 2,794 articles matching title-abstract-keywords associated with information technology, government, corruption, and developing countries, we obtain a set of 31 highly relevant empirical studies that match most of the key words searched, and whose titles and abstracts indicate substantial treatment of corruption. From this set of 31 we use a forward and backward bibliographic snowballing [55], to identify an additional set of 33 relevant studies; bringing to 64 our total number of studies for review. We then conduct a data extraction and open coding exercise to identify mutually exclusive themes in relation to corruption, as well as details of various studies such as research approach, empirical evidence, connection to theory, findings, as well as level of analysis. We take a ‘systematic approach’ to identifying relevant studies and a ‘traditional narrative’ literature review in our write-up, combining strengths of both [56]. [Detailed appendices excluded due to word length but available upon request].

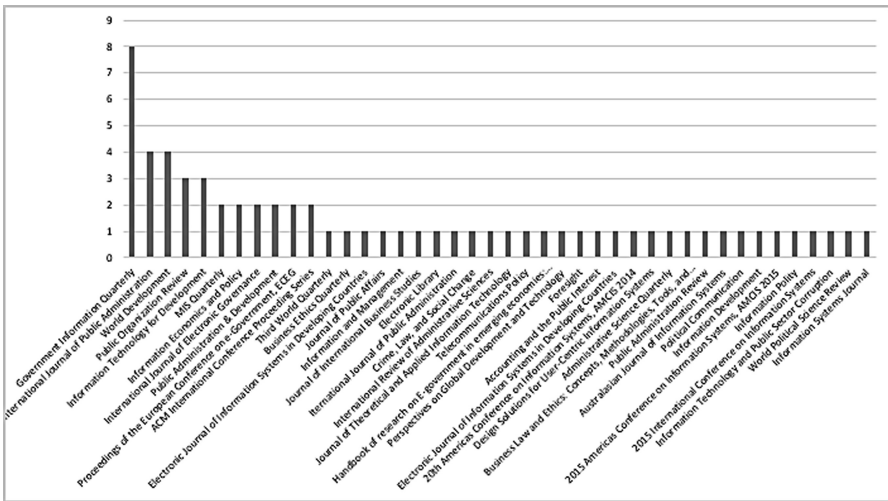
### 4 Literature Review Findings

Our systematic review of empirical studies on IT and government corruption in ICT4D, Information Systems and related publications of Development, Management, and Public Administration, reveals three broad categories of research on IT and corruption: (1) observational studies of IT, corruption and related variables (2) Case studies of IT as an anti-corruption tool (3) Case studies of focal IT phenomena in a setting of corruption. As shown in Fig. 1 the majority of research on IT and government corruption are observational studies or studies of focal IT phenomena in a setting of corruption, with relatively few case studies of IT’s role in anti-corruption.



**Fig. 1.** Distribution of research on IT and government corruption in developing countries from a review of ICT4D, Information Systems, Public Administration, Development and related journals

Of the journals publishing work on the topic, majority were Public Administration journals, with Information Technology for Development (ITD) having the most of all ICT4D journals, and Government Information Quarterly (GIQ) the single biggest outlet (Fig. 2).



**Fig. 2.** Distribution of articles by publication outlet on topic of IT and government corruption in developing countries

Next, we discuss each stream of research in terms of how the literature conceptualizes corruption; what the relationship between corruption, IT, and other constructs are; and, how (corrupt) action and its formative context (developing countries) are conceived.

#### 4.1 Observational Studies of IT, Corruption and Related Variables

Observational studies comprise a significant portion of research on IT and government corruption (Fig. 1). Studies adopt statistical or econometric approaches to draw inferences or to establish relationships between variables. They assess relationships between measurable corruption proxies such as ‘corruption perception’ or ‘control of corruption’, IT-related variables, and socioeconomic or demographic variables. Studies commonly exploit publicly available cross-country corruption data from international organizations, e.g., Transparency International’s corruption perceptions index (CPI), and the World Bank’s control of corruption index (CCI), to test hypotheses that may or may not be sensitized by theory, or to develop explanations. Corruption related datasets are combined—as dependent or independent variables—with datasets on IT and related variables to assess associations, and less commonly, causation.

**IT-Related Constructs as an Independent Variable (Corruption as Dependent).** IT application in government processes is suggested to reduce corruption [57–62]. E-government is said to enhance government-citizen relationships and to enable monitoring and control of public officers’ behaviours [58, 59]. It has also been suggested that e-government and internet adoption act complementarily to reduce corruption [63]; that rule of law is a powerful pre-condition if e-government is to reduce corruption [62]; that there is an inverse relationship between Internet diffusion and government corruption that is mediated by voice and accountability [64]; that the level of e-government development is negatively associated with national level corruption in political, legal and media institutions, as well as mediated effects in business and citizen service systems [47]; that e-government service maturity contributes to controlling corruption, and national culture moderates the anti-corruption effect [65]. Government web presence, online participation, mobile phone penetration and internet adoption have also been associated with lower levels of corruption [66–70]; as have social media penetration [71, 72]. Other studies report contradictory outcomes as technology investments might either provide enablers for corruption control or enhance opportunities for other forms of corruption [73]. The direction of causality between internet adoption and corruption is, however, said to be bi-directional [74], suggesting more complex relationship between the two.

**IT Related Constructs as a Dependent Variable (Corruption as Independent).** Few observational studies explore how corruption influences IT-related variables despite corruption being suggested to inhibit e-government and to “make it unlikely for e-government to progress beyond basic information publishing” [75]. Despite fewer studies looking at corruption as an independent variable, anecdotal and case study evidence supports the view that corruption inhibits the potential of IT to render change in government administrations of developing countries. Corruption in developing economies has been suggested to restrict moral and governance capacity required for e-government success broadly, such that public administrations inevitably end up with systems that fail to meet stakeholders’ expectations [76]. For example, in Malawi, a state-of-the-art Integrated Financial Management System (IFMS) implemented to help control government spending, was secretly manipulated by government administrators leading to massive embezzlement [77, 78]. In Hyderabad, India, a successfully implemented hotline

system intended to streamline complaints and repair requests to the water board was perversely used by administrators who resented the increased monitoring. Subsequent follow-up visits on complaints which administrators had reported as resolved revealed that in roughly half of cases, repairs had not been made [7]. In Karnataka and other parts of India, despite end-to-end computerization of the public distribution system, widespread leakage persisted along the supply chain [9, 10, 79]. In Ghana, Zimbabwe, and elsewhere, despite digitizing court records, ‘missing docket’ remains a *modus operandum* for court administrators who conceal case files to induce bribes from litigants [80–83].

**Context in Observational Studies of IT and Corruption.** Context is not problematized in most observational studies. However, patterns emerge that relate to the broader national context. For example, magnitude of e-government effects on corruption has been shown to vary across cultures [84], and to be higher in developing countries [60, 61]. Gross domestic product (GDP) per capita and education are significant factors influencing IT potential in curbing corruption, implying that using IT to fight corruption might be more effective in concert with socioeconomic development and education improving strategies [85]. Information access is also associated with lower corruption, pointing to significance of the digital divide across countries for corruption [86]. Rule of law is a determinant of lower corruption and policies based on internet and mobile phone use are strengthened by legal enforcement [87, 88].

## 4.2 Studies of IT as an Anti-corruption Tool

Studies explore the question of how IT might work as an anti-corruption tool. A frequent thread in such research is the role of IT in enabling transparency and accountability, based on a theoretical assumption that corruption arises from the agency problem, manifesting through information asymmetry and unchecked monopoly power. Studies often draw upon theoretical lens such as affordance [89], surveillance [90], accountability [91], the panopticon [92], agency theory [93, 94], Foucauldian ideas on knowledge and technologies of power [95], general deterrence theory [88], among others. Corruption is not considered directly in such studies (largely due to methodological and empirical constraints of observing and measuring corruption) but through perceptions of it, or in relation to the *potential* role of IT in its constraint, such as for transparency, accountability, or some other means (rather than an *actual* role observed in empirical settings).

**IT for Transparency and Accountability.** A commonly noted way IT is suggested to control corruption is by enabling transparency and accountability [96]. For example, an e-government initiative for anti-corruption, the Online Procedures Enhancement for civil application (OPEN) system in Korea is said to have had impressive reform and anti-corruption effects through transparency and accountability mechanisms [97, 98]. In implementing OPEN, the regulatory dimension as well as strong leadership were crucial enablers for success [99]. IT is also claimed to enhance surveillance capabilities of government [90], which might in turn increase transparency and enable accountability, for example, by enabling vertical and horizontal ‘hybrid’ forms of monitoring [100], creating a ‘panoptic’ organizational control [92], and enabling deterrence [88]. Aside enterprise systems, social media has been suggested to allow openness and



accountability that might reduce citizen perceptions of corruption [71, 72, 89]. Low news media rights, low internet and cellular phone use, among other factors, are claimed to be indicators for low levels of accountability and higher levels of corruption perception [91].

Nonetheless, as illustrative cases from Brazil and Nigeria suggest, IT-enabled transparency initiatives do not control corruption independent of organizational and broader historical and national context [101, 102]. Furthermore, media (radio) programmes do not offer a new platform for citizens to challenge those in power, but are spaces where existing power structures reproduce [103]. E-government initiatives to discipline public sector staff towards a particular mode of working, rather than reforming the provision of public services, are more likely to reproduce the established practices it seeks to change [95]. Neglecting organizational deep structures, as well as political timing, are additional factors in IT failure to meet government objectives [104].

**Other Means of IT as an Anti-corruption Tool.** Aside transparency and accountability approaches, studies identify alternate means of how IT might make a difference in corruption control. For example, IT might enable reduction of corruption opportunities in organizational settings by reconfiguring work practices [105]. Also, transaction cost economics concepts such as bounded rationality, opportunism, and asset specificity are viewed as applicable to corruption, such that corruption varies in accordance with changes in the specificity of assets invested to support corrupt transactions [106]. Computerization initiatives that reduce uncertainty and asset specificity of government services are therefore suggested to lead to lowered perceptions of corruption [107]. In addition, IT might enable corruption control through its institutional effects such as strengthening regulatory measures [99], or introducing institutional logics that might transform corrupt government practices over time [108, 109].

**Context in Studies of IT as an Anti-corruption Tool.** Organizational context affects the potential of IT as an anti-corruption enabler. Weak administrative and technical capacity in African contexts are said to condition high likelihood of IT failure in reform efforts [110, 111]. Strong administrative and technical capacity in Korea enabled success of IT-enabled anti-corruption efforts such as OPEN [99], relative to the poorer performance of similar system in Bangladesh [98]. Broader context is also shown to be a significant influence on effects of IT in anti-corruption. For example, rather than focusing on assumptions about the electronic media as a tool of accountability, Stremlau et al. [103] emphasize the unexpected effects radio programs have in their social and political context, including overlapping relationships between on-air and off-air networks to reproduce power.

### 4.3 Studies of Focal IT Phenomena in a Setting of Corruption

Corruption has been noted in passing or in name only in various studies of IT phenomena in developing country governments [9, 108, 112–114]. Consideration of corruption is not sustained, and comes up in relation to some focal IT phenomena such as adoption and use, IT failure, unrealized implementation outcomes, etc. For example,

Masiero [10, 112] studying the computerization of India's Public Distribution System (PDS) in Karnataka, notes the widespread government corruption that enables leakage and diversion along the supply chain ("rice mafia"), thereby impeding effective IT-enabled provisioning to the vulnerable poor. Such entrenched corruption defining the context of IT related phenomena in developing countries is suggested to have institutional and historical roots [108, 109, 111], and to involve rationalities present in developing countries [115].

## 5 Analysis and Discussion

### 5.1 View of (Corrupt) Action in the Extant Literature

Our literature review of IT and government corruption in developing countries identifies three broad research orientations: (1) observational studies of IT, corruption and related variables (2) Case studies of IT as an anti-corruption tool (3) Case studies of focal IT phenomena in a setting of corruption. Studies exhibit conceptual as well as methodological diversity, with observational studies being the most common. Studies are published mostly in non-ICT4D journals (Fig. 2) where the link between IT/ICTs and development is seldom problematized, and the setting of developing countries is not a substantive consideration.

This observation is significant as ICT4D research requires careful framing and theorization that considers the context of developing countries seriously if it is to elucidate the peculiarities of IT related practices in such settings [24, 35, 54]. A major puzzle remains why corruption is endemic in developing countries (and their government administrations in particular); and relatedly, how and why IT faces exceptional challenges when deployed to support reforms in such contexts. The three orientations of research reviewed provide limited insight into these questions that require probing the historical, organizational and broader context of developing countries.

As suggested in Sect. 2.2, one way to view the extant literature is by recourse to their assumed view of the nature of corrupt action (and relatedly, the implication of IT interventions). Specifically, the degree to which corruption is assumed to be a phenomenon of 'atomized' individuals (whether as the action of a self-interested economic agent or a passive agent chiefly driven by internalized social structures), versus something more complex involving actors embedded in specific social settings and nested relations.

In that regard, observational studies of IT and government corruption – the dominant research approach in our sample—is seen to adopt an undersocialized view of corrupt action since it relies on economic assumptions of standalone, self-interested actors whose ongoing social relations are not considered. Exemplary observational studies draw evidence from macro-level country and cross-country data to suggest effects of technology on controlling government corruption [47, 57–60, 116], consistent with a rational choice theoretic understanding that individual (micro) level phenomena aggregate to the macro level. But such aggregate level studies typically fail to show how and why IT interplays with corrupt practices in specific ways under salient

contextual or cultural conditions [84, 117–119], or how the context of developing countries matter.

Case studies that explore how IT might function as an anti-corruption tool similarly tend to adopt an economic view of actors that does not adequately consider the social context and dynamic ongoing relations of corrupt action. The undersocialized economic view considers IT as a tool that solves technical-rational problematizations of corruption—for example, as a rent-seeking behaviour or principal-agent problem—through mechanisms such as reducing information asymmetry by enhancing transparency, reducing opportunism by re-engineering processes, controlling (constraining/enabling) behaviour, or disintermediating corruptible agents by increasing automation.

But the endemic misuse of public office for private gain in developing countries is not adequately explained as a problem of corrupt individuals *per se*. Such individualistic framing might imply some undesirable personal traits or motivations in people from developing countries as causal (an untenable and discriminatory proposition without basis in contemporary social science). Rather, explanations of endemic corruption in developing countries (and the role of IT) might be usefully related to the peculiar, historically formed structural conditions and ongoing social relations.

Yet, in addition to the lack of sustained focus on corruption, approaches that look at IT phenomena in a setting of corruption can be said to assume a view of corrupt action that is oversocialized, meaning the influence of the prevailing social setting on corrupt action is simply taken for granted. From such perspective, IT appears subjugated to social forces of corruption and is said to “amplify underlying social structures”, values and interests that drive corruption, or is at best epiphenomenal [27, 28].

## 5.2 Towards a Reframing of Corruption Research in ICT4D

Although corruption is frequently understood as deviant behaviour by particular corrupt people, it might be fruitfully addressed as a socially embedded phenomenon rather than a problem of ‘atomized’ actors (isolated rational agents or passive actors internalized with social structures). An embeddedness approach highlights the simultaneous importance of actors and the complex social settings and dynamic relations in which they are situated and act.

Various theoretical lenses might be used to explore an embedded view of IT and government corruption in developing countries. For example, structural views of action and IT related practices, as well as related theoretical positions such as the institutional logics perspective which considers individual cognition and its recursive relationship with broader social structures. For example, in a study of IT supported government administration reforms in a developing country, Addo & Avgerou (unpublished) consider the interplay over time of different IT systems with government corruption under different institutional arrangements. To explain the interplay of IT and government corruption, they trace changes in the institutional and sociotechnical work environment and link these to changes in work arrangements within which they are embedded and use IT. Such work is an exemplary ICT4D exploration as it takes seriously IT and organizational change while problematizing the development context and the embedded nature of corruption.

Furthermore, given that that economic and social exchange are facilitated by being embedded in a social structure that goes beyond individual level motivations [23, 120], more exploration could be made of the importance of formal and informal institutions, as well as embeddedness in social networks that make up the fabric of economic life [121]. Social structures and network ties are noted as significant for sustaining corrupt transactions [3, 122, 123]; as are norms and trust relations beyond individual self-seeking [124], yet their implications for IT and government corruption appear under-explored.

Methodologically, while studying corruption directly remains a challenge, more empirical studies that draw upon ethnography (with its ‘thick description’) might enrich knowledge of corruption, its experience in developing country settings, and the role of IT. Other forms of empirical evidence and creative research designs are also needed to probe the characteristics of organizational and broader contexts in developing countries and their influence on corruption and related situated IT phenomena.

## 6 Conclusion

For IT interventions to enable meaningful gains in the fight against government corruption in developing countries, a good first step might be to dismantle the still common technical-rational view of IT as a simple tool that can (deterministically) accomplish things such as stamp out corruption. Indeed, decades of research in Information Systems and ICT4D undermine such a view. An embeddedness perspective on corruption opens up possibilities to explore why, how and under what conditions IT and government corruption interplay in specific ways within the complex, dynamic, organizational and social fabric of developing countries.

## References

1. Bardhan, P.: Corruption and development: a review of issues. *J. Econ. Lit.* **35**(3), 1320–1346 (1997)
2. Lambsdorff, J.: *The Institutional Economics of Corruption and Reform. Theory, Evidence and Policy.* Cambridge University Press, Cambridge (2007)
3. Rose-Ackerman, S.: *Corruption and Government: Causes, Consequences, and Reform.* Cambridge University Press, Cambridge (1999)
4. Johnston, M.: Keeping the answer, changing the questions: corruption definitions revisited. In: von Alemann, U. (ed.) *Dimensionen politischer Korruption. Beiträge zum Stand der internationalen Forschung*, pp. 61–76. VS Verlag für Sozialwissenschaften, Wiesbaden (2005)
5. Treisman, D.: What have we learnt about the causes of corruption from ten years of cross-national empirical research? *Annu. Rev. Polit. Sci.* **10**, 211–244 (2007)
6. Tanzi, V.: Corruption around the world: causes, consequences, scope, and cures. *Int. Monet. Fund* **45**(4), 559–594 (1998)
7. Davis, J.: Corruption in public service delivery: experience from south asia’s water and sanitation sector. *World Dev.* **32**(1), 53–71 (2004)

8. Dutt, P., Traca, D.: Corruption and bilateral trade flows: Extortion or evasion? *Rev. Econ. Stat.* **92**(4), 843–860 (2010)
9. Masiero, S., Prakash, A.: Does computerisation reduce PDS leakage?: Lessons from Karnataka. *Econ. Polit. Wkly.* **50**(50), 77–81 (2015)
10. Masiero, S.: Imagining the State through Digital Technologies : A Case of State-Level Computerization In the Indian Public Distribution System, no. June, pp. 1–234 (2014)
11. World Bank Group. *Corruption and development* (1998)
12. Ayeni, V.: *Public Sector Reform in Developing Countries: A Handbook of Commonwealth Experiences*. Commonwealth Secretariat, London (2001)
13. Brinkerhoff, D., Brinkerhoff, J.: Public sector management reform in developing countries: perspectives beyond NPM orthodoxy. *Public Adm. Dev.* **35**, 222–237 (2015)
14. World Bank Group. *An Evaluation of World Bank Group Activities in Information and Communication Technologies*, Washington, DC (2011)
15. United Nations. *E-Government Survey*, NewYork (2016)
16. Schuppan, T.: E-government in developing countries: experiences from sub-Saharan Africa. *Gov. Inf. Q.* **26**(1), 118–127 (2009)
17. World Bank: *World Development Report 2016: Digital Dividends*. World Bank, Washington, DC (2016)
18. Bhatnagar, S.: *Public Service Delivery : Role of Information and Communication Technology in Improving Governance and Development Impact* (2014)
19. De, R.: Implementation of E-Government Systems in Developing Countries. In: Anttiroiko, A.-V., Mälkiä, M. (eds.) *Encyclopedia of digital government*, pp. 995–999. Idea Group Reference, Hershey (2007)
20. Erdmann, G., Engel, U.: Neopatrimonialism reconsidered: critical review and elaboration of an elusive concept. *Commonw. Comp. Polit.* **45**(1), 95–119 (2007)
21. Mosher, F., Chapman, B., Page, E.: *Public Administration*, Encyclopedia Britannica (2009)
22. Chabal, P., Daloz, J.: *Africa Works. Disorder as Political Instrument*. Indiana University Press, Bloomington (1999)
23. Granovetter, M.: Economic action and social structure: the problem of embeddedness. *Am. J. Sociol.* **91**(3), 481–510 (1985)
24. Avgerou, C.: The significance of context in information systems and organizational change. *Inf. Syst. J.* **11**(1), 43–63 (2001)
25. Avgerou, C.: Theoretical framing of ICT4D research. In: Choudrie, J., Islam, M., Wahid, F., Bass, J., Priyatna, J. (eds.) *Information and Communication Technologies for Development. ICT4D 2017. IFIP Advances in Information and Communication Technology*, vol. 504, pp. 10–23. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_2](https://doi.org/10.1007/978-3-319-59111-7_2)
26. Hayes, N., Westrup, C.: Context and the processes of ICT for development. *Inf. Organ.* **22**, 23–36 (2012)
27. Njihia, J.M., Merali, Y.: The broader context for ICT4D projects: a morphogenetic analysis. *MIS Q.* **37**(3), 881–905 (2013)
28. Danziger, J., Dutton, W., Kling, R., Kraemer, K.: *Computers and Politics: High Technology in American Local Governments*. Columbia University Press, New York (1982)
29. Laudon, K.: *Computers and Bureaucratic Reform*. Wiley, New York (1974)



# The Contributions of WhatsApp to Social Inclusion: A Case of Internally Displaced Persons in Nigeria

Salihu Ibrahim Dasuki<sup>1</sup>(✉) and Naima Hafiz Abubakar<sup>2</sup>

<sup>1</sup> University of Sheffield, Sheffield, UK  
s.dasuki@sheffield.ac.uk

<sup>2</sup> American University of Nigeria, Yola, Nigeria

**Abstract.** This paper addresses the topic on how WhatsApp can improve the lives of internally displaced persons (IDPs) affected by conflict. To theorize the complex relationship between mobile technologies and social inclusion, Sen's five distinct instrumental freedoms was drawn upon to understand the use of WhatsApp by IDPs affected by Boko Haram insurgency in Nigeria and its impact on their social inclusion. Based on a one-week fieldwork of an ongoing research, the case narrative presented both the freedom outcomes afforded the IDPs by the use of WhatsApp and also the impediments that hinder the developmental impact. Finally, we conclude by providing some implications for research and practice.

**Keywords:** WhatsApp · Freedoms · IDPs · Nigeria

## 1 Introduction

According to the UNHCR (2017) report titled “*Global Trends: Forced Displacement in 2017*”, 65.8 million people are forcibly displaced from their homes due to violence, conflicts, persecutions or violations of human rights. Children below the age of 18 constitute 52% of these displaced persons. Furthermore, Sub-Saharan Africa is a host to more than 26% of the world displaced population and the number has continued to grow due to ongoing conflicts in Central Africa Republic, Sudan and Nigeria which is the focus of our research. Currently, Nigeria is facing a huge humanitarian challenge as a result of the continuous attack by the militant group “*Boko Haram*” in the North Eastern region. Due to this instability, many of its citizens are internally displaced into new communities where they struggle to get adequate access to suitable housing, clean water, education and health facilities to satisfy basic human needs. This increasing number of internally displaced persons (IDPs) in Nigeria has impacted adversely on social inclusion generally. Warschauer (2004) defines social inclusion as “*the extent that individuals are able to fully participate in society and control their own destinies*”. In the context of IDPs, it is universally agreed that mobile technologies can offer new opportunities for income and employment (Hyde-Clarke 2013), support social inclusion by opening new dimensions in social interaction (Chiumbu 2012), and enabling self-empowerment amongst IDPs (Diminescu et al. 2009). To date, there has been

limited research on the how IDPs use mobile phones in sub-Saharan Africa (Bacishoga et al. 2016). The few existing studies seem to concentrate on simply providing mobile access to immigrants (Kutscher and Kreß 2016) or technologies used by refugees living in host communities in developed countries (AbuJarour and Krasnova 2018) or provide little insights into the process on how mobile technologies can enhance a more social inclusion of IDPs (Andrade and Doolin 2016). To fill this gap, we carried out a research based on a one-week field work in Nigeria to qualitatively examine how IDPs are using the mobile platform - WhatsApp (a peer to peer messaging app that allows users text, chat, and share media, including voice messages and video, with individuals or groups) in order to understand ways in which it can promote social inclusion.

Also we examined the factors that impede IDPs from using WhatsApp to achieve social inclusion. Drawing upon Sen's (1999) capability approach (CA) as a theoretical lens, we show an alternative way for evaluating the impact of WhatsApp on social inclusion and point out the significance of socio-cultural context and the need to consider these factors when designing and implementing policies on access and use of mobile platforms. Furthermore, our study contributes to a better understanding of the impact of WhatsApp on IDPs, which positions our study within the domain of enriching sustainable development goals (SDG) 16 which aims at using technologies in integrating IDPs both economically and socially. Also, due to the relative novelty of WhatsApp use by IDPs in Nigeria, little substantive research and theoretical literature exists on the experiences of IDPs and how such experience may inform the ways we think about social inclusion in relation to technology. On the practical side, our insights may advise governments and other stakeholders in their efforts towards the use of information and communication technologies to empower IDPs in sub-Saharan Africa.

The rest of this paper is structured as follows. We provide a literature review in Sect. 2. In Sect. 3, we discuss our theoretical framework. We present our research methods in Sect. 4 and introduce our findings and analysis in Sect. 5. In Sect. 6, we conclude our paper and discuss areas for future research.

## 2 Internal Displaced Persons and ICTs

Forcefully displaced persons have to adapt into their new host communities and construct new meaningful lives (Andrade and Doolin 2016). They are faced with a range of issues such as overcoming their disrupted education, learning a new language, negotiating family relationships, and dealing with discrimination (Abujarour and Krasnova 2018). One solution to these challenges is the use of ICTs as tools to navigate the new information environment that they encounter (Andrade and Doolin 2016). Particularly, the Internet and social media can provide a communicative space that connect IDPs with a wide range of people and also enable their participation in the information society (Caidi et al. 2010). For example, Navarrete and Huerta (2006) work on transnational communities of immigrants show that the Internet has transformed the way in which displaced person interact thus helping them to break the time and distance barrier. The combined characteristics of emerging technologies, that is, text, image, audio and video has shown to satisfy both the communication needs of

displaced persons and also vital in creating and promoting their sense of belonging in the community (Abujarour and Krasnova 2017).

Furthermore, social media such as Facebook, twitter, Instagram etc. have provided a platform for disconnected social groups to interface thus allowing displaced persons to maintain and build contact with new and existing contacts and as well as distant networks (Abujarour and Krasnova 2017). It has also enabled them to monitor events and participate in the political activities of their communities (Andrade and Doolin 2016; Caidi et al. 2010). For example, Gifford and Wilding (2013) work on ICT use by refugees in Melbourne shows that social media gives refugees the space to voice their experiences and present themselves to their friends, community and hosting country, thereby giving them a sense of belonging. Within the ICT4D domain, Andrade and Doolin (2016) draw upon the capability approach to understand how refugees in Australia exercise their agency and enhance their well-being using ICTs in ways that assist them live a valuable life in their new society. They find out that technology as a resource enabled the refugees to participate in an information society, to communicate effectively, to understand a new society, to be socially connected, and to express a cultural identity. Similarly, Abujarour et al. (2018) explored the relationship between the intensity of Internet use and the sense of social connectedness of Syrian refugees in Germany, as well as the impact of social connectedness on their social inclusion. In this study, we extend the research efforts of Andrade and Doolin (2016); Abujarour and Krasnova (2017) by exploring the use of WhatsApp by IDPs in Nigeria and its contribution to their social inclusion.

### 3 Theoretical Framework

An appreciation of the domain of ICT for the social inclusion of IDPs is incomplete without theorizing the notion of human development itself. According to the Human Development Report (2016), human development is defined as *“the expansion of the richness of human life, rather than simply the richness of the economy in which human beings live”*. This definition resonates with the Amartya Sen’s capability approach (CA) which focuses as the expansion of human freedom both as the primary end and means of development (Sen 1999). It critiques the economic theories of development such as modernization that concentrate on income, gross domestic production and expenditure (Sahay and Walsham 2017). CA constitute of two key elements namely functionings and capabilities. Functionings represent the beings and doings and are constitutive of a person’s wellbeing. Capabilities on the other hand is referred to as the freedoms that people have to enjoy valuable beings and doings (Alkire 2005). However, Sen has not provided a list of valuable capabilities or functionings. As such, the CA framework has been criticized as an unworkable idea, incomplete and unspecified (Robeyns 2005; Nussbaum 2000). Sen intentionally resists prescribing a set of capabilities, rather he emphasizes the need for a democratic process to identify the list of valued capabilities that are culture and context sensitive. Sen (1999) proposes five distinct instrumental freedoms that directly or indirectly enhance people to live more freely. They are:



- **Political Freedoms:** Freedom of expression and the freedom to scrutinize and criticize authorities, to enjoy a free press and multi-party elections.
- **Transparency Guarantees:** Freedom to trust others and to ensure that information is honestly disclosed.
- **Economic Facilities:** Opportunities people have to participate in economic activities.
- **Social opportunities:** Freedom to health facilities and education.
- **Protective Security:** Opportunities available to prevent vulnerable people from abject deprivation.

Sen (1999) noted that the instrumental freedoms complement and reinforce each other. For example, people's participation in policy making can enhance transparency of the process. In this paper we examine how these five instrumental freedoms can be interpreted and applied to the Nigeria context in order to ascertain WhatsApp contribution to the social inclusion of IDPs in Borno State.

## 4 Research Method

To address the research aim of this study, a qualitative investigation was conducted to understand how IDPs in North Eastern Nigeria were using WhatsApp to enhance their social inclusion. A broadly interpretive approach was adopted in this study (Walsham 2006) with the aim of understanding the social context of the use of WhatsApp. This is an ongoing study and data was collected for one week in June, 2018 in Maiduguri city of Borno State. The state has witnessed outbreaks of violence mainly due to the Boko Haram insurgency. Boko Haram is a jihadist militant organization based in the North-Eastern part of Nigeria. The insurgency has led to thousands of deaths with at least one attack taking place every month. As of October 2017, there were approximately 275,720 IDPs in Maiduguri, 5% of the IDP population are females; 56% are children below 18 years old and 7% are persons over 60 years (IOM 2017). There are about 2,406,151 mobile phone subscribers residing in Borno State (NBS 2017). Many of the IDPs have smart phones and majority of them are active mobile subscribers who use WhatsApp. WhatsApp popularity in Nigeria has eaten into the traditional SMS (Short Message Service) and voice platforms provided by the major mobile operators such as Glo, MTN and 9mobile since the application enables users to make voice and video calls and text messaging for a relatively cheap data cost. Currently the cost of a new smart phone in Nigeria is as low as 4000 Naira (approximately \$11) and subscribing for a monthly WhatsApp bundle using the network providers is as low as 60 Naira (approximately \$0.17).

Data for this study was collected via interviews with four randomly selected participants who are IDPs and active WhatsApp users. The interview session took place at a safe location in Maiduguri and each session lasted about 45 min. The participants comprised of one woman (33 years old) and three men (34 years old, 42 years old and 39 years old). Two of the participants had a university degree, one had a higher national diploma and one had a high school certificate. All participants before insurgency lived outside Maiduguri; they all came from different cities affected by the insurgency

namely Gwoza, Konduga, Bama and Baga. All participants are now living in rented accommodation with their families in Maiduguri. We explained the objectives of the study and sought consent from each of the participants prior to commencing the interviews. The informed consent form states that participation in the study was voluntary and reports resulting from the study would not contain any information that could be used to identify the participants. Interview questions related to their experience in using WhatsApp, how they have used it to adapt to their new communities and self-empowerment and how they use it to enhance their social inclusion. Interviews were conducted in Hausa language and later translated into English. We use pseudonyms for participants to preserve confidentiality and anonymity. Qualitative data were transcribed and then analysed following the guidelines of thematic analysis (Braun and Clarke 2014) and relating it with the concepts for Sen's capability approach. The following section shows how the Sen's five instrumental freedoms was drawn upon to understand the freedoms afforded to these IDPs as a result of their use of WhatsApp.

## 5 Analysis

### 5.1 Political Participation and Transparency

The 2015 election in Nigeria was the most anxious since the civilian regime in 1999. This was as a result of the rise in unemployment, corruption, poverty and more importantly the rising insecurity due to the Boko haram insurgency. The militants had seized almost 70% of the territory in Borno state. Many town and villages were under their control; the population of Maiduguri was gradually swelling with IDPs who had fled from the terrorist. The residents felt let down by the ever rising insurgency and insecurity caused by Boko Haram and what was described as non-effort by the then President, Goodluck Ebele Jonathan of the People's Democratic Party (PDP). Despite the deteriorating insecurity situation, the government promised to hold the February 17, 2015 elections by boosting military presence and providing assurance of citizens' safety. The electoral body also made institutional arrangements for the thousands of IDPs to cast their votes at the IDP camps. Thus, many IDPs started using their WhatsApp communities to disseminate anti-government messages and reasons while the PDP led government should be voted out. This was done across various political WhatsApp groups constituted of hundreds of members. Ngamdu, 34, a political activist that fled his hometown, Bama to Maiduguri said he used WhatsApp to vigorously campaign against the previous administration and it was the fastest and easiest channel to reach a wide audience:

*"I kept sending broadcast messages about the atrocities of the PDP led government and how Borno state has been destroyed because of their lack of commitments to ending the insurgency. And you know it's easy for information to go viral on WhatsApp and I am a member of over 30 WhatsApp groups. When I send the message to one political group, members see it and share it to another political group and it keeps been shared and before you know it in few hours the message would have reached over 20000 individuals within and out of Borno state. I believe this helped market the then opposition party APC "*

Apart from political campaigns, Ngamdu noted that the WhatsApp group provided a platform for political discussions and people became more aware of daily political events and issues happening in Borno State. More importantly, citizens used WhatsApp to monitor the election activities on election day especially as there is a rising demand for real time information in Nigeria with a lack of uninterrupted 24-hour coverage on local television channels and radio stations, high costs of print media and impediments in freedom of expression and press freedoms. To prevent election rigging, Ngamdu noted that:

*“Majority of the members of the various WhatsApp group became reporters in their polling units and also at the IDP camps during the election period. Before the election, broadcast messages were always sent daily stating in Hausa “Ku fita ku yi zabe. Ku Kasa, ku tsare, ku raka ku tsaya” meaning you should come out and vote. After voting, ensure you guard, protect and escort the results to the collation centre and wait until it is counted”. So immediately people finished voting, people take pictures of the result sheet and share it on the WhatsApp group while others are sharing information on the tallies of the total numbers of votes of each political party”.*

The WhatsApp platform also played a watchdog role in ensuring the transparency in elections in Borno state. It ensured citizens participation by allowing the citizens to report news and information surrounding the election. However, Ngamdu noted that many of these IDPs turned political activists were also harassed during the day of election with some of them having their phones seized by police due to recording of evidence of election malpractice. However, this did not hinder the activist in reporting the live election feeds and results. Since after the elections, citizens have continued to use WhatsApp in offering suggestions on how the government can fix the country. Also, many have used the platform to reach out to their elected representatives who have their legislative aides registered in these groups that respond to citizens' complaints on behalf of the politicians. Andrade and Urquhart (2012) argue that ICTs are able to assist political liberty of its alleges beneficiaries however several wider institutional factors usually constrain these political liberties.

## 5.2 Economic Opportunities

Due to Boko Haram insurgency, Borno state has witnessed a rise in poverty and unemployment. Many private businesses have shut down as a result of the violence leaving many unemployed. However, the findings of the study revealed that citizens of the states are adopting the use of WhatsApp for entrepreneurship and also seeking temporary employment. Ayshe, 33, a divorcee who lives alone with her two kids took up the use of WhatsApp to start her own business. She specialises in selling a variety of baby clothes and products. According to her:

*“When we moved to Maiduguri after Boko Haram took over Baga, I was unemployed So I decided why don't I continue the business I was doing while in Baga but using my phone since I did not have the money to rent a shop. So what I did is tie myself to one of the groups for example the Kanuri Jewel is a very popular WhatsApp group here. I started posting my products with some information such as pictures and price and instantly I started getting a lot of enquiries through private messages.*

*Gradually sales started coming in and I started expanding myself into other groups and I also got referrals from my existing customers”*

Ayshe further noted that a lot of people prefer the online business as it prevents them from having to visit the markets. Crowded places such as markets are usually soft targets for Boko Haram suicide bombers. Also Ayshe noted how she has also been able to further provide temporary employment as a result of her business. She stated that:

*“I have employed two delivery boys who reside in the IDP camp close to me who are in charge of ensuring the products reaches the customers. I pay them for each delivery they make. Payments are being made before any delivery is made. Once I receive a credit alert on my phone, I immediately pack the client’s product and call any of the delivery boys to come pick it up”*

Ayshe further noted that due to the emergence of WhatsApp, the number of women entrepreneurs in Borno has continued to grow, however there were still few challenges with the business model of WhatsApp amongst married women. She noted that some of her friends who started the business and stopped highlighted jealousy of their husbands as shown in the quote below:

*“I had a friend who was also into the business; she sells locally made house incense. After a week or so of her marriage, she told me she had stopped and I asked her why. She informed me that because she had to address customer enquiries all the time, she was finding it difficult to engage in her house chores. The first thing she does when she wakes up is check her phone and also customers keeping sending and contacting her in the night and her husband was not too comfortable with her chatting with her male clients thus leading to several marital problems. To save her marriage she had to quit the business”.*

Ayshe also highlighted the dominating factor of husband and culture hindering many of the married women from engaging in this WhatsApp led home business. She stated this:

*“You see due to our culture and religion, when a lady is married here, she is now under the control of her husband who is responsible for taking care of her. Usually, these women come into the marriage with their phone but how they access and use the internet is usually determined by the husbands. For a business like this that requires talking to men, it may not go down well with their husbands”*

Interestingly, the findings of the study also showed that culture and religion hindered some women from using WhatsApp to become business entrepreneurs. Usually, culture in most countries in Africa constrains the participation of women in social, economic and political activities - even in agendas that impact their lives (Nyemba-Mudenda and Chigona 2018).

### **5.3 Social Opportunities**

Since its inception in 2009, the Boko Haram ideology has always been western education is a sin. The institutions of higher education in Maiduguri which are symbols of western education have been a major target of the Boko Haram militant group. One of its major institutions came under attack in January 2017 and since then several suicide attacks have been executed and foiled within and around the premises. These attacks usually lead to temporary shutdown of the institutions pending when normalcy returns.

Modu, 42 years, a lecturer from Gwoza working in one of the institutions found the use of WhatsApp as a novel approach to form an online classroom and continue engagement with 43 students enrolled for his 2<sup>nd</sup> year undergraduate political module whenever there was an attack and the university was temporary closed.

Majority of the students all have smart phones with WhatsApp installed in it. The WhatsApp environment was used to share course resources, information about upcoming deadlines and time extensions, also words of encouragement were shared across the platform keeping students connected through their phones in these difficult times. Modu stated:

*“During this break, I will post a message on the WhatsApp group about political theories and asked them to go read about it on the internet and relate it to the Nigeria context. Within some few hours, messages start popping up and the students start debating on the topic. Some students will ask me: Mallam Modu, I’m sure you agree with my argument and disagree with Aisha’s own? But I am always on the neutral side since we do not have one single answer in political studies. The good side of this WhatsApp group is that even when the university is in session, it’s still very active”*

Modu also stated how the students drive learning and discussion on the WhatsApp group. The students became more engaging and it allowed shy students to engage as shown in the quote below:

*“I remember once the network was so poor and I couldn’t post any message to the Whatsapp group throughout the morning. Once the network was back, several messages came into my phone and the first I could remember was from a student who hardly talks in class: Hi Sir is there no activity for us today? I replied that my network was bad and immediately they start sending in their messages. I also use the group to post messages encouraging the students to be resilient and not be deterred by the threats of Boko Haram and more importantly to always be vigilant”.*

It is evident that the use of the WhatsApp group has resulted in building up trust between the students and the lecturer and encouraging collaborative learning. When the university was re-opened, the students who are made up of many displaced persons provided a good feedback on the use of WhatsApp as noted by Modu. The findings show that Mr Modu who is a lecturer has been able to use WhatsApp to enhance his teaching and learning in a vulnerable environment. The finding of the study show that WhatsApp indeed can enhance the freedom of teaching and learning but like every other virtual learning environment, there are social, human and environmental factors that could hinder its usage (Cetinkaya, 2017).

#### **5.4 Protective Security**

Whatsapp provides opportunities and possibilities for individuals to interact and engage with people during crises by disseminating relevant information. In this study, Whatsapp have enabled active citizenship where members of the community take ownership of their community safety. Jafaru, 39, an IDP and a community leader from Konduga noted that being a member of the neighbourhood WhatsApp group seems to have made members more security conscious. Jafaru stated:

*“There was a day one of the group members posted “who else heard that loud bang. Is it another bombing?” immediately there were several responses to the*

*questions, apparently it was one of the transformers within the neighbourhood that blew off..Also whenever there is an attack immediately people post messages informing members who are not aware and also advise them on routes to follow when getting home in case they are not at home”*

Jafaru believes that the WhatsApp group have made neighbourhood safe places and have served for preventive purposes.

*“In the group we share security alerts and pictures of wanted criminals and terrorist from the security agencies and these criminal are not stupid. If they know that there is a WhatsApp group where members of the community pay attention to and monitor in collaboration with the local vigilantes, then they know: Okay we should not be in this area because the members are monitoring us already”*

Other benefits of the WhatsApp group are that it allows members to report suspicious activities in the community. Also, the local vigilantes have been given phones and their numbers have been added into the WhatsApp group. Jafaru noted that the local vigilantes have found the WhatsApp group helpful in solving community crime. During the interview, Jafaru raised some concerns about the effectiveness of the use of WhatsApp for protective security. He noted that many of the members sometimes hesitate to discuss security issues that specifically have to do with boko haram and report incidents in the group due to fear of retaliation. Also, Jafaru noted that whenever some members report criminal incidence in the group chats calling the attention of local vigilantes, the response time from the vigilantes is usually ineffective. The findings show that citizens are increasingly eager to create safe communities for themselves and WhatsApp has provided the opportunities for participatory community policing. Although there are few factors that are usually encountered that may hinder WhatsApp usage to achieve community policing which on the other hand can decrease the feelings of community safety (Pridmore et al. 2018). To avoid this, Van Steden et al. (2011) argued that institutional arrangements should be provided to actively involve all stakeholders in the use of technology in enhancing their personal and environmental safety.

## 6 Conclusion

Studies on IDPs affected by Boko Haram insurgency in Nigeria are underrepresented in the literature due to either the lack of interest by scholars or the difficulties of access to them. Hence, the main newsworthy contribution of this study is the nuanced account of WhatsApp use by IDPs and how such use enhances their freedoms to live a valuable life. From the case narratives, using the Sen’s five instrumental freedoms, we have illustrated how the use of WhatsApp in the case study led to increased social, economic and political opportunities for the IDPs. While discussing all these positive outcomes, we have also identified the social, economic and infrastructural constraints that hinder the full conversion of use of WhatsApp into freedoms in this particular context. However as indicated it is pertinent for ICT4D scholars to understand and work towards mitigating the contextual factors that influence the full realization of these freedoms. In proposing areas for potential mobiles for development research, the limitation of this study is acknowledged. This study was limited to a single case study and was carried under a short time frame, although there is scope for conducting a

longitudinal study using both qualitative and quantitative sources and other resilience frameworks on the basis of the existing results in order to provide more insight on the contributions of WhatsApp to the social inclusions of IDPs in Nigeria.

## References

- AbuJarour, S., Krasnova, H.: E-learning as a means of social inclusion: the case of Syrian refugees in Germany. In: Americas Conference on Information Systems (AMCIS 2018), New Orleans, LA, 16–18 August 2018 (2018)
- AbuJarour, S., Krasnova, H.: Understanding the role of ICTs in promoting social inclusion: the case of Syrian refugees in Germany. In: European Conference on Information Systems (ECIS 2017), Guimarães, Portugal (2017)
- AbuJarour, S.A., Krasnova, H., Hoffmeier, F.: ICT as an enabler: understanding the role of online communication in the social inclusion of Syrian refugees in Germany. In: Proceedings of the 26th European Conference on Information Systems, Portsmouth, pp. 1–17 (2018)
- Andrade, A., Urquhart, C.: Unveiling the modernity bias: a critical examination of the politics of ICT4D. *Inf. Technol. Dev.* **18**(4), 281–292 (2012)
- Andrade, A.D., Doolin, B.: Information and communication technology and the social inclusion of refugees. *MIS Q.* **40**(2), 405–416 (2016)
- Alkire, S.: Why the capability approach? *J. Hum. Dev.* **6**(1), 115–135 (2005)
- Bacishoga, K.B., Hooper, V.A., Johnston, K.A.: The role of mobile phones in the development of social capital among refugees in South Africa. *Electron. J. Inf. Syst. Dev. Ctries.* **72**(1), 1–21 (2016)
- Caidi, N., Allard, D., Quirke, L.: Information practices of immigrants. *Annu. Rev. Inf. Sci. Technol.* **44**(1), 491–531 (2010)
- Cetinkaya, L.: The impact of Whatsapp use on success in education process. *Int. Rev. Res. Open Distrib. Learn.* **18**(7) (2017)
- Chiumbu, S.: Exploring mobile phone practices in social movements in South Africa—the Western Cape anti-eviction campaign. *Afr. Identities* **10**(2), 193–206 (2012)
- Clarke, V., Braun, V.: Thematic analysis. In: Michalos, A.C. (ed.) *Encyclopedia of Quality of Life and Well-Being Research*, pp. 6626–6628. Springer, Dordrecht (2014). <https://doi.org/10.1007/978-94-007-0753-5>
- Diminescu, D., Renault, M.: TIC et parrainage dans les mouvements militants de défense des sans-papiers en France. *tic&société* **3**(1–2) (2009)
- Hyde-Clarke, N.: The impact of mobile technology on economic growth amongst ‘survivalists’ in the informal sector in the Johannesburg CBD, South Africa. *Int. J. Bus. Soc. Sci.* **4**(16) (2013)
- Gifford, S.M., Wilding, R.: Digital escapes? ICTs, settlement and belonging among Karen youth in Melbourne, Australia. *J. Refug. Stud.* **26**(4), 558–575 (2013)
- IOM 2017. IOM Framework for Addressing Internal Displacement (2017). [https://www.iom.int/sites/default/files/press\\_release/file/170829\\_IDP\\_Framework\\_LowRes.pdf](https://www.iom.int/sites/default/files/press_release/file/170829_IDP_Framework_LowRes.pdf). Accessed 11 Jan 2019
- Kutscher, N., Kreß, L.: Internet is the same like food – an empirical study on the use of digital media by unaccompanied minor refugees in Germany. *Transnatl. Soc. Rev.* **6**(1–2), 200–203 (2016)
- Navarrete, C., Huerta, E.: Building virtual bridges to home: the use of the Internet by transnational communities of immigrants. *Int. J. Commun. Law Policy*, 1–20 (2006)
- NBS 2017: Telecommunication Sector Data (2017). <https://www.nigerianstat.gov.ng/download/729>. Accessed 08 Nov 2019

- Nyemba-Mudenda, M., Chigona, W.: mHealth outcomes for pregnant mothers in Malawi: a capability perspective. *Inf. Technol. Dev.* **24**(2), 245–278 (2018)
- Nussbaum, M.: Women’s capabilities and social justice. *J. Hum. Dev.* **1**(2), 219–247 (2000)
- PremiumTimes: Four UN aid workers killed, one abducted in Rann Attack (2018). <https://www.premiuntimesng.com/news/headlines/260374-four-un-aid-workers-killed-one-abducted-rann-attack.html>. Accessed 23 Aug 2018
- Pridmore, J., Mols, A., Wang, Y., Holleman, F.: Keeping an eye on the neighbours: Police, citizens, and communication within mobile neighbourhood crime prevention groups. *Police J.*, 1–24 (2018). <https://journals.sagepub.com/doi/full/10.1177/0032258X18768397>
- Robeyns, I.: The capability approach: a theoretical survey. *J. Hum. Dev.* **6**(1), 93–117 (2005)
- Sahay, S., Walsham, G.: Information technology, innovation and human development: hospital information systems in an Indian state. *J. Hum. Dev. Capab.* **18**(2), 275–292 (2017)
- Sen, A.: *Freedom as development* (1999)
- UNHCR: *Global Trends: Forced Displacement in 2017* (2017). <https://www.unhcr.org/globaltrends2017/>. Accessed 18 Jan 2018
- Van Steden, R., Van Caem-Posch, B., Boutellier, J.C.J.: The ‘hidden strength’ of active citizenship: the involvement of local residents in public safety projects. *Criminol. Crim. Justice* **11**(5), 433–450 (2011)
- Walsham, G.: *Doing interpretive research*. *Eur. J. Inf. Syst.* **15**(3), 320–330 (2006)
- Warschauer, M.: *Technology and Social Inclusion: Rethinking the Digital Divide*. MIT Press, Cambridge (2004)





# Ride Hailing Regulations in Cali, Colombia: Towards Autonomous and Decent Work

Katherine M. A. Reilly<sup>1</sup>(✉) and Luis H. Lozano-Paredes<sup>2</sup>

<sup>1</sup> Simon Fraser University, Vancouver, BC, Canada  
kreilly@sfu.ca

<sup>2</sup> Universidad Torcuato Di Tella, Buenos Aires, Argentina

**Abstract.** In this article we explore the decent work standard developed by Richard Heeks for digital online labour markets and use a review of empirical research about ride-hailing to adapt this framework to the location-based service delivery market. The framework is then tested against an in-depth analysis of informality and precarity in the ride hailing sector in Cali, Colombia. Findings show that location-based platform workers in Cali lack many decent work protections. However, the case study also demonstrates that workers are evolving creative ways to grapple with specific aspects of precarity within the ride-hailing sector. Based on this analysis, we argue that policy analysis and worker innovations need to ‘meet in the middle’ rather than follow policy recommendations emanating from other jurisdictions. We suggest some specific policy reforms that will be appropriate to the Colombian and Latin American context.

**Keywords:** Decent work · Platform economy · Ride hailing · Colombia

## 1 Introduction

The digital platform economy is rapidly reorganizing the activities of businesses, workers and consumers alike [40], and policy makers are often forced to introduce policy solutions before the full implications of new business models are realized and understood [15]. In particular, the platform economy offers greater flexibility to workers, and the possibility to ‘be your own boss.’ However, this informality may worsen or introduce new forms of precarity among workers in ways that are not currently well understood. Indeed, the platform economy challenges definitions of informality and precarity and therefore renders standard policy responses obsolete. Meanwhile, if policy interventions are to be successful, policy makers need to take into consideration workers’ adaptations to their rapidly changing context [42].

With this in mind, this paper applies Heeks’ [19] decent work standard for platform labour to the ride hailing sector in Cali Colombia. Since Heeks’ standard was designed for online platform labour, we use a literature review to adapt it to the ‘location-based service delivery’ market, paying particular attention to the ride-hailing sector, which includes Uber, Lyft, 99Taxis or Easy Taxi. The framework is then used to assess informality and precarity in the ride hailing sector in Cali, Colombia. Results show that workers are developing creative solutions to address precarity or improve opportunity

within the ride-hailing sector. We suggest how Colombian and Latin American policy can take these findings into account to produce appropriate regulatory frameworks.

## 2 Emerging Decent Work Standards for the Digital Economy

The International Labour Organization (ILO) defines decent work as “opportunities for work that is productive and delivers a fair income, security in the workplace and social protection for families, better prospects for personal development and social integration, freedom for people to express their concerns, organize and participate in the decisions that affect their lives and equality of opportunity and treatment for all women and men” [26]. The decent work standard offers a way to assess whether labour arrangements are ‘empowering’ to workers, and by extension whether the platform economy offers the possibility of empowerment to workers [43].

The platform economy is theorized to offer unequal levels of opportunity to workers [25 p. 18; 11] and it has the potential to create new patterns of exclusion and precarity [3; 34; 6; 29; 38]. We need frameworks to evaluate the impacts on workers, and to provide guidance to policy-makers [53].

Heeks [19] addresses this gap with his ‘Decent Work in the Digital Economy’ guidelines. The framework is based on a review of empirical studies of crowd work platforms [22]. Ride-hailing and related services such as food delivery have different dynamics, since they are geographically constrained [14 p. 32]. So, Heeks’ model must be adapted to the location-based service delivery market.

Heeks found that potential *benefits* from crowd work include access to employment opportunities, unbiased or objective inclusion in labour markets, reasonable earnings (often higher than workers would otherwise earn), career development opportunities, greater flexibility [1], and in some cases reduced costs [19 p. 10].

Ride hailing studies corroborate Heeks’ findings about flexibility [32; 18 p. 11; 7], access to employment opportunities [28], and overcoming access barriers that exist in established taxi industries [18 p. 6; 4]. This suggests that ride-hailing apps empower workers to be independent contractors. An analysis of the Mexican case found that Uber drivers can earn significantly higher salaries than traditional taxi drivers depending on hours worked, contributions to social security, and patterns of vehicle ownership [36]. Informal taxi work can be made less precarious through the introduction of ride-hailing apps [34 p. 386]. Finally, ride sharing services have been shown to make more efficient use of automobile resources than traditional taxis [1; 8].

Location-based work is not associated, however, with career development opportunities except as it allows workers to take time away from other full time work until something better comes along, or they complete studies [18 p. 12]. Nor does location-based work reduce the costs of work, however it may be used to supplement income or offset the costs of household expenses such as car maintenance.

Heeks organized key *challenges* according to the ILO’s 2013 decent work scheme: (1) working conditions, (2) the employment situation which includes things like the availability of jobs or the possibility for career development, and (3) the overall employment context including laws and policies, or the possibility for collective bargaining.

Working conditions for crowd workers revolve around whether a platform environment enables them ‘win’ contracts and complete tasks for fair compensation. Based on this, Heeks divides working conditions into four key issues: the adequacy of compensation, work processes, working hours, and health and safety.

As with crowdworkers, ride hailing workers express concerns about the costs of ride hailing. Compensation may be inadequate to cover costs [50 p. 6] such as driving to pick-up locations, waiting for customers, car insurance, car maintenance or depreciation, as well as cell service [34 p. 387].

The notion of work processes marks a departure from existing ILO decent work standards, which previously spoke of productive work. Platforms position workers as independent contractors, and the idea of “decent work processes” directs our attention to the need for fair conditions in which to operate an independent business. In the ride-hailing space drivers complain about the lack of transparency in how computer algorithms assign rides, which makes it difficult to plan business practices [32; 47 p. 3775]. Also, surge pricing obliges drivers to work at peak times of day in order to earn the highest incomes [51 p. 11; 50 p. 6; 34 p. 392] which takes away their autonomy.

Finally, regarding health and safety [52], studies suggest that workers would need to drive long days to earn a basic income, leading to fatigue [47 p. 3768]. Drivers may also experience feelings of isolation [50 p. 6], or drive late at night or in unsafe neighborhoods [34 p. 384].

The nature of employment concerns employment status, access to employment opportunities, stability and security of work, the potential for career development, discrimination, and dignity or respect at work.

Employment status is key to understanding decent working conditions in the ride-hailing sector. While ride hailing platforms legally designate drivers as independent contractors, they set up information systems that treat them like employees [20] or ‘dependent contractors’ [41; 35]. Also, since many workers in the global south lack the basic language, skills and infrastructure to take these jobs, they are often subcontracted by middle managers or fleet operators [28; 30 p. 46–47; 16; 45 p. 169; 38]. Also, the security and stability of ride-hailing work is heavily dependent on the algorithms used to organize the system. Drivers are vulnerable to sudden changes in service offerings, pricing or algorithms, including ratings systems [44; 46].

Career development opportunities are a major consideration in the crowdworking space, but are less relevant in the ride-hailing space. In contrast, discrimination and dignity are significant issues in the ride-hailing space. Hua and Ray [23] find that ride-hailing features racialized and gendered patterns of work, and authors report on discrimination both through ride-hailing apps [46] and in person [17].

A third category of issues concerns the overall context for employment, including availability of social protections, possibilities for collective bargaining, access to platform governance, and accountability and legal frameworks.

The lack of social protections for drivers is widely discussed, in particular the fact non-employees may lack access to minimum wage, overtime pay, unemployment insurance, health protections and benefits, rights to collective bargaining [31; 50 p. 6; 34 p. 385]. However, it is important to note that effective social protections are often non-existent for large segments of the working poor in developing countries. In this

context, the question is often more what can be gained from ride-hailing, rather than what is lost.

There is also a general power and information asymmetry between workers and platform owners in the platform economy [47 p. 3761–71; 11], which is made worse by the fact that labour market flexibility downloads risk and insecurity from firms onto workers [34 p. 385). Meanwhile, drivers face challenges with collective bargaining since the network is designed to connect them with gigs, but not each other [2, p. 12]. However, there are many examples of workers organizing to protect their rights, and online discussions about how to do so productively [5].

Overall, Heeks highlights the significance of work processes to labour relations in the platform economy, with implications for levels of worker autonomy, opportunities for worker creativity and entrepreneurialism, and the human rights of workers with regards to surveillance, data ownership and a host of related issues. This issue is common to all workers in the platform economy.

However, because ride-hailing is localized there are some significant differences in this sector. Health and safety issues are considerably more important to drivers than crowd workers. The barriers to employment are also very different, including access to an automobile. Training is less likely to work as a way to empower workers in this sector of the economy. Finally, because drivers are so directly dependent on their platform system for connecting with customers, knowledge about those work systems, or control over data about public transport, is essential to the empowerment of localized workers, and their ability to make companies accountable.

Based on this, many policies for decent work in the platform economy could apply across the labor spectrum, such as provision of leave and minimum salary. Others would need to cater to a particular sector [12]. For example, specific health and safety guidelines are necessary for drivers, but would be far less relevant to crowd workers. Similarly, training may not be as necessary in the ride-hailing space, and could be replaced with regulations for the onboarding of new workers, but is a significant concern for crowd workers [54]. Finally, the two largest concerns for localized platform workers are the possibility and right to operate with some measure of autonomy within a highly-automated system, as well as the right to form collectives to organize their work and defend their rights.

### **3 Decent Work Standards and Ride Hailing in Cali, Colombia**

In Cali, Colombia labor informality exceeds 48% of the population so ride hailing offers an important labor outlet [10]. Even though it is deemed illegal by authorities, it is embraced by workers, and protests against the sector have not arisen [37]. This situation has the potential to generate greater precarity among taxi drivers, so analysis of their situation is merited. This section evaluates the choices and circumstances of workers in Cali against the standards proposed by Heeks on the basis of empirical research carried out by Lozano-Paredes in spring 2018. This included a survey of ride-hailing workers (sample of 200, confidence 95%, margin of error 3.87%, variability 5%), and 5 in-depth interviews.

When surveyed about their motivation for taking up ride-hailing, workers indicated that the platform economy offered a quick way to earn extra income (46%), or that they did not find another option (33%). Interviews clarified that this career path requires few qualifications, has a low level of capital risk since the driver maintains ownership of the main business asset (the vehicle), there is no need to pay an association fee, and there is little supervision, so drivers can meet their personal goals on their own schedule. In interviews drivers indicated that ride-hailing offers a means to fulfill immediate economic need, and that they wanted to gain as much as they could in the sector while it was still possible, before legislation was introduced.

On the theme of working conditions, 79% of surveyed workers indicated that earning justified continuing to engage in ride-hailing. The Colombia minimum wage is COP 781 242 per month, (USD 270) and the average take home earnings for platform workers after expenses, is COP 2 300 000 per month (USD 767). Meanwhile, a poll of taxi drivers conducted by the National Federation of Merchants [13], for the city of Bogotá D.C., determined that, on average, taxi drivers have a monthly income of COP 1 725 000, (USD 575) after paying for expenses such as the rental of the vehicle, maintenance, which are on average COP 363 200 (USD 121) per month. Only 3% of surveyed workers reported valuing flexibility as a key motivator for ride-hailing, though flexibility was emphasized more strongly during interviews.

However ride-hailing workers do not comply with national working time directives. In July 2017, the Colombian Labor Code increased the working day from 8 to 10 h. This allowed employers to schedule 10 h shifts without exceeding 48 h per week. However, interviewees reported working an average of 60 h per week.

Finally, regarding health and safety, drivers need only comply with the minimum standards for car circulation. Colombia has mandatory insurance for car accidents called the Seguro Obligatorio de Accidentes de Tránsito (SOAT). This is a requirement for driving in general, and not specific to platform work. It is included in the cost of a car, and is amortized over the life of the car by ride hailing workers.

On the topic of employment conditions, there did not appear to be any barriers to working in the ride hailing sector, and both Uber and Cabify offer training opportunities, including a course in mobile-use for all participating drivers. This is not the case with the local application, WayCali. At the current time, training is business driven, rather than government mandated. Also, both Uber and Cabify offer workers access to a portable work history, reputation ratings and weekly earnings. However this data is not interoperable between the different platforms (no data portability).

All platforms have company policies guaranteeing anti-discrimination and data protection together with privacy for clients and workers. Colombian regulation lags behind the corporate sector in this regard, and even binding regulation regarding data protection [33] has not been applied to Transportation Network Companies. However, there is no space to resolve disputes between workers, platforms and clients.

Dignity and respect at work are difficult to evaluate. There are not currently any regulations in Colombia addressing this issues, but surveyed drivers did indicate that

their expectations were fulfilled by working with ride-hailing platforms (64.7 indicated they were substantially, and 35.3% indicated they were entirely fulfilled).<sup>1</sup> Workers did not express complaints regarding poor treatment by clients, and the *perception* is that platforms offer a good work environment. It may be that workers expect nothing more than a well-performing platform that allows them to turn a profit. In Cali, workers value the autonomy, flexibility and independence offered by ride-hailing, and their perceptions are shaped by this context.

Finally, regarding the employment context, contributions to social security are voluntary in Cali, and only 8% of surveyed ride-hailing workers made contributions to insurance, sick and/or maternity leave, or a pension plan. Another 45% reported contributions from previous work. Non-contribution is especially low among those at the beginning of their professional life (88.2%) and close retirement (50%). Younger workers do not feel a need to invest in social security, while older workers feel it is too late. Drivers reported that they would prefer not to pay social security, as it cut into their income. Indeed, they saw future formalization of the sector as a threat, and saw the ability to avoid taxes as a benefit of informal work. This reflects findings for the full labour market in Colombia [27].

Colombian regulation does not offer a categorization for platform works, however platform drivers could possibly be qualified as self-employed “independent workers.” This might put them under the Occupational Hazard System, which says that contractors who take on employees for more than a month must contribute to the General System of Labor Risks, however this practice is not currently in effect.

Finally, Colombian legal frameworks do not currently contemplate collective negotiation and collective communication between independent workers, and Colombia currently does not offer a national law regarding platform workers’ rights. The debate on this subject is currently open and ongoing. This means that drivers within the ride hailing systems currently do not have access to their metadata or any kind of consumer digital asset management or quality control. Meanwhile, since platforms and platform work are technically illegal in Colombia, there are no grounds for companies such as Cabify, WayCali or Uber to share their data with national, regional or local governments.

This evaluation shows that Colombian regulations fall well short of the decent work standards for the platform economy. Currently, in the absence of regulations, businesses fulfil some of the standards suggested by Heeks, and workers are not necessarily demanding changes. But the situation does put workers at risk of precarity. The research also shows that there is considerable diversity between workers, with motivations ranging from supplemental income, to entrepreneurial activity [24 pg. 37–38 and 64], to informal labour, and it is important to ensure that decent work standards take this into consideration.

<sup>1</sup> It is worth noting here that the Colombian Government created a decree which attempted to regulate Transportation Platforms in Colombia, under the name of “Luxury Cabs” (Ministry of Transportation of Colombia, Decree 2297/2015). This regulation however failed because it was not substantially different from existing taxi regulations.

## 4 Entrepreneurialism by Workers in the Ride Hailing Sector

It would be tempting to suggest that policy interventions in Colombia simply fill in the gap between existing conditions and global standards. However, local context needs to be taken into account if policy development, implementation and uptake is to be successful. This section takes a larger look at the ride-hailing sector in Cali, Colombia based on the above mentioned interviews plus ethnographic work carried out by Lozano-Paredes in spring 2018.

This research showed that there is considerable entrepreneurial activity within the ride hailing sector in Cali. In particular, two groups of drivers have emerged that use WhatsApp to build local ride hailing “platforms.” One group has about 300 drivers and the other 50. Drivers use these platforms to supplement their work during off peak times for the big platform companies, and, also to address some of the forms of precarity they experience in the ride hailing space.

The groups were created by enterprising ride-hailing drivers. Workers pay a monthly fee to join a dispatch group, which simply delivers dispatches. It neither offers nor demands verification of driver data, there is no need for compliance with mechanical technical norms, there is no accident insurance, nor contributions to social security.

A second WhatsApp group is available to customers where they can post pickup requests. The customer group grows through referrals as well as previous ratings in established platforms such as Uber. This group also includes intermediaries such as security guards and doormen at apartments, hotels and clubs who post requests on passenger’s behalf. Administrators pick up these requests and send them out to drivers through the dispatch channel. Intermediaries are paid COP 1 000 (USD 0.35) for each ride contracted or COP 75 000 (USD 27) for every 50 services contracted. If the service is to the airport, the payment goes up to COP 5 000 (USD 1.77) per ride.

As these services have evolved, the larger group has adopted the Zello walkie-talkie app for dispatch, and it has come to be known as *Los Sellos*. Through this free application groups of up to 2,500 drivers can sustain communication with each other. To access the Zello service drivers must pay a onetime membership fee of COP 100 000 (USD 35) and a monthly membership fee of COP 40 000 (USD 15). Passengers still post their requests to the WhatsApp group, but dispatch becomes more fluid.

The cost of a ride is calculated using a free application called Blumeter. Blumeter is an application that allows users to manage rides made outside of the Uber platform. Pricing can reflect Uber’s rates, or it can be customized by the driver.

Over time, organizers have introduced groups for local neighborhoods and suburbs. They have also introduced an inter-city service between Cali and Popayán (140 kms away) and Buenaventura (120 km). Requests are received on the main network, and the administrator forwards them to the administrator of the area or route network, who assigns the fare to a driver. The intercity routes are also used for packages.

One of the main reasons these emergent WhatsApp networks are successful, is that Uber, Cabify and WayCali face significant challenges with payments collections in Cali. The cost of using a credit card is very high in Colombia, which means that customers are unlikely to use their credit card for small transactions, such as a \$1 taxi ride. They would much rather pay in cash. In order to accommodate this, the big

platform companies have devised cash payment schemes. Each time a driver takes a cash payment, they incur a debt to the platform for the cost of the commission. The next time that a passenger uses a credit card to pay, this debt is paid down.

This creates an incentive for drivers to avoid customers who use credit cards, as well as an incentive to leave the platform if their commission debt becomes too large. Since there is no shared information system between platforms, and no credit history for drivers, drivers can do this with impunity. In addition, drivers can avoid the commissions charged by big platform companies all together if they connect more directly with customers. Altogether, there is a massive incentive for more localized platforms in cities like Cali, and they produce a win-win situation for drivers and customers, who get the same level of service, but at a lower cost to customers and a higher salary for workers.

In these networks, the passengers, drivers and owners of vehicles know that they are immersed in a scheme that offers few guarantees or protections. For example, there is no support for accidents whatsoever. This risk is apparently already calculated by the workers, who report that it is a risk worth taking. They gain higher income this way, and also avoid some of the pitfalls of working with platform companies, such as problems with rate settlement and poor complaint mechanisms between drivers and platforms.

Drivers see these schemes as a means to achieve personal gain, and to grow a micro-business by acquiring more vehicles, and these forms of entrepreneurialism should not be quashed. These emergent driver-run platforms are more informal than more established platforms like Uber or Cabify. However, through these schemes, workers are finding creative ways to improve their working conditions. For example, drivers, especially female drivers, enjoy the security of knowing that passengers have been vetted by trusted community members such as security guards posted at known buildings. And also, local collaborations can help drivers connect with fares during ‘dead hours’ when markets are saturated, thereby improving their income. In addition, these local systems allow drivers to enhance their service offering through delivery of packages, or carpooling [39]. And of course, these systems reduce the commissions that are paid to foreign firms or local platform companies, which is one of the surest way of putting money in the pockets of low-income earners.

## 5 Drawing Conclusions

In the Colombian context, labor regulations were designed for a radically different labor model, and do not guarantee decent conditions for platform workers. From the point of view of current regulations, the majority of platform workers in Colombia would be considered autonomous workers. Colombian legislation for autonomous workers is clearly insufficient to ensure adequate protections. In particular, the social security system was designed for salaried work, suggesting that Colombia requires new flexible forms of social security.

Based on the research presented here, Colombia should consider a new statute of *autonomous and decent digital work*, which lays out clear obligations for the companies involved, and offers new ways to extend the benefits currently enjoyed by those who have salaried work to workers in more flexible jobs. However, overregulation that



reduces or destroys the incentives that produce innovations in cities like Cali should be avoided. In total, new regulation should seek to achieve a minimum from which no one can be lowered, but not a maximum which no one can reach.

The standards for decent work in the platform economy presented in this paper offer a useful starting point. But in consideration of case study results, they need to be adapted for the Colombian context. They should provide certain clear minimums for drivers, such as regulations for accident and liability insurance. But they should not establish maximum's which no one can reach, such as the requirement that all drivers be made formal employees. The concept of "precariousness" and "informality" in Colombia should be revised to (1) recognize as formal those who have temporary or partial contracts and invoice a minimum amount per month, and (2) grant space to workers who voluntarily choose to categorize themselves as entrepreneurs. Rules such as mandatory pension contributions need to be treated with care, because they can place a heavy burden on informal workers as well as spaces of innovation. Similarly, the right to negotiate collective agreements should be balanced with the right of workers to stand outside of those agreements.

Policies to address ride hailing under conditions of informality need to be evaluated in the context of emergent business models that have significant implications for workers' rights and protections. Policy makers need to consider how to balance community innovations with the previously discussed standards of decent work, and policy proposals need to take into consideration not only the situation of workers in "regular" platforms such as Uber and Cabify, but also the entrepreneurial spirit of workers in the emergent WhatsApp and "Sellos" networks. Decent work standards should be designed such that they do not undermine entrepreneurship, while at the same time protecting against new forms of precarity for sub-contracted workers. Especially in emerging and developing countries, attention should be fixed on the need to empower workers to be entrepreneurs and/or innovators and therefore to produce the conditions for their own welfare, while also protecting them from the extremes of economic abuses.

## References


1. Anderson, D.N.: Not just a taxi? For-profit ridesharing, driver strategies, and VMT. *Transportation* **41**(5), 1099–1117 (2014)
2. Bajwa, U., Knorr, L., Ruggiero, E.D., Gastaldo, D., Zendel, A.: Towards an understanding of workers' experiences in the global gig economy. Global Migration & Health Initiative, Toronto (2018)
3. Bensusán, G.: Nuevas tendencias en el empleo: retos y opciones para las regulaciones y políticas del mercado de trabajo. Comisión Económica para América Latina y el Caribe (CEPAL), Santiago (2016)
4. Berger, T., Chen, C., Frey, C.B.: Drivers of Disruption? Estimating the Uber Effect. Oxford Martin School, University of Oxford, Oxford (2017)
5. Campbell, H.: How to organize a group of Uber drivers (2016). <https://therideshareguy.com/how-to-organize-a-group-of-uber-drivers/>. Accessed 11 July 2018
6. Cañigual, A.: Can digital sharing economy platforms pull Latin America's informal sector into the mainstream? Yes. *Americas Quarterly*, Summer (2015)
7. Chen, M., Chevalier, J., Rossi, P., Oehlsen, E.: The value of flexible work: evidence from Uber drivers. Working Paper 23296. UCLA Anderson School of Management (2017)
8. Cramer, J., Krueger, A.: Disruptive change in the taxi business: the case of Uber. *Am. Econ. Rev.* **106**(5), 177–182 (2016)

9. Decreto 2297 de 2015, Pub. L. No. 2297/2015., 10 (2015). <https://www.mintransporte.gov.co/descargar.php?idFile=13043>
10. Departamento Administrativo Nacional de Estadística. MEDICIÓN DE EMPLEO INFORMAL Y SEGURIDAD SOCIAL TRIMESTRE MÓVIL MARZO - MAYO DE 2017 (Technical Bulletin No. COM-030-PD-001-r004)
11. Drahokoupil, J., Piasna, A.: Work in the platform economy: beyond lower transaction costs. *Intereconomics* **52**(6), 335–340 (2017)
12. Esbenschade, J., Shifrin, E.: The Leased Among us: Precarious Work, Local Regulation, and the Taxi Industry. *Labor Stud. J.* (2018). <https://doi.org/10.1177/0160449X18768047>
13. FENALCO: Situación de los Conductores de Taxis en Bogotá (2016). <http://www.fenalcobogota.com.co/images/pdf/TAXIS-v2.pdf>
14. Forde, C., et al.: The Social Protection of Workers in the Platform Economy, p. 128. European Parliament Think Tank (2017)
15. Galperin, H., Alarcon, A.: The Future of Work in the Global South. International Development Research Centre (IDRC), Ottawa (2017)
16. Geitung, I.: Uber drivers in Cape Town: working conditions and worker agency in the sharing economy. University of Oslo, Oslo (2017)
17. Glöss, M., McGregor, M., Brown, B.: Designing for Labour: Uber and the On-Demand Mobile Workforce, pp. 1632–1643. ACM (2016)
18. Hall, J., Krueger, A.: An analysis of the labor market for Uber’s Driver-partners in the United States. Working Paper No. 22843. National Bureau of Economic Research (2016)
19. Heeks, R.: Decent work and the digital gig economy: a developing country perspective on employment impacts and standards in online outsourcing, crowdwork, etc. Development Informatics Working Paper Series No. 71 Manchester, UK: Centre for Development Informatics, Global Development Institute, SEED University of Manchester (2017)
20. Hernández, C.A., Nava, Y.: Subcontratación: relación laboral encubierta. *Telos* **14**(3), 333–345 (2012)
21. Hou, L.: Destructive sharing economy: a passage from status to contract. *Comput. Law Secur. Rev.* **34**, 965–976 (2018)
22. Howcroft, D., Bergvall-Kåreborn, B.: A typology of crowdwork platforms. *Work Employ Soc.* **33**, 21–38 (2018)
23. Hua, J., Ray, K.: Beyond the precariat: race, gender, and labor in the taxi and Uber economy. *Soc. Identities* **24**(2), 271–289 (2018)
24. Ibáñez Pérez, M.: Viabilidad Técnica y Financiera del Servicio de taxis en el Sistema Integrado de Transporte Público. Universidad Nacional de Colombia, Bogotá (2012)
25. Ilavarasan, V.: Automation and workforce in India: 16 terrible consequences or impossible? In: Galperin, H., Alarcon, A. (eds.) *The Future of Work in the Global South*, pp. 16–23. International Development Research Centre (IDRC), Ottawa (2017)
26. ILO. Decent work, 28 June 2018. <http://www.ilo.org/global/topics/decent-work/lang-en/index.htm>
27. Jassir, I., Guataquí Roa, J., Hartmann Cortés, K., Valdés Rocha, J.: El déficit de trabajo decente en Colombia. Borradores de Investigación No. 70. Facultad de Jurisprudencia, Universidad del Rosario (2015)
28. Kashyap, R., Bhatia, A.: Taxi drivers and taxidars: a case study of Uber and Ola in Delhi. *J. Develop. Soc.* **34**(2), 169–194 (2018)
29. Krakovsky, M.: The new jobs. *Commun. ACM* **61**(1), 21–23 (2017)
30. Kute, S.: The sharing economy in the global south: Uber’s precarious labour force in Johannesburg. University of the Witwatersrand, Johannesburg (2017)
31. Ledesma Cespedes, C.: Estudio regional sobre trabajo autónomo y economía informal. International Labor Organization, Peru (2013)

32. Lee, M.K., Kusbit, D., Metsky, E., Dabbish, L.: Working with machines: the impact of algorithmic and data-driven management on human workers. *ACM* (2015)
33. Ley Estatutaria 1581 de 2012 de Colombia Por la cual se dictan disposiciones generales para la protección de datos personales. Public Law No. 1581/2012 (2012)
34. Malin, B.J., Chandler, C.: Free to work anxiously: splintering precarity among drivers for Uber and Lyft. *Commun. Culture Critique* **10**(2), 382–400 (2017)
35. Mercado Gonzales, C.M.: *Crowdword offline o Uber economy y su impacto en las relaciones laborales*. Pontificia Universidad Católica del Perú, Lima (2017)
36. Miguel (no surname provided). ¿Cuánto Gana Un Chofer De Uber En México? (2017). <https://ingresopasivointeligente.com/cuanto-gana-un-chofer-de-uber-en-mexico/>. Accessed 9 July 2018
37. Ministerio de Transporte de Colombia. Por el cual se modifica y adiciona el Capítulo 6 del Título 1 de la Parte 2 del Libro 2 del Decreto 1079 de 2015, en relación con la prestación del Servicio Público de Transporte Terrestre Automotor Especial, y se dictan otras disposiciones Public Law No. 431/2017
38. Nastiti, A.: Worker Unrest and Contentious Labor Practice of Ride-Hailing Services in Indonesia. 2016 Arryman Fellows Papers. Indonesian Scholarship and Research Support Foundation (2016)
39. Orobio, J.C.: El carpooling es una solución viable para descongestionar el tráfico del sur. Government of Cali (2018)
40. Párraga, F.T.: Economía digitalizada y relaciones de trabajo. *Revista de derecho social* **76**, 59–82 (2016)
41. Pérez, J.: Uber y el monopolio de los datos. Universidad de Chile (2016)
42. Ramos, J., Sehnbruch, K., Weller, J.: Quality of employment in Latin America: theory and evidence. *Int. Labour Rev.* **154**(2), 171–194 (2015)
43. Randolph, G., Dewan, S.: Skills, social protection and empowerment in the platform economy: a research and policy agenda for the global South. In: Galperin, H., Alarcon, A. (eds.) *The Future of Work in the Global South*. International Development Research Centre, Ottawa (IDRC)
44. Ravenelle, A.J.: Sharing economy workers: selling, not sharing. *Camb. J. Reg. Econ. Soc.* **10** (2), 281–295 (2017)
45. Romero, Y.H., Sosa, R.V.G.: Modelo de gestión del servicio de transporte UBER. ¿Quién pierde y quién gana? *Espacios Públicos* **19**(47), 157–175 (2016)
46. Rosenblat, A., Levy, K., Barocas, S., Hwang, T.: Discriminating Tastes: Uber’s Customer Ratings as Vehicles for Workplace Discrimination. *Policy Internet* **9**(3), 256–279 (2017)
47. Rosenblat, A., Stark, L.: Algorithmic labor and information asymmetries: a case study of Uber’s drivers. *Int. J. Commun.* **10**, 3758–3784 (2016)
48. Sánchez Quiñones, L., Zamora, S.: Tribuna: Un estatuto digital para una revolución laboral (2017). [https://cincodias.elpais.com/cincodias/2017/12/05/legal/1512463452\\_233355.html](https://cincodias.elpais.com/cincodias/2017/12/05/legal/1512463452_233355.html). Accessed 9 July 2018
49. Smith, R., Leberstein, S.: Rights on demand: ensuring workplace standards and worker security. In: *The On-demand Economy*. National Employment Law Project (NELP) (2015)
50. Todolí i Signes, A.: El Impacto de la “Uber economy” en las relaciones laborales: los efectos de las plataformas virtuales en el contrato de trabajo. *IusLabor* **3**, 1–25 (2015)
51. Tran, M., Sokas, R.K.: The gig economy and contingent work: an occupational health assessment. *J. Occup. Environ. Med.* **59**(4), 63–66 (2017)
52. Vacano, M.V.: “Sharing economy” versus “informal sector”: Jakarta’s motorbike taxi industry in turmoil. *Anuac* **6**(2), 97–101 (2017)
53. Wier, M.L.: Uber reflects challenges of gig economy. *Canadian HR Reporter*, 30(18), 1–8 (2017)
54. Williams, R.: Ridesharing and women: benefits, barriers, and opportunities for progress. *Medium*, 6 March 2018



# ***Ex-Ante* Analysis of Adoption of Introduced Chicken Strains Among Smallholder Farmers in Selected Areas of Tanzania**

Rogers Andrew<sup>1</sup>(✉) , Jeremia Makindara<sup>2</sup>, Said H. Mbaga<sup>3</sup>,  
and Roselyne Alphonce<sup>4</sup>

<sup>1</sup> Department of Policy, Planning and Management,  
Sokoine University of Agriculture, Morogoro, Tanzania  
randrew@sua.ac.tz

<sup>2</sup> Department of Business Management, Sokoine University of Agriculture,  
Morogoro, Tanzania  
makj@sua.ac.tz

<sup>3</sup> Department of Animal, Aquaculture and Range Sciences,  
Sokoine University of Agriculture, Morogoro, Tanzania  
mbagash@sua.ac.tz

<sup>4</sup> Department of Agricultural Economics and Agribusiness,  
Sokoine University of Agriculture, Morogoro, Tanzania  
alphonce@sua.ac.tz

**Abstract.** Keeping local chickens is an integral part of Tanzania's rural economy although it suffers low genetic potential. To address the problem, the Africa Chicken Genetic Gains (ACGG) project introduced and tested improved strains of chicken viz. Sasso and Kuroiler in Tanzania. The paper aimed to predict the rate of adoption of Sasso and Kuroiler chicken strains by using the Adoption and Diffusion Outcome Prediction Tool (ADOPT). Developmental research design involving provision of 25 six weeks old chicks to farmers was adopted. Data were obtained from a questionnaire survey and Focus Group Discussion in three regions of Tanzania. The results indicate that the peak for adoption is likely to be 34, 29 and 38% after 8, 7 and 9 years in Bahi, Ifakara and Wanging'ombe sites respectively. The sensitivity report indicates that the adoption rate may increase to reach 59, 49 and 57% and may decline to about 17, 16 and 21% in Bahi, Ifakara and Wanging'ombe respectively. Extension efforts to facilitate availability of the strains, feeds, treatment and reducing upfront and operating costs are main factors affecting change in the adoption rate to optimize the inherent genetic potential. It is recommended to facilitate extension efforts for adoption rate improvement by upgrading local chicken value chain to enable farmers to access the strains, feeds, medication and market.

**Keywords:** Ex-ante · Prediction adoption · ADOPT ·  
Introduced chicken strains · Tanzania

## 1 Introduction

Keeping local chickens is an integral part of Tanzania's rural economy whereby about 3782000 households keep chickens. According to [1], it is estimated that there are about 35.5 million local chickens and 24.5 million commercial chickens raised by individual households and small to medium commercial companies. The sector contributes about 1% of the national Gross Domestic Product (GDP). In 2013, the estimated monetary value of meat and eggs was TZS 874 billion and 364 billion respectively [2]. However, local chicken rearing suffers high mortality (over 50%) due to diseases, poor management, low input uses and inherent low genetic potential [1]. The low genetic potential of local chicken in Tanzania has multifaceted effects to increased contribution of the sector to the country's GDP and protein intake among rural dwellers. According to [3], the weight of chicken ranges between 1.6 and 2.0 kg, while annual eggs produced per hen per year is 36 eggs on average.

In response to the low genetic potential of local chicken in Tanzania, the Africa Chicken Genetic Gains (ACGG) project introduced and tested tropically adapted and improved strains of chicken viz. Sasso and Kuroiler at village level in Tanzania. Kuroiler and Sasso are said to be fast growing and can produce about 150 eggs per year under moderate management [4, 5]. The concept of the on farm testing adopted by ACGG, is expected to provide empirical information for a better understanding of the diffusion, adoption, and impact of improved technologies to guide producer groups, researchers and policy makers in making prudent and informed decisions about allocating resources [6–8].

Adoption of new agricultural technologies leads not only, to increasing productivity and food security, but also enhances agricultural development while reducing poverty. However, adoption of the introduced chicken strains may not be straightforward since farmers are economic agents who can only decide to adopt a new technology only if they are exposed to it [9], expected benefit exceeds the benefit of available related technology, and the technology is affordable [10, 11]. Generally, farmers look at some or all of factors and choose to adopt a technology based on their utility and profit maximization behaviour [12]. The assumption is that farmers engage in adoption of new technology only if the benefits or perceived utility of using the new technology outweighs the benefits of the current or old technology.

## 2 Adoption Theories

Adoption is a process that involves series of stages one undergoes from first hearing about a product to finally accepting or using it. In addition, it includes the moment at which the decision maker acts to make the spread of the technology happen [13]. Diffusion and adoption theories and frameworks seek to describe the dynamic process of the implementation and adoption of innovations [14]. There are several diffusion and adoption theories and frameworks [15]. Nevertheless, [13] contends that, the Diffusion

of Innovations theory by Rogers [16] and Bass Diffusion Model by Brass [17] are classical theories popularly that describe how, why, and at what rate new ideas and technology are spread. Roger's model is applicable after adoption is complete while Bass' model estimates the probability that adoption will occur in response to exposure to the innovation (external influence) and the social interaction effect (internal influence), which is then applied to the total adoption by some point in time [18]. In case of this study, a combination of these models was used to explain the likelihoods of farmers to adopt the introduced strains since the strains were already on farm and farmers have had an opportunity to make comparison on their merits and demerits relative to available local chicken strains.

### 3 Factors Affecting Adoption of New Technologies

[11] assert that farmers' decisions about whether and how to adopt new technology are conditioned by dynamic interaction between characteristics of the technology itself and the array of conditions and circumstances. Generally, the literature on adoption of new technologies generalizes that complexity of economic, social, environmental and psychological boundaries of farmers [13, 19–23] highly affect the decision of adopting the innovations. Moreover, [16], a renowned father of adoption theories, classifies factors into major five attributes of an innovation causing variance in the rate of adoption of a technology. These are: relative advantage, compatibility, complexity, trialability and observability. This paper uses the tool that is built based on the scholarly accumulated 22 variables affecting adoption of agricultural technology to predict the adoption rate and time to peak.

### 4 Empirical Review

There is extensive literature on technology adoption in developing countries across a variety of topics [24]. In Tanzania, several studies on adoption of agricultural technologies have been conducted [25–28]. All these studies used ex-post analyses mainly using Tobit or Probit regressions. These analyses have been useful for increasing our understanding on why some individuals adopted and others did not technologies. These studies nevertheless used either probit or logit regression models both of which, according to [10], fall short of proper methodological approaches to the exploration of the drivers of technology adoption in agriculture as they overlook non-exposure and selection biases. Further, the ex-post regression studies have contributed little to the problem of designing innovation adoption and scaling up pathways. The paper uses ex-ante approach to evaluate likelihood of innovation uptake at large scale to guide producers, research institutions and policy makers in making prudent and informed decision with regard to the introduced strains.

## 5 Methodology

### 5.1 Description of Study Areas

The present study used data collected at three sites in three regions in Tanzania. The Regions are Dodoma, Morogoro and Njombe, specifically in Bahi, Ifakara and Wanging`ombe Districts respectively. Dodoma is a semi-arid region, located at 6°48`S 39°17`E and an altitude of 1 125 M above sea level. Annual rainfall is about 500 to 700 mm and annual average temperature of about 22.6 °C. Between the driest and wettest months, the difference in precipitation is 129 mm and the average temperatures vary by 5.1 °C [29]. The area is mainly characterized by drought tolerant crops like sorghum, groundnuts, finger millet and sunflower. ACGG project sites in Bahi district were in four villages namely; Mayamaya, Bahisokoni, Mudemu and Mpamatwa.

Morogoro Region is located between latitude 5o58` 10o0`S 35o30`E and an altitude of about 525 M above sea level. The annual rainfall ranges from 600 to 1200 mm with an average annual temperature of about 25o °C. Morogoro Region is characterized with an average annual rainfall is 1160 mm with average temperature of 16 °C. There are typically two distinct long and short rainy seasons of March–May and November–January/February, respectively, but the rain sometimes falls uninterrupted from October to March [29]. The production system in Ifakara district is dominated by rice and maize production, horticultural produces and bananas. The on farm test sites were located in four villages namely; Kibaoni, Kikwalila, Lipangalala and Lumemo.

Njombe Region is located between 8°51`0`S, 34°50`0`E and an altitude of about 2 000 M above sea level. Its climate is classified as warm and temperate. In winter, there is much less rainfall than in summer. The average annual rainfall is 1160 mm with an average temperature of 18.6 °C [29]. On farm testing sites were located in four villages namely; Ujindile, Uhambule, Msimbazi and Ufwala. Farming system of the sites is dominated by tea, maize, sunflower, pulses and horticultural production.

### 5.2 Research Design

The study adopted developmental research design whereby farmers were selected and provided with introduced chicken based on their farming practices, typically low input production system. Developmental research design assumes a traditional model of skill in which the unit of analysis is taken to be the individual. It is maintained that as if expertise “resides under the individual’s skin” in the form of explicit or tacit knowledge, skills and cognitive properties [30, 31]. In this context, the design included process and context of chicken keeping. Process refers to the technical requirement of chicken keeping while context stressed on the socio-economic characteristics and biophysical conditions that might affect growth and productivity. [32] argues that developmental approach can assist in determining the most effective agents of influence. Households recruited to receive the chickens were selected based on the following criteria:

1. Experience of chicken keeping for at least two years;
2. Keeping at least 15 adult chickens, but no more than 50;

3. Willingness to accept 25 birds of randomly selected strains;
4. Commitment to provide night shelter, and a minimum supplemental feeding;
5. Willingness to participate in the project for a minimum of 72 weeks.

Implementation of the design involved provision of 25 six weeks pre-brooded chicks to selected farmers. The chicks were vaccinated against Mareks and Newcastle diseases at the hatchery, followed by Infectious Bronchitis (IB) at 0, 7, 10, 16 and 21 days. Newcastle vaccine was repeated at 10 and 21 days using Lasota vaccine. At 6<sup>th</sup> week, the chicks were again vaccinated for fowl pox before being distributed to farmers. Farmers continued keeping these strains based on their practices with additional supplementation and were encouraged to keep records for evaluation purposes.

### 5.3 Data Collection

Data were collected through household survey involving face-to-face and focus group discussion (FGD). 202 out of 264 targeted beneficiary households in the twelve vil-lages participated in data collection. The households, which were involved, represent about 76.5% of the total intervened household in the study zones. Out of total farmers, 111 farmers were Sasso chicken keepers while, 91 farmers were Kuroiler chicken keepers. The data collected were streamlined to 22 variables (Fig. 1) that are funda-mental to adoption prediction. These include: profit orientation, risk orientation, enterprise scale, interested nonparticipant farmers,, production constraints, practice complexity, observability, advisory support, the relative upfront cost of the practice, time for profit and benefit to be realized in the future and ease and convenience of managing the introduced strains.

### 5.4 The Estimation Procedure

Adoption and Diffusion Outcome Prediction Tool (ADOPT) (Fig. 1) was applied to predict the likely peak level and proportional of the household that might adopt the introduced chicken strains and the probable time taken to reach that peak under pre-ailing environment. ADOPT is an MS Excel-based tool that evaluates and predicts the likely level of adoption and diffusion of specific agricultural innovations with a par-ticular target population in mind [13, 33, 35]. As indicated (Fig. 1), ADOPT uses 22 parameters covering four areas that influence the rate and peak level of adoption: (i) population specific influence, (ii) relative advantage of the population, (iii) actual advantage of using the technology/relative advantage of the practice and iv) learning of the actual advantage of the technology. According to [33], the tool operationalizes a framework that is based on well-established adoption theory and literature [16]. Given that, technology uptake is a complex and nonlinear process, influenced by multiple factors; it requires theories/tool useful to provide a full picture of the adoption process [34]. ADOPT provides a comprehensive framework which takes into account the interaction of various factors that influence decision-making among the farmers with regard to innovation uptake [13, 33, 35, 36]. The output of the tool is a value in years of time to peak adoption and a percentage value for peak adoption level.



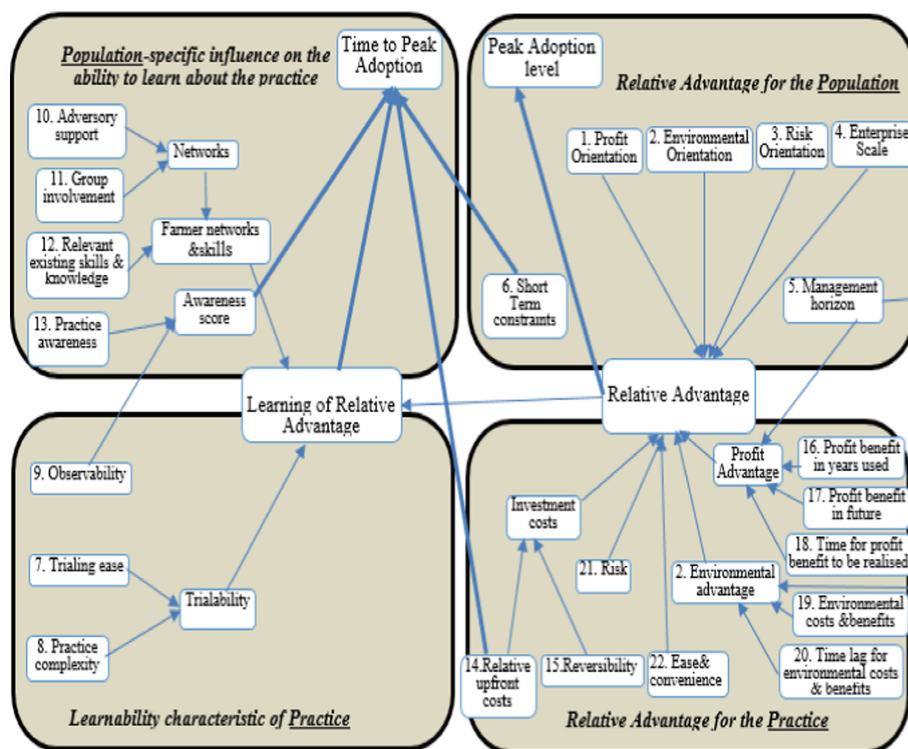


Fig. 1. Adoption and diffusion outcome prediction tool (ADOPT) framework

## 6 Results and Discussions

### 6.1 Prediction of Adoption of Introduced Chicken Strains

The general assessment of the introduced chicken strains indicates that farmers in selected sites consider the introduced strains useful and beneficial to them. The results indicate that the peak for adoption of the introduced chicken strains in Wanging'ombe, Bahi and Ifakara sites will be 38, 34 and 29% after 9, 8 and 7 years respectively (Fig. 2). The predicted adoption peak level in Wanging'ombe is the highest because of market access for both inputs and poultry products. The district is located nearby Makambako Town center, which is so potential for business activities. In Ifakara, it is noted that the predicted level of adoption is low in comparison with other sites. Contrary to expectation, Ifakara has the highest scavenging areas around homesteads and good environment that support production of crops to support chicken feeding. Bahi District is rather dry with limited food production, culminating in less feed available for chickens. The lower level of predicted adoptions is largely contributed by fact that either farmers in the area have many other options of income generating activities, or probably the strains are still new and it may take time to evaluate and make commitments to invest. Moreover, the predicted adoption rates and the expected

peaks presents an impressive result given that in Sub Saharan Africa (SSA) new agricultural technology uptake has been reported to be rather low especially if the technology requires the use of a combination of inputs [37]. For example, uptake of tissue banana in Kenya was only about 10% after 12 years [8]. The findings are also consistent with other ex post adoption studies of agricultural technologies in Africa. For example, in Tanzania, [27] reported that in Arusha region, 23.7% of farmers adopted minimum tillage practices (such as zero tillage, ripping and minimum tillage) while in the Dodoma region, 29.1% adopted pit as planting technique. On the contrary, [38] observed that if all farmers had been exposed to improved varieties, potential adoption rate of improved pigeon pea in Northern Tanzania would be 62%. These findings imply that there is potential for adoption of introduced chicken strains once all farmers become aware of at least one strain.

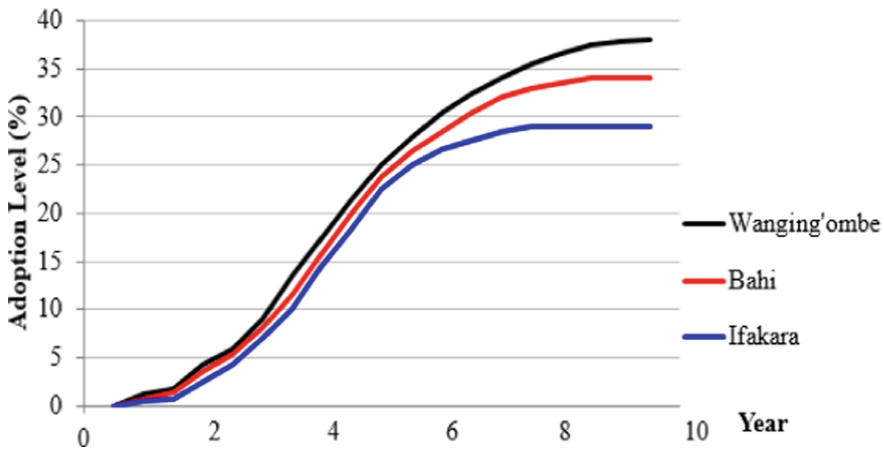


Fig. 2. Predicted adoption level of introduced chicken strains

### 6.2 Sensitivity Analysis and Factors Affecting Changes in Adoption Rate

Sensitivity analysis (Fig. 3) indicates that the adoption peak level may change because of changes in prediction parameters. There is likelihood of adoption peak to reach about 59, 49 and 57% in Bahi, Ifakara and Wanging'ombe respectively. However, the step down procedure indicates that the peak level may also decline to about 17, 16 and 21% in Bahi, Ifakara and Wanging'ombe respectively.

Factors affecting the adoption include the scale of chicken keeping, relative upfront costs, profit accrued in the year of introduction, projected profit/benefit, risks and ease and convenience of keeping introduced strains (Fig. 4). An increase in the scale of operation may contribute to change in the adoption rate by 17% up and by 14% down. These results are consistent with the literature on the correlation between farm size and adoption of the innovation [39, 40].

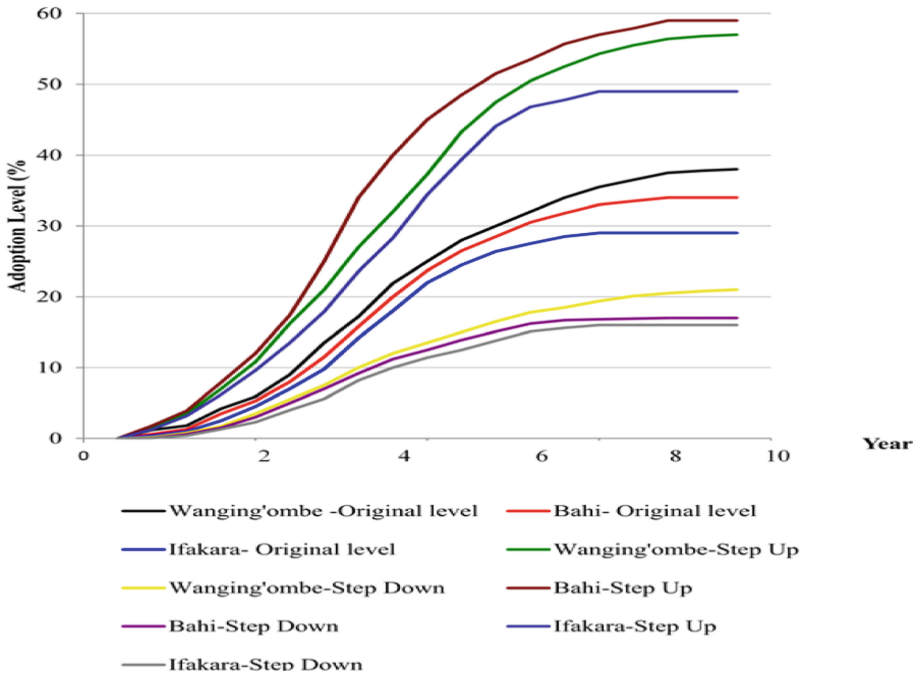


Fig. 3. Sensitivity curve for changes in adoption level of the introduced chicken strains

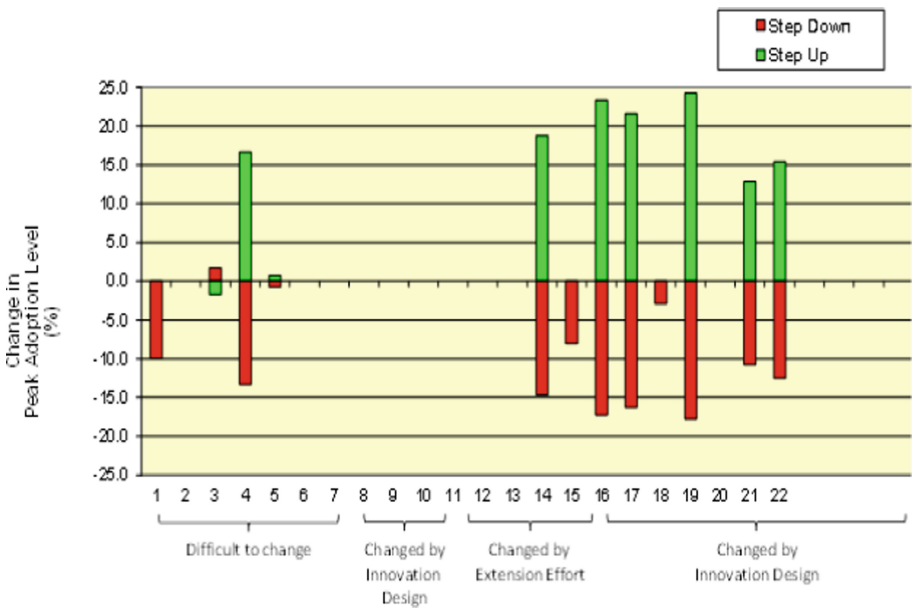


Fig. 4. Factors affecting change in the peak level of adoption rate in Bahi sites

Likewise, a low upfront cost is critical to improved innovation uptake among smallholder chicken keepers. Farmers observe that reduced upfront costs would contribute to increase adoption of the introduced strains by 18.5% (Fig. 4). The findings are consistent with rich literature that explains negative relationship between the upfront costs of adoption of the innovation [41–43].

Farmers considered profit and future benefit in general to be critical in supporting increased adoption. Raised awareness that the introduced strains are beneficial may contribute to the increase in adoption as depicted in Fig. 3. However, farmers revealed that if profit and future benefit relative to available local chickens is not realized, it may contribute to decrease in the adoption rate by 16%. According to [44], exposure to information about the profit of the new technologies as such significantly affects farmers' choices about it.

Furthermore, sensitivity analysis indicates that risks (mortality, higher consumption and failure to brood) associated with keeping introduced strains play greater role in affecting farmers' decisions in adopting the technology. Taking into account on the risk associated with keeping introduced strains, adoption will be reduced by 11% (Fig. 3). However, if the observed risks are reduced, adoption rate may be increased by 13%. The effect of risk revealed by this study is in line with the result by [45] who observed that the risk-averse farmers may not adopt modern technology if it raises production risk by increasing yield variability too much. In contrast, if the new technology has the potential to attenuate variability in economic outcomes, then it would be more rapidly adopted among risk-averse farmers.

Lastly, the results indicate that ease and convenience are other potentially important contributing factors to the adoption decision among farmers. Other things being equal, ease and convenience of managing introduced chicken strains were found to contribute to increase in the adoption rate by 15. Difficulties in keeping these strains especially the requirement for additional inputs was found to affect the increase in adoption of introduced strains by 13%.

## 7 Conclusions and Recommendations

Using the ADOPT tool to quantitatively predict the adoption, it is concluded that there is high possibility of adoption and diffusion of the introduced chicken strains, albeit at a different pace between selected districts where the on farm test was conducted. The difference in reaching the peak adoption is associated with the extent to which the farmers were motivated and the presence of alternative income portfolios. The sensitivity analysis pinpoints scale of chicken keeping, relative upfront costs, and profit accrued in the year of introduction, projected profit/benefit, risks and ease and convenience of keeping introduced strains as the main determinant of peak adoption. It is recommended that to enhance adoption and diffusion rates more efforts should be directed at ensuring readily availability of the introduced test strains and promotion of innovative ways of reducing of upfront costs.

**Acknowledgements.** The authors acknowledge Bill and Melinda Gates Foundation (BMGF) for financial support to the Africa Chicken Genetic Gains (ACGG) Project and Sokoine University of Agriculture (SUA) for their support in accomplishing this study. Secondly, sincerest thanks are extended to the Commonwealth Scientific and Industrial Research Organization (CSIRO) for granting authors the Adoption and Diffusion Outcome Prediction Tool (ADOPT) for analysis. Lastly, particular gratitude goes to the smallholder chicken keepers who agreed to participate in the on farm test of the introduced chicken strains and provided data for this study.

## References

1. URT.: Tanzania Climate Smart Agriculture Programme: 2015–2025 (2015). <http://www.kilimo.go.tz>. Accessed 19 Oct 2016
2. Komwihangilo, D.M.: The role of chicken in the Tanzanian economy and opportunities for development: an overview: first national innovation platform, July 13–15th 2015 Blue Pearl Hotel, Dar es Salaam, Tanzania (2015)
3. United Republic of Tanzania (URT): National Sample Census of Agriculture Small Holder Agriculture. Volume III: Livestock Sector National Report (2012). <http://www.kilimo.go.tz>. Accessed 09 May 2016
4. WSPA: Enhancing rural livelihoods and nutrition through higher welfare poultry production in India. Case study (2011). <http://www.wspa-international.org>. Accessed 19 Oct 2016
5. Rodelio, B.C., Silvino, Q.T.: Sustainable organic farming in the Philippines: history and success stories (2013). <http://www.afaci.org>. Accessed 12 Aug 2016
6. Peshin, R.: Farmers' adoptability of integrated pest management of cotton revealed by a new methodology. *J. Agron. Sustain. Dev.* **33**(3), 563–572 (2013). <https://doi.org/10.1007/s13593-012-0127-4>
7. Milkias, D., Abdulahi, A.: Determinants of agricultural technology adoption: the case of improved highland maize varieties in Toke Kutaye District, Oromia Regional State, Ethiopia. *J. Invest. Manag.* **7**(4), 125–132 (2018). <https://doi.org/10.11648/j.jim.20180704.13>
8. Langat, B.K., et al.: Drivers of technology adoption in a subsistence economy: the case of tissue culture bananas in western Kenya. An Article Presented at the 4th International Conference of the African Association of Agricultural Economists, 22–25 September 2013, Hammamet, Tunisia (2013). <http://ageconsearch.umn.edu/bitstream/161444/2>. Accessed 11 Nov 2017
9. Foster, A.D., Rosenzweig, M.R.: Microeconomics of technology adoption. Economic Growth Centre Discussion Article No. 984. Yale University, New York (2010). <https://doi.org/10.1146/annurev.economics.102308.124433>
10. Pindiriri, C.: Breaking the tradition trap: assessing drivers of modern technology adoption by smallholder farmers in Hurungwe district, Zimbabwe. In: African Economic Conference held in Abuja, Nigeria, 5–7 December 2016. <https://www.afdb.org/uploads/tx>. Accessed 12 Jan 2018
11. Loevinsohn, M., Sumberg, J., Diagne, A.: Under what circumstances and conditions does adoption of technology result in increased agricultural productivity? Protocol, EPPI Centre, Social Science Research Unit, Institute of Education, University of London, London (2012). <https://eppi.ioe.ac.uk>. Accessed 01 May 2017
12. Qasim, M.: Determinants of Farm Income and Agricultural Risk Management Strategies: The Case of Rain-Fed Farm Households in Pakistan's Punjab. University Press GmbH, Kassel (2012)
13. USAID: Scaling agricultural technologies and innovation diffusion, p. 57 (2015). [http://pdf.usaid.gov/pdf\\_docs/PA00KFQG.pdf](http://pdf.usaid.gov/pdf_docs/PA00KFQG.pdf). Accessed 19 Oct 2016

14. Miranda, Q.M., Farias, S.J., Schwartz, A., de Almeida, P.L.J.: Technology adoption in diffusion of innovations perspective: introduction of an enterprise resource planning system in a non-profit organization. *Revista de Administração e Inovação (J. Technol. Manag. Innov.)* **13**(1), 48–57 (2016). <https://doi.org/10.1016/j.rai.2016.02.002>
15. Wisdom, J.P., Chor, B.H.K., Hoagwood, E.K., Horwitz, M.S.: Innovation adoption: a review of theories and constructs. *J. Adm. Policy Ment. Health* **41**(4), 480–502 (2014). <https://doi.org/10.1007/s10488-013-0486-4>
16. Roger, E.M.: *Diffusion of Innovations*, 5th edn. The Free Press, New York (2003)
17. Bass, F.M.: A new-product growth model for consumer durables. *Manag. Sci.* **15**, 215–227 (1969)
18. Wright, V.: Rates of adoption: the diffusion of agricultural innovations. service design research working article 06-11. Published by the Victorian Government Department of Primary Industries East Melbourne (2011). <http://geoffkaineresearch.com>. Accessed 15 Oct 2018
19. Holden, T.S.: Risky choices of poor people: comparing risk preference elicitation approaches in field experiments. *Centre for Land Tenure Studies Working Article* **10**(14) 46 (2014). <https://doi.org/10.13140/2.1.4482.7200>
20. Francis, C., Mundy, V., Janke, R., King, J.: *Alternative approaches to on-farm research and technology exchange* (1995). <http://digitalcommons.unl.edu>. Accessed 11 Nov 2016
21. Yesuf, M., Kassie, M., Köhlin, G.: Risk implications of farm technology adoption in the Ethiopian highlands. *Discussion Article Series on Environment for Development*, p. 18 (2009). <http://www.efdinitiative.org>. Accessed 17 Oct 2016
22. Emerick, K., De Janvry, A., Sadoulet, E., Dar, M.H.: *Technological innovations, downside risk, and the modernization of agriculture* (2015). <http://are.berkeley.edu/~esadoulet>. Accessed 20 Sept 2018
23. Hill, R.V.: Investment and abandonment behaviour of rural households: an empirical investigation. *Am. J. Agric. Econ.* **92**(4), 1065–1086 (2010). <https://doi.org/10.1093/ajae/aaq055>
24. Shaw, C.S.: *Agricultural Technology Adoption in West Africa. A Thesis Submitted to the Office of Graduate and Professional Studies of Texas A&M University in partial fulfilment of the requirements for the degree of Master of Science* (2014)
25. Pedersen, K.E.: *Factors affecting the adoption of improved banana technologies in Northern Tanzania*. Published by Rockwool Foundation Research Unit (2012). <https://www.rockwoolfonden.dk>
26. Kaliba, A.R.M., Verkuijl, W., Mwangi, A.J.T., Mwilawa, P., Anandajasekeram, H., Moshi, A.J.: Adoption of maize production technologies in Central Tanzania. In: *International Maize and Wheat Improvement Center (CIMMYT), the United Republic of Tanzania, and the Southern Africa Centre for Cooperation in Agricultural Research (SACCAR)* (1998). <http://www.tanzaniagateway.org>. Accessed 21 Sept 2018
27. Kahimba, F.C., Mutabazi, K.D., Tumbo, S.D., Masuki, K.F., Mbungu, W.B.: Adoption and scaling-up of conservation agriculture in Tanzania: case of arusha and dodoma regions. *J. Nat. Resour.* **5**, 161–176 (2014). <https://doi.org/10.4236/nr.2014.54016>
28. Namwata, B.M.L., Lwelamira, J., Mzirai, O.B.: Adoption of improved agricultural technologies for Irish potatoes (*Solanum tuberosum*) among farmers in Mbeya Rural district, Tanzania: a case of Ilungu ward. *J. Anim. Plant Sci.* **8**(1), 927–935 (2010). <http://www.m.ilewa.org/JAPS/2010/8.1/4.pdf>. Accessed 19 Aug 2018
29. Climatic Data Org.: *Tanzania Climatic Data* (2016). <https://en.climate-data.org>. Accessed 12 Mar 2018
30. AFNETA: *Alley Farming Training Manual*, vol. 1, p. 196 (1992). <http://biblio.iita.org/documents>. Accessed 21 Nov 2016

31. Richey, R.C.: Developmental research: the definition and scope. In: Proceedings of Selected Research and Development Presentations at the National Convention of the Association for Educational Communications and Technology Sponsored by the Research and Theory Division, 16th, Nashville, TN, 16–20 February 1994 (1994). <http://files.eric.ed.gov>. Accessed 15 Aug 2016
32. Paikoff, R.L.: Adapting developmental research to intervention design: applying developmental psychology to an AIDS prevention model for Urban African American Youth. *J. Negro Educ.* **65**, 44–59 (1996). [www.jstor.org/stable/2967367](http://www.jstor.org/stable/2967367). Accessed 12 Aug 2016
33. Kuehne, G., et al.: Predicting farmer uptake of new agricultural practices: a tool for research, extension and policy. *J. Elsevier: Agric. Syst.* **156**, 115–125 (2017). <https://doi.org/10.1016/j.agsy.2017.06.007>
34. Meijer, S.S., Catacutan, D., Ajayi, O.C., Sileshi, G.W., Nieuwenhuis, M.: The role of knowledge, attitudes and perceptions in the uptake of agricultural and agroforestry innovations among smallholder farmers in Sub-Saharan Africa. *Int. J. Agric. Sustain.* **13**(1), 40–54 (2015). <https://doi.org/10.1080/14735903.2014.912493>
35. Dhehibi, B., et al.: Adoption and factors affecting farmer's adoption of technologies in farming system: a case study of improved technologies in ICARDA's Arabian Peninsula regional program. *J. Sustain. Dev.* **10**(6), 1–13 (2017). <https://doi.org/10.5539/jsd.v10n6p1>
36. Akroush, S., Dhehibi, B.: Predicted willingness of farmers to adopt water harvesting technologies: a case study from the Jordanian Badia (Jordan). *Am.-Eurasian J. Agric. Environ. Sci.* **15**(8), 1502–1513 (2015). <https://doi.org/10.5539/sar.v6n1p80>
37. Mukasa, A.N.: Technology adoption and risk exposure among smallholder farmers: panel data evidence from Tanzania and Uganda. African Development Bank Group Working Article No. 233 April 2016, Conference held on 4–5 December 2015 in Addis Ababa, Ethiopia. <https://www.afdb.org/fileadmin/uploads/afdb>. Accessed 9 Aug 2018
38. Simtowe, F., et al.: Determinants of Agricultural Technology Adoption: The Case of Improved Pigeon Pea Varieties in Tanzania. *Q. J. Int. Agric.* **50**(4), 325–345 (2011). <https://www.researchgate.net/publication/225274683>. Accessed 10 Aug 2018
39. Mignouna, B., Manyong, M., Rusike, J., Mutabazi, S., Senkondo, M.: Determinants of adopting imazapyr-resistant maize technology and its impact on household income in Western Kenya. *J. Agrobiotechnology Manag. Econ.* **14**(3), 158–163 (2011). <https://mospace.umsystem.edu/xmlui/handle/10355/12458>. Accessed 6 July 2018
40. Lavison, R.: Factors influencing the adoption of organic fertilizers in vegetable production in Accra, Msc thesis, Accra Ghana (2013). <http://197.255.68.203/handle/123456789/5410>. Accessed 21 April 2018
41. Muzari, W., Gatsi, W., Muvhunzi, S.: The impacts of technology adoption on smallholder agricultural productivity in Sub-Saharan Africa: a review. *J. Sustain. Dev.* **5**(8), 69–77 (2012). <https://doi.org/10.5539/jsd.v5n8p69>
42. Wekesa, E., Mwangi, W., Verkuijl, H., Danda, K., De Groote, H.: Adoption of maize technologies in the coastal lowlands of Kenya. CIMMYT, Mexico, D.F (2003). <https://ageconsearch.umn.edu/bitstream/56109/2/coastalKenya.pdf>. Accessed 13 Oct 2018
43. Makokha, S., Kimani, S., Mwangi, W., Verkuijl, H., Musembi, F.: Determinants of fertilizer and manure use for maize production in Kiambu District, Kenya. CIMMYT, Mexico (2001). <https://repository.cimmyt.org/xmlui>. Accessed 7 June 2017
44. Caswell, M., Fuglie, K., Ingram, C., Kascak, S.: Adoption of agricultural production practices: lessons learned from the US. Department of Agriculture area studies project. Washington, DC. US Department of Agriculture. Resource Economics Division, Economic Research service, Agriculture Economic Report No. 792 (2001)
45. Salazar, C., Rand, J.: Production risk and adoption of irrigation technology: evidence from small-scale farmers in Chile. *Lat. Am. Econ. Rev.* **25**(2), 2–37 (2016). <https://doi.org/10.1007/s40503-016-0032-3>



# Assessing User-Designed Dashboards: A Case for Developing Data Visualization Competency

Aprisa Chrysantina<sup>(✉)</sup> and Johan Ivar Sæbø

Department of Informatics, University of Oslo, Oslo, Norway  
aprisac@if.uio.no

**Abstract.** Health information dashboards, which are collections of relevant indicator visualizations for management, have become a common feature and strategy for improved information use in the health sector. They should provide any manager with quality information in a format that points out the performance of health service provision, and thus necessitate good knowledge of visualization techniques to both develop and interpret. Since health management is a dispersed and decentralized activity, dashboards need to be relevant to varied users, and various administrative levels of the health services. This can be achieved by enabling all users to make their own dashboards, based on the indicators they need, and presented in a suitable manner to track the local priority activities.

In this study we examine user-defined dashboards in Indonesia, which has implemented a flexible and open source platform for health management (DHIS2). While the technical flexibility of the platform has been taken advantage of by providing platform customization training, the study finds that the quality of the dashboards created face numerous challenges. These challenges point to poor visualization competence. We conclude by calling for such competence to be addressed by the training curricula, as well as by utilizing existing “best practice” dashboards from WHO now available for the same platform.

**Keywords:** Dashboard design · Open source platform ·  
Data visualization literacy · Capacity building

## 1 Introduction

Ever since the beginning of ICT4D research, the applied domain of health services has been an important topic. This is both due to the importance of health for development, and the wide variety of digitalization efforts seen in the sector. Despite progress and advances in the use of ICT for health development, many problems in diverse program areas remain unaddressed, thus leaving spaces for research and innovations [1, 2]. Design, governance, and sustainability are a recurring set of issues faced by health information systems (HIS) in developing countries [3].

The central focus of our paper concerns the adaptation work needed on a free and open source platform for health management. A platform is by default a half-product [4], where the real value lies in the ability to accommodate tailored solutions on the



more generic and stable core part of the system. Considerable work is typically needed to customize such half-products to any given organizational context. To use such platforms, Msiska and Nielsen [5] argue for the need for diverse capacities related to platform deployment, customization, and use.

We do this by looking at the implementation of DHIS2 (District Health Information Software) in Indonesia. This software platform is rooted in a philosophy of decentralized adaptation and contextualized use [6]. With local health variations, it was at the software's inception two decades ago designed to not only accommodate, but actively encourage local adaptation.

DHIS2 customization and use requires different sets of skills and allows multiple ways of adapting and adopting the software [7, 8]. The literature coming out of projects implementing DHIS2 has explored the processes and skills required both to innovate the platform by development and modification of apps and modules within DHIS2 [5], and to use the existing end-user interface features [9]. In this paper we focus on the latter, where end-users themselves customize the software to their needs.

We specifically look at local adaptation of dashboards, which are collection of various user-defined visual and tabular information. Across Indonesia, health staff at national, provincial, and local level have been trained in using DHIS2, including how to make their own dashboards for routine health service provision monitoring. The training has focused on how to customize DHIS2, while the decisions on what the dashboards should display and how this information should be displayed has been up to the various users to decide.

The creation of dashboards entails at least the bringing together of domain knowledge from ICT and health. However, as we will argue, there are other skills that are as important to fully utilize the new functionalities the introduction of ICT included. In our case, skills related to visualization and communication of information need a stronger focus in the development of locally appropriate systems.

This paper attempts to answer following empirical research question: What are the challenges of user-designed dashboards? Analyzing such dashboards in Indonesia will then inform our understanding on the skills and capacities needed to leverage these functionalities of the flexible digital platform.

We organize this paper as follows. In next section, we will examine literature on dashboard design and data visualization capacity, followed by a case study of dashboard design practice by end-users in Indonesia. We also propose a tool to evaluate dashboard and data visualization modified from Few's list of common dashboard design mistakes [10] and practical recommendations on dashboard design and data visualization capacity building.

## 2 Related Literature

### 2.1 Health Dashboard and Information Use

The underlying philosophy of the DHIS2 software is that health service provision should be managed through an integrated district health system. This idea of a health district as an administrative geographical entity is rooted in the World Health

Organization's Alma Ata declaration on primary health care, and is seen as the ideal unit for local health management [11]. The size of a district is dependent on a balance between resources, autonomy, and closeness to the health service provision.

Local use of the information is a consistent challenge in managing public health service. Despite the early identification of the need for building local capacity for evidence-based management [12], there is still not much evidence on the ground of improved information use at district level [13]. Lately, there has been an international effort to address this led by WHO to develop best-practice dashboards for various health programs, and provide them as downloadable packages for DHIS2 to provide some consistency in what and how data is displayed [14, 15]. A dashboard is a collection of key performance indicators for any given area, displayed in various visualizations where the aim is to improve routine monitoring, and has for some time been applied in health information systems in developing countries [16].

## 2.2 Data Visualization Competency of Health Staff

Appropriate and relevant dashboards are not straightforward to make. All users of dashboards need data literacy in order to read graphs and tables appropriately and to recognize misleading or inappropriate use of such [17]. In addition to that, to create dashboards, users need to understand data visualization techniques to avoid creating misleading or ambiguous data visualizations [18]. Such proficiency is also specific to the discipline or domain in question, such as health, and not necessarily generically applicable. Few [10] lists common mistakes with dashboard design, ranging from clutter, inappropriate contextualization, to wrong use of visualization techniques.

Data visualization proficiency is thus needed at local level when the technology promotes local adaptability of dashboards. This devolution is in line with reducing the gap between developers and users of technology [3, 19], but it raises the issue of the appropriate skills being present [5, 7]. The training of local health staff to appropriately use the technology of choice for health management need to take this into account. There is an urgent need to understand the current practice and challenges of making locally relevant dashboards.

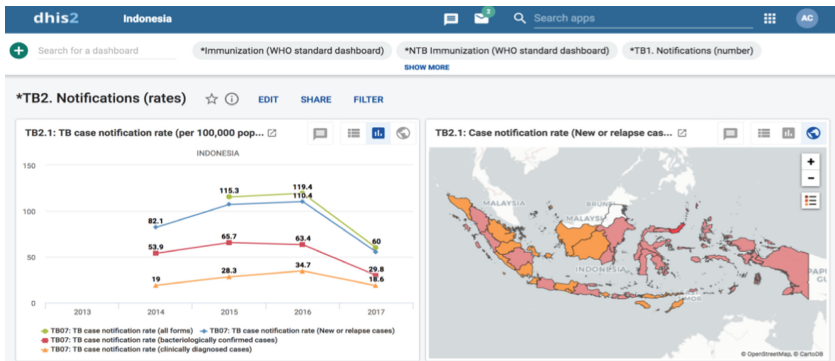
## 3 Research Design

Case study was chosen to achieve the research objectives as it allows researchers to study IS in its natural settings [20]. This research design is highly versatile in ICT research [21] and is appropriate for exploration of a flexible platform adoption such as DHIS2. The case investigated is the use of dashboards in the DHIS2 platform as applied in Indonesia, through carrying out quantitative and qualitative analysis of a subset of the dashboards.

### 3.1 Case Overview

The initiative to implement DHIS2 in Indonesia originated from the need for data integration from different sources across health programs such as HIV/AIDS,

Tuberculosis, Malaria, Immunization, Nutrition, Mother and Child Health (MCH), to be available at health administration levels such as health care facilities and district health offices. Once data from different programs reach the DHIS2 data warehouse, they can be visualized through maps, graphs or tables. Finally, various visualizations can be displayed together in health program dashboards (see Fig. 1).



**Fig. 1.** Sample of tuberculosis program dashboard in DHIS2

The platform was rolled out in 5 provinces in Indonesia in 2017. Training curricula and material for health program managers and health information system staff include how to create and manage visualizations and dashboards. The initial implementation included 5 provinces, 10 districts, and 100 healthcare facilities implementing DHIS2 dashboards in the country.

During the roll out, each district and province was mandated by the MoH to develop dashboards for at least 6 focus health programs (HIV/AIDS, Tuberculosis, Malaria, MCH, Immunization, and Nutrition). In addition, each facility was required to create at least one cross-program dashboard that contained data from above programs. The ministry also encouraged the districts and facilities to routinely analyze, present, discuss, and use the data in their dashboards, including in routine meetings for health program planning and decision making. By their own initiatives, many of these entities also created dashboards for their own local needs. For example, several districts created home care and environmental health dashboards although they are not mandatory. This is consequently followed by the emergence of a high number of health program dashboards.

While development of standards for visualizations, including indicators, data analysis, and dashboards was initiated in the pilot implementation in 2015, no such standardized guidelines for dashboards could be documented in the case study. Varied ways of data visualization and dashboard management had emerged, based on the unique ways these different entities interpreted the national mandate to develop the dashboards.

By default, dashboards created by users are saved as private dashboards. But users can choose to share the viewing or editing authority with particular users, user groups, or all users in the instance.

**3.2 Data Collection**

This study included three steps which are: (1) collecting screenshots of 316 shared dashboards in use in Indonesia, representing all implementation level of the dashboards (national, province, district, and facility level), (2) conducting quantitative and qualitative analysis of 80 (25.3%) of these dashboards to see how they are applied for various health programs and administrative areas.

To standardize the time of assessment, all dashboards were screenshot on July 11, 2018. For the purpose of this research, we limited analysis to the dashboards that are shared to national level user group with an assumption that by sharing their dashboards, the creators are confident of the quality of their dashboard, both in terms of data visualization and data quality.

**3.3 Data Analysis**

Eighty dashboards were randomly selected from the pool of 316. Quantitative analysis was conducted to assess the following dimensions; which administrative level they represented, which health programs they included, the content in terms of selected indicators, time periods, and types and number of visualizations.

From Few’s [10] common dashboard design problems, we developed relevant qualitative assessment criteria that would fit the nature of the DHIS2 dashboards. For example, we would look for appropriateness of a visualization method in conveying the intended information. After analyzing the dashboards, we categorized them in 5 main problem categories as only a subset of Few’s problem categories are relevant for the user-defined dashboards in question (Table 1).

**Table 1.** Dashboard problem categories (Adapted from Few [10]).

Problem category	Description
Context problem	Dashboard or data visualizations are unable to provide context or significance, or providing false or misleading meaning for the health program planning and management
Layout problem	Problems related to how the indicators and visualizations are arranged
Visualization technique problem	Problems related to the choice of chart types or management within an individual chart; such as choice of indicators, time period, or organization units, stack style, etc
Logical problem	To build into a comprehensive and logical context or story of a program achievement, logical order of presented, compared, and analyzed indicator and visualization is needed. Failing to visualize with logical order may not create contextual problem depending on the dashboard or visualization reader
Data quality problem	As an addition to how the data are presented in the dashboard and how the dashboard is organized, we also found data quality issues that need to be revisited to allow informed information use. This include incompleteness, inconsistency, and inaccuracy of the data

## 4 Dashboard Analysis

From the 316 dashboards, analysis was done to 80 (25.3%) dashboards with results shown in Tables 2 and 3. The majority of the dashboards analyzed were from district and facility levels; 45% and 26.25%, respectively. This is relevant as the emphasis on technical assistance for dashboard implementation in the context was to district and facility levels. In terms of dashboard topics, majority were focused on the six targeted programs (60%) and the rest are evenly split into general dashboard (20%) and dashboards on other health programs (20%) such as environmental health, home care, other communicable diseases, etc.

**Table 2.** Overview of dashboards

Org Unit Level		Dashboards having these types of visualizations			
- National:	4 (5%)	- Map		29 (36.25%)	
- Provinces:	10 (12.5%)	- Table		27 (33.75%)	
- Districts:	36 (45%)	- Bar/Column		70 (87.5%)	
- Facility:	21 (26.25%)	chart		45 (56.25%)	
- Not specified	9 (11.25%)	- Other			
Programs		Freq. of visualization counts		Freq. of visualization types	
<i>Focus program</i>	48 (60%)	- 0-4	32 (38.1%)	- Bar	137 (25%)
HIV/AIDS	6	- 5-9	26 (30.1%)	- Column	189 (34.5%)
TB	9	- 10-14	13 (15.5%)	- Line	63 (11.5%)
Malaria	7	- 15-19	5 (5.9%)	- Table	48 (8.8%)
MCH	9	- >19	4 (4.7%)	- Map	48 (8.8%)
Nutrition	8			- Pie	36 (6.6%)
Immunization	9			- Others	26 (4.7%)
<i>Other program(s)</i>	16 (20%)				
<i>Not program specific</i>	16 (20%)				

On the visualization methods, bar and column charts are the most popular as they appear in 87.5% of all the examined dashboards; followed by map (36.25%) and table (33.75%). Half of the dashboards (56.25%) had other visualization methods (spider, pie, area, line, speedometer charts). All the examined dashboards show 547 visualizations or an average of 6.83 visualizations per dashboard. Although map and table are relatively popular visualization methods, there are only 48 maps and 48 tables in 29 and 27 dashboards, respectively, meaning only less than 2 maps or tables are used per dashboard. It is a contrast with 326 bar and column charts that appear in only 70 dashboards, or more than 4 per dashboards in average. Majority of the dashboards have less than 10 visualizations (72.5%); while only 5% of 80 dashboards show 20–38 visualizations.

Although Few [10] has pointed out that the whole dashboard has to be visible in one full screen, with the responsive web design and access from mobile phone, it is no longer a strict guide to follow. In addition to that, guidelines from WHO [20] recommends 2 to 9 visualizations per dashboard for TB, HIV/AIDS, and nutrition; and 26 and 30 visualizations for malaria and immunization. These suggested numbers are

related to the nature of the program. However, the guidelines also show that the visualizations can be grouped and arranged to ensure that the dashboard is easy to read and easy to understand. The analysis based on Few's criteria [10] is shown in Table 3.

**Table 3.** Frequency of dashboard problems

Problem type	Frequency
Context problem	61 (73.5%)
Dashboard layout problem	35 (42.2%)
Visualization technique problem	69 (83.1%)
Logical problem	47 (56.6%)
Data quality problem	28 (33.7%)

#### 4.1 Context Problem

Problems of contextualization was the second most common mistake, with over three quarters of dashboards showing such challenges. This type of problem includes (1) no message that can be drawn, be it from collective data visualizations, that is either comprehensive or useful for program monitoring, planning, or decision making, (2) visualizations are not communicating with each other, (3) visualizations that are not clearly described through title, subtitle, legend or label thus context is not easily understood, or (4) individual or collective visualizations are not aligned with the purpose, theme or topic of the dashboard.

#### 4.2 Dashboard Layout Problem

This challenge was found in 42.2% of the dashboards. While still a high figure, it represents the least common item in our list, showing the acute problems found in the dashboards. Dashboard layout problems are related to dashboard clutters or the use of too many visualizations in one dashboard, unnecessary gaps or empty spaces on the screen. Despite this, the problem is relatively easy to fix and is not critical to information use and decision making compared to other problems.

#### 4.3 Visualization Technique Problem

Among all 80 examined dashboards only 11 did not experience visualization technique problem. The typical cases in this problem category includes (1) inappropriate choice of visualization type for particular dataset or analysis, for example the use of pie or spider chart for time trend data or even repeated visualization of indicator(s) for the sake of visualization variation, (2) inappropriate modes such as stack or non-stacking, (3) inappropriate choice of time period or indicators that result in the presentation of irrelevant time period for analysis or comparison of unrelated indicators or indicators with high with low figures such as total population with case finding, (4) poor choice or management of indicator, time period, or organization unit that causes clutters, etc. In many cases, this type of problem also causes other problems such as context problems and layout problems.

**Table 4.** Sample visualization problems

	
<p><b>Sample 1: Context and data quality problem</b> This figure can hardly be analyzed due to incomplete, untimely, inaccurate, and inconsistent data.</p>	<p><b>Sample 2: Layout, context, and visualization technique problem.</b> The visualizations are not well arranged, creating empty spaces and imbalance in the dashboard (layout problem). Some visualization titles indicate relative time period (“last 12 months”) but show data in fixed time period (“Jan-Dec 2018”) (context and visualization technique problem).</p>
	
<p><b>Sample 3: Visualization technique problem</b> One of the most common problem is using pie chart to visualize time trend data. Pie chart is unable to show the dynamic of an indicator over time. The more categories it has to visualize, the more difficult to note the value difference without reading the label.</p>	<p><b>Sample 4: Visualization technique problem</b> Live births, infant BCG immunization, first neonatal visits, and complete neonatal visits are stacked in this visualization. Stacking indicators of similar populations/subject may amplify health situations that do not exist and make a visualization difficult to read.</p>

#### 4.4 Logic Problem

To build comprehensive understanding and insight of program performance, either for monitoring, planning, or decision making; the logical and chronological management of visualizations within a dashboard, indicators within a visualization, and time period is important. For example, in tuberculosis program, it is more common and easier to manage the cohort cases from the active case finding, diagnosis confirmation, treatment given, to the treatment results. Same works for cross program management such as MCH and immunization that chronologically managed from pregnancy, delivery, baby services including baby immunizations (Table 4).

#### 4.5 Data Quality Problem

Another common problem (33.7%), which is not related directly dashboard design, is low data quality such as incomplete data, inaccuracy, and inconsistency. Many dashboards show visualizations with missing data that can be caused by: (1) poor data quality in data source; (2) problem(s) in defining or customizing the indicators; or (3) problem(s) of data transfer from other data sources.

### 5 Capacity to Visualize Data and to Create Dashboard

During DHIS2 roll out in early 2017, a team consisting of DHIS2 consultants from national and district level provided training to the health staff. Prior to the training, data had been integrated from several sources into DHIS2. The staff were trained in how to use DHIS2 to make dashboards over 2 days: (1) getting familiarized with the platform interface, (2) creating visualizations (tables, graphs, and maps) with the integrated data, then (3) presenting them in dashboard(s).

This training was then followed by series of capacity building activities, delivered during monitoring visit conducted quarterly from 2017 to 2018. MoH and consultants from international and national level trained the health staff to import their data and manually enter their data. However, due to budget limits, in these follow up visits, the training was only delivered to district health staff and some health care facilities staff.

The majority of health staff who created the data visualizations and the dashboards came from different educational background such as public health, midwifery, medicine, information systems, and computer sciences disciplines. Data management competency, which comprises data visualization literacy, to our knowledge has not yet been required to be included in health workforce competency standards. As an example, data management skill appears in competency standards of public health graduates [22] but not listed in competency standards of midwife graduates [23].

In addition to that, how data visualization training is delivered and how competent the graduates are, still yet to be understood. This paper, however, provides initial knowledge on how health staff visualize data and design their dashboards which portrays data visualization literacy of health staff in the field.



## 6 Discussion

While the case illustrates that the users at district level in Indonesia are able to technically make dashboards in DHIS2, data visualization skills are low, echoing existing literature [17, 18]. The various users had been given training in how to use DHIS2, but visualization competency was not part of the curriculum. Such skills are also not part of the required competencies for the relevant positions. After adopting the framework for dashboard design by Few [10], the most common challenges found are visualization technique and context problems. A large majority (83.1%) of assessed dashboards were marked as having visualization technique problems, typically relating to the choice of chart type and management of indicators within the chart. 73.5% of dashboards were found to have issues with contexts. Logical problems and layout problems were not so frequent, relatively speaking. In addition, poor data quality was also a common finding, although was not necessarily linked to the design of the dashboards themselves.

A clear implication of poor dashboard design is false interpretations of presented data and information that are potential to lead to poor decision making, planning, and resources allocation in health program management.

## 7 Concluding Remarks

The dashboards were made by district staff across Indonesia, which bears testimony to the flexibility and relative ease of use of the dashboard design functionality. This is in line with both the stated aim of the Ministry of Health, as well as the underlying philosophy of local customization that is inscribed in DHIS2. However, it is not enough to place the user-as-designer to make appropriate technology if the right skills are not present. The flexibility of the technology necessitates skills that go beyond mastering the technology itself (DHIS2) and having good knowledge in the domain of application (health). Data visualization techniques is also a set of crucial skills needed to make the fullest of the introduction of the technology. One outcome of this study has been to document the key challenges related to dashboard design and visualization proficiency among district users in Indonesia. Further capacity building in the use of DHIS2-based system should be adjusted to include also these aspects.

In addition to including data visualization techniques in the training curriculum, a complementary approach would be to make use of the WHO standard disease dashboards which are now available to download to DHIS2. In the case of these not being fully relevant for the local context, they can still be adjusted and can be used as templates for local adaptation that would help district and facility staffs to make meaningful dashboards themselves.

Apart from the data visualization literacy for health information use, data quality remains to be an issue. The root problem of incomplete, inaccurate, and inconsistent data needs to be investigated and addressed.

## References

1. Walsham, G.: ICT4D research: reflections on history and future agenda. *Inf. Technol. Dev.* **23**(1), 18–41 (2017). <https://doi.org/10.1080/02681102.2016.1246406>
2. Mukherjee, A.S.: Empowerment: the invisible element in ICT4D projects? The case of public health information systems in India and Kenya. University of Oslo, Norway (2017)
3. Heeks, R.: Do information and communication technologies (ICTs) contribute to development? *J. Int. Dev.* **22**(5), 625–640 (2010). <https://doi.org/10.1002/jid.1716/abstract>
4. Dittrich, Y.: Software engineering beyond the project—sustaining software ecosystems. *Inf. Softw. Technol.* **56**(11), 1436–1456 (2014)
5. Msiska, B., Nielsen, P.: A framework to assess and address human capacities needed to leverage open source software platforms in developing countries. In: Choudrie, J., Islam, M. S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017*. IAICT, vol. 504, pp. 81–92. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_8](https://doi.org/10.1007/978-3-319-59111-7_8)
6. Braa, J., Hedberg, C.: The struggle for district-based health information systems in South Africa. *Inf. Soc.* **18**, 113–127 (2002). <https://doi.org/10.1080/01972240290075048>
7. Roland, L.K., Sanner, T.A., Sæbø, J.I., Monteiro, E.: P for platform. Architectures of large-scale participatory design. *Scand. J. Inf. Syst.* **29**(2), 2–34 (2017)
8. Hanseth, O., Bygstad, B.: Flexible generification: ICT standardization strategies and service innovation in health care. *Eur. J. Inf. Syst.* **24**(6), 645–663 (2015). <https://doi.org/10.1057/ejis.2015.1>
9. Saugene, Z.: Customization of generic open source software for health sector in developing countries. University of Oslo, Norway (2013)
10. Few, S.: *Information Dashboard Design*. O'Reilly, Sebastopol (2006)
11. Gorgen, H., Kirsch-Woik, T., Schmidt-Ehry, B.: *The District Health System Experiences and Prospects in Africa: Manual for Public Health Practitioners*. Deutsche Gesellschaft für (2004)
12. Pappaioanou, M., et al.: Strengthening capacity in developing countries for evidence-based public health: the data for decision-making project. *Soc. Sci. Med.* **57**(10), 1925–1937 (2003)
13. Wickremasinghe, D., Hashmi, I.E., Schellenberg, J., Avan, B.I.: District decision-making for health in low-income settings: a systematic literature review. *Health Policy Plann.* **31** (suppl\_2), ii12–ii24 (2016)
14. WHO: *Analysis and use of health facility data: general principles* (2018)
15. Poppe, O., Sæbø, J.I., Nielsen, P., Sanner, T.A.: Standardising through software. *Sel. Pap. IRIS* **8**(2017), 4 (2017)
16. Mutale, W., et al.: Improving health information systems for decision making across five Sub-Saharan African countries: implementation strategies from the African health initiative. *BMC Health Serv. Res.* **13**(2), S9 (2013)
17. Schield, M.: Information literacy, statistical literacy and data literacy. *IASSIST Q. (IQ)* (2004)
18. Carlson, J., Fosmire, M., Miller, C.C., Nelson, M.S.: Determining data information literacy needs: a study of students and research faculty. *portal: Libr. Acad.* **11**(2), 629–657 (2011)
19. Suchman, L.: Located accountabilities in technology production. *Scand. J. Inf. Syst.* **14**(2), 7 (2002)
20. Benbasat, I., Goldstein, D.K., Mead, M.: The case research strategy in studies of information systems case research. *MIS Q.* **11**(3), 369–386 (1987). <https://doi.org/10.2307/248684>
21. Cavaye, A.L.M.: Case study research: a multi-faceted research approach for IS. *Inf. Syst. J.* (1996). <https://doi.org/10.1111/j.1365-2575.1996.tb00015.x>

22. Fakultas Kesehatan Masyarakat Universitas Hasanudin: Buku Kurikulum: 8 Kompetensi Sarjana Kesehatan Masyarakat. Universitas Hasanudin, Makassar (2016)
23. Kementerian Kesehatan RI: Keputusan Menteri Kesehatan Republik Indonesia tentang Standar Profesi Bidan (Nomor 369/MENKES/SK/III/2007). Kementerian Kesehatan RI, Jakarta (2007)



# Is Inclusive Digital Innovation Inclusive? An Investigation of M-Shwari in Kenya

Wenxiu (Vince) Nan<sup>(✉)</sup> and M. Lynne Markus

Bentley University, Waltham, MA 02452, USA  
{wnan, mlmarkus}@bentley.edu

**Abstract.** Inclusive digital innovations are IT-enabled innovations with the potential to promote inclusive socioeconomic development for the poor and underserved inhabitants of developing countries. This paper inquires about the extent to which this worthy objective has actually been achieved. Specifically, the paper focuses on M-Shwari, the Kenyan mobile savings and credit service. Although members of the development community and other stakeholders might hope M-Shwari to serve poor, rural, and financially underserved Kenyans, the research findings show that M-Shwari primarily reaches wealthier urban inhabitants who are already financially served. These results call for greater scholarly attention to excluded groups when evaluating the impacts of digital innovations in developing countries.

**Keywords:** Inclusive digital innovations · Inclusive development · Financial inclusion · Excluded segments · M-Shwari

## 1 Introduction

Digital innovations provide digitized services and goods that can be accessed and consumed on a massive scale by circumventing traditional costs and risks associated with physical components and relationships (e.g., Tilson et al. 2010; Yoo et al. 2012; Kallinikos et al. 2013). In the past decade, digital innovations have been leveraged as important enablers of inclusive socioeconomic development (e.g., Avgerou 2008; Nielsen 2017). For example, M-Pesa, the mobile financial service in Kenya, has been applauded as a success story in serving financially excluded people and enabling inclusive development (e.g., Jack et al. 2013; GSMA 2015; Aron 2017).

The potential benefits of digital innovations are of great interest to scholars, especially those in the field of Information and Communication Technologies for Development (ICT4D). Nevertheless, in his comprehensive literature review, Nielsen (2017) identified a significant lack of empirical and theoretical research on digital innovations *in developing countries*. Although digital innovations offer new opportunities for developing countries, a number of studies reveal the reproduction of old challenges and barriers and the emergence of new ones (e.g., Madon et al. 2009; van Dijk 2013; Kibere 2016). Accordingly, Nielsen (2017) queried: “*Will digital innovation*

*become the source of yet another digital divide?*” (p. 7). Obviously, we need more empirical research on the intended and unintended consequences of particular digital innovations in developing countries (Walsham and Sahay 2006), and we need to develop a better understanding of how users participate in digital innovations in these contexts (Nielsen 2017).

In response to that call for future research, this paper attempts to assess the impacts of a potentially inclusive digital innovation. Drawing on the inclusive innovation literature (e.g., George et al. 2012; Foster and Heeks 2013), we define inclusive digital innovations as innovations with the potential to enable inclusive socioeconomic development. The paper focuses mainly on the excluded inhabitants of developing countries, referring broadly to poor people bypassed by mainstream development (e.g., Heeks et al. 2013). The reason for this focus is our fundamental question about whether digital innovations can truly promote inclusion if they are not used by those who were previously excluded. Accordingly, the paper addresses this research question:

*To what extent do inclusive digital innovations serve excluded segments of developing country populations?* Focusing on excluded groups could have important implications for future ICT4D research: The extent to which previously excluded groups employ inclusive digital innovations could be considered an important criterion for evaluating digital innovation success.

This paper answers the research question by looking into a particular inclusive digital innovation: M-Shwari. Building on the ubiquitous M-Pesa infrastructure, M-Shwari was introduced in Kenya in 2012 as an advanced mobile financial innovation offering convenient, affordable, and secure savings and credit services. As of 2015, there were over 10 million M-Shwari accounts, accounting for about 20% of the Kenyan adult population.<sup>1</sup> Despite this remarkable adoption level, the uptake of M-Shwari has been limited compared with M-Pesa (Mirzoyants-McKnight and Attfield 2015). Given that M-Pesa is considered a financial inclusion success (e.g., GSMA 2015; Aron 2017), it is of interest to see whether the less well-known M-Shwari has been similarly successful in reaching excluded segments of the Kenyan population.

Using data retrieved from the Kenyan FinAccess Household Survey 2016,<sup>2</sup> this paper finds that M-Shwari does not effectively reach poor, rural, and financially underserved inhabitants. These findings contribute to ICT4D and mobile financial services literatures by calling for greater attention to excluded groups when examining the consequences of digital innovations in developing countries.

## 2 Literature

In this section, we discuss inclusive digital innovations in developing countries and analyze M-Shwari as an instance of inclusive digital innovation. Then, we move on to identify the excluded segments that M-Shwari might be hoped to serve.

<sup>1</sup> <http://www.cgap.org/blog/top-10-things-know-about-m-shwari>.

<sup>2</sup> <http://fsdkenya.org/dataset/finaccess-household-2016>.

## 2.1 Inclusive Digital Innovation in Developing Countries

One of the most prominent issues in developing countries is social exclusion, which causes further unequal distribution of resources and life chances (e.g., van Dijk and Hacker 2003). Central to social exclusion is the lack of access or obstacles to meaningful participation in social activities and the ability to benefit from mainstream development (e.g., Sen 2000). Such marginalization is also deeply rooted in the realm of innovation ecosystems. Heeks et al. (2013 p. 2) argued that “*innovations in developing countries have been conventionally associated with inequality, and have little connection or relevance to the low-income majority of the population.*” Against this background, growing scholarly attention has been given to inclusive innovation, which focuses on active inclusion of groups who are marginalized or excluded from mainstream development (George et al. 2012; Foster and Heeks 2013; Heeks et al. 2013).

Over the past decade, digital innovations have been leveraged to promote inclusive development in developing countries. One noteworthy feature of inclusive digital innovations is the provision of digitized services to marginalized or excluded groups in a convenient and affordable way, by alleviating the traditional time, space, and physical constraints on service delivery. In this way, digital innovations can arguably stimulate inclusive development not only by more equally distributing life chances, but also by affording the marginalized the ability to obtain needed resources and thus participate more fully in socioeconomic life.

Mobile financial services have been the first inclusive digital innovations in developing countries and the most successful so far. Mobile financial services employ telecommunication technology and non-bank retail channels to extend the delivery of basic financial services to those who could not be reached profitably with traditional branch-based financial services (GSMA 2015). Mobile financial services are considered digital innovations because they are enabled by digitally rearranging formerly disconnected sociotechnical elements (e.g., cash, mobile phone, transactional agents) such that users are able to access and use previously unavailable basic financial services. The fundamental novelty lies in the digitization of cash into e-money and the use of mobile phones as the medium for money transfer. Operating with e-money, mobile financial services provide a range of advantages over traditional cash-based services. That is, they relax time-space constraints, reduce transaction costs, and help users avoid financial risks associated with the use of cash (Jack et al. 2010; Aron 2017). Studies show that use of mobile financial services by financially excluded people has contributed to greater financial inclusion and generated socioeconomic benefits at the household, business, community, and society levels (e.g., Jack and Suri 2014; Wanyonyi and Bwisa 2013; Aron 2017; Demircuc-Kunt et al. 2017).

## 2.2 M-Shwari: An Inclusive Digital Innovation

To discuss M-Shwari in Kenya, we need to start with M-Pesa, the most successful mobile financial service to date. M-Pesa provides the basic financial service of money transfer via mobile phones. In the six years after its launch in 2007, registered M-Pesa

accounts outnumbered the Kenyan adult population.<sup>3</sup> This impressive level of adoption was partly due to the growth of a network of transactional agents (Jack and Suri 2014) who help users with registration and provide cash-in, cash-out services. In a country with 1,500 bank branches, roughly 165,000 M-Pesa agents were scattered across the country as of 2016.<sup>4</sup> Building upon this extensive M-Pesa infrastructure, M-Shwari was launched in November 2012 as a joint product of the Commercial Bank of Africa and Safaricom. Beyond the basic money transfer provided by M-Pesa, M-Shwari provides the advanced financial services of savings and credit. M-Shwari enables users to save digitally by transferring e-money between M-Pesa and M-Shwari accounts with no fees.

Like M-Pesa, M-Shwari is an example of an inclusive digital innovation in developing country, mainly because it holds the potential to promote financial inclusion by serving those who have little or no access to savings and credit services. M-Shwari can close the financial services gap created by the poor *formal* financial services infrastructure and limited *informal* financial services options in Kenya. Developing countries tend to have poor formal financial infrastructure (e.g., low and biased penetration of bank branches and ATMs), which leads to low adoption and usage of formal financial services (Triki and Faye 2013; Evans and Pirchio 2015). In particular, fewer than 30% of Kenyan households save (and fewer than 20% borrow) with formal institutions (Demirgüç-Kunt et al. 2018). This limited usage level is attributable to financial barriers such as inaccessibility (i.e., geographic limitation), affordability (i.e., minimum opening balance), and ineligibility (i.e., heavy bureaucratic processes) (Beck et al. 2008).

It is therefore not surprising that Kenyan households, especially those excluded, rely on a variety of *informal* financial services (e.g., Rutherford 2000; Jack and Suri 2014), i.e., hiding cash at home, keeping livestock, saving or borrowing with friends, and saving or borrowing with ROSCAs and ASCAs<sup>5</sup>. Although these approaches can work, they involve costs and risks (Karlan et al. 2014). The noteworthy shortcomings of ROSCAs and ASCAs concern geographical constraints and limited liquidity (Mas 2010). Saving at home is neither safe nor protected from the temptation of spending (Banerjee and Duflo 2007). The general risk associated with informal savings is money loss (Wright and Mutesasira 2001). In addition, the current microcredit services in Sub-Saharan Africa are criticized for inefficient loan repayment, high interest rates, and ineffective provision to target groups (Stewart et al. 2010).

The insufficient and ineffective provision, operation, and distribution of traditional savings and credit services are in part due to excessive use of cash (Radcliffe and Voorhies 2012). However, the savings and credit services of M-Shwari involve cash to a minimum level, offering a number of advantages. The major benefits of M-Shwari are accessibility and convenience. M-Shwari allows users to receive personalized savings

<sup>3</sup> <http://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C>.

<sup>4</sup> Ibid.

<sup>5</sup> ROSCAs refer to groups that regularly collect money from each member and give it to one person in turn; ASCAs refer to groups that regularly collect money from members, and lend to its members or other people with interest.

and credit services anytime and anywhere via their phones, overcoming the time-space constraints of traditional financial services. Moreover, M-Shwari's reduced need for cash offers security and privacy for users as no one can find out how much is saved or borrowed (Cook and McKay 2015; Mirzoyants-McKnight and Attfield 2015). Thus, M-Shwari has the potential to provide advanced financial services to the previously underserved and to advance inclusive development by enabling the poor to live productive lives, achieve stable livelihoods, and plan for the future.

### 2.3 Excluded Population Segments

From the point of view of M-Shwari's commercial operators, the first priority is make a profit from inclusive digital innovations (Qureshi 2013). However, from the perspective of the inclusive innovation and development communities, what really matters is the extent to which an inclusive digital innovation actually fulfills its promise of inclusion for poor and marginalized population segments. With advancement of ICT, excluded groups have received increased scholarly attention. For example, in the digital divide literature, studies shed light on those with low socioeconomic status, who lag behind in terms of accessing and using ICTs. (e.g., van Dijk and Hacker 2003; Dewan and Riggins 2005). Also, in the inclusive innovation literature, Forster and Heeks (2013, p. 335) defined inclusive innovation as the inclusion within some aspect of innovation of groups who are currently marginalized. Similarly, George et al. (2012) argued that inclusive innovative activities should target individuals in disenfranchised sectors of society. In their conceptualizing inclusive innovation, Heeks et al. (2013, p. 4) contended that "*an innovation is inclusive if it is adopted and used by the excluded group.*"

So, who constitute the excluded segments that members of the inclusive innovation and development communities might hope M-Shwari to serve? The mobile financial services literature provides some insights. However, that research focuses on the socioeconomic characteristics of *actual* users. The common finding is that households who are better educated, affluent, banked, and living in urban areas are more likely to use mobile money transfer services like M-Pesa (e.g., Jack and Suri 2011; Mbiti and Weil 2011; Munyegera and Matsumoto 2014). M-Shwari, as a more recent phenomenon, has received little attention, with two exceptions. Cook and McKay (2015) and Mirzoyants-McKnight and Attfield (2015), drawing on the interviews with M-Shwari users, showed that users tend to be young, male, and urban dwellers with a high level of education. Although those findings are informative, they do not tell us whether and to what extent *excluded population segments* are among the actual users. By contrast, this paper focuses on the gap between whom M-Shwari currently serves and whom the development community would hope the innovation to serve.

Exclusion is a multidimensional concept (Prahalad 2012) that varies across inclusive digital innovations. Therefore, it needs to be contextualized in a particular research setting. Three socioeconomic factors—poverty, residence, and the degree of financial inclusion/exclusion—are of particular interest to financial inclusion scholars for the



study of the financially excluded (e.g., Demirgüç-Kunt et al. 2018; Jack and Suri 2014; Sahay et al. 2015; Triki and Faye 2013). Drawing on that literature, we consider the excluded segments in this paper to be the poor, the rural, and financially underserved Kenyan households.

### 3 Methods

To identify the impact of M-Shwari on excluded segments of the Kenyan population, this paper employs set diagram analysis. In social science, set diagrams are particularly useful for studying the intersections among the different categories to which social actors belong (Mahoney and Vanderpoel 2015). This paper uses this technique to graphically represent the overlap between actual users of M-Shwari and previously excluded groups in terms of poverty, residence, and traditional financial inclusion. Data was retrieved from the Kenyan FinAccess Household Survey 2016. This survey is the fourth in a series of surveys (2006, 2009, and 2013) that measure financial inclusion in Kenya. Because M-Shwari was launched in late 2012, this study used Survey 2016 to capture the users and usage of M-Shwari. As this survey is nationally representative, the associated results can be confidently extrapolated to Kenyan population (Saigo 2010). We sampled data on the usage of a variety of financial services and the socioeconomic factors of interest. The resulting dataset has 8,665 observations.

As discussed above, three factors were used for set diagram analysis: poverty, residence, and degree of financial inclusion. While *residence* (urban versus rural) is readily available, we need to construct variables to show (1) whether a household lives above (or below) the poverty line and (2) the extent to which a household is financially included (or excluded). It is estimated that about 50% of Kenyan population live below the poverty line.<sup>6</sup> To reflect that fact, we created a binary variable—*poverty*—by using \$0.50 per day per capita as the cut point. 46% of respondents were thus identified as poor.

In the financial inclusion literature, the degree of financial inclusion (or exclusion) is measured by considering a household's usage of formal and informal financial services (e.g., Triki and Faye 2013; Demirguc-Kunt et al. 2018). Following this tradition, this study constructed three mutually exclusive variables: *served*, *underserved*, and *unserved*. A household is termed *served* if the highest level of reported usage of financial services is through service providers that are regulated and supervised by regulatory agencies (i.e., commercial banks, post banks, etc.). When a household's highest level of financial services usage is through unregulated forms of structured provision (i.e., ROSCAs, moneylenders, shopkeepers, etc.), we count the household as *underserved*. Finally, if households have little or no access to the aforementioned financial services, we regard them as *unserved*. Summary statistics and variable descriptions are reported in Table 1.

---

<sup>6</sup> [https://www.unicef.org/kenya/overview\\_4616.html](https://www.unicef.org/kenya/overview_4616.html).

**Table 1.** Summary statistics and variable description

Variable	Mean (SD)	Min	Max	Description
<i>M_Shwari</i>	0.14 (0.35)	0	1	1: use M-Shwari; otherwise, 0
<i>M_Pesa</i>	0.71 (0.45)	0	1	1: use M-Pesa; otherwise, 0
<i>Poverty</i>	0.54 (0.50)	0	1	1: above poverty line; otherwise,0
<i>Residence</i>	0.44 (0.50)	0	1	1: urban; 0: rural
<i>Served</i>	0.70 (0.46)	0	1	1: financially served; otherwise, 0
<i>Underserved</i>	0.08 (0.28)	0	1	1: financially underserved; otherwise, 0
<i>Unserved</i>	0.22 (0.41)	0	1	1: financially unserved; otherwise, 0

## 4 Results

The results of our set diagram analysis are shown in Fig. 1. In the figure, the upper, middle, and lower panels compare and contrast different segments assessed by three factors: (1) above vs. below poverty line; (2) urban vs. rural; and (3) served vs. underserved and unserved. The right-hand panel accordingly represents the excluded segments. Each *white* circle shows the size of the segment (as % of respondents); e.g., 53.6% of households live above the poverty line. Each *lined* circle then represents the intersection between M-Pesa users (as % of respondents) and the segment; e.g., 35.5% of respondents are M-Pesa users *and* live in urban areas. Similarly, each *dotted* circle captures the overlap among M-Shwari users (as % of respondents), M-Pesa users, and the segment; e.g., 4.7% of respondents are M-Shwari users who use M-Pesa and live in rural areas. Overall, 70.9% and 14.4% of respondents use M-Pesa and M-Shwari, respectively.

This figure supports two key observations. First, M-Shwari users tend to live above the poverty line and in urban areas. Consider the upper and middle panels. Whereas M-Pesa (the lined circles) is widely used by Kenyan households regardless of poverty and residence, M-Shwari (the dotted circles) is predominantly used by urban households with decent livelihoods. A majority of M-Shwari users (11.7% out of 14.4%) live above the poverty line, and two thirds (9.7% out of 14.4%) live in urban areas. The biased distributions reveal that M-Shwari fails to reach poor, rural households.

Second, *none* of the underserved and unserved respondents has so far been served by M-Shwari. The lower panel shows that 70.1% are identified as the served, and most of them are M-Pesa users. This result resonates with the finding in the literature that *basic* mobile financial services, such as M-Pesa, have contributed to the deepened financial inclusion by turning the formerly underserved and unserved into the served (e.g., Aron 2017). Nonetheless, it is surprising to note that the *advanced* M-Shwari service is exclusively used by the already-served, and, accordingly, *none* of the previously excluded households—about 30% of respondents—has participated in M-Shwari.

To sum up, when we zoom out and compare the left-hand and right-hand panels, it is clear that M-Shwari (the dotted circles) primarily serves wealthier urban inhabitants

who are already financially included. By contrast, the excluded segments—the poor, rural, and financially underserved and unserved—have thus far hardly been served by M-Shwari at all. We can therefore conclude that the advanced M-Shwari service has not yet contributed to inclusive socioeconomic development to the same extent that the more basic M-Pesa service did.

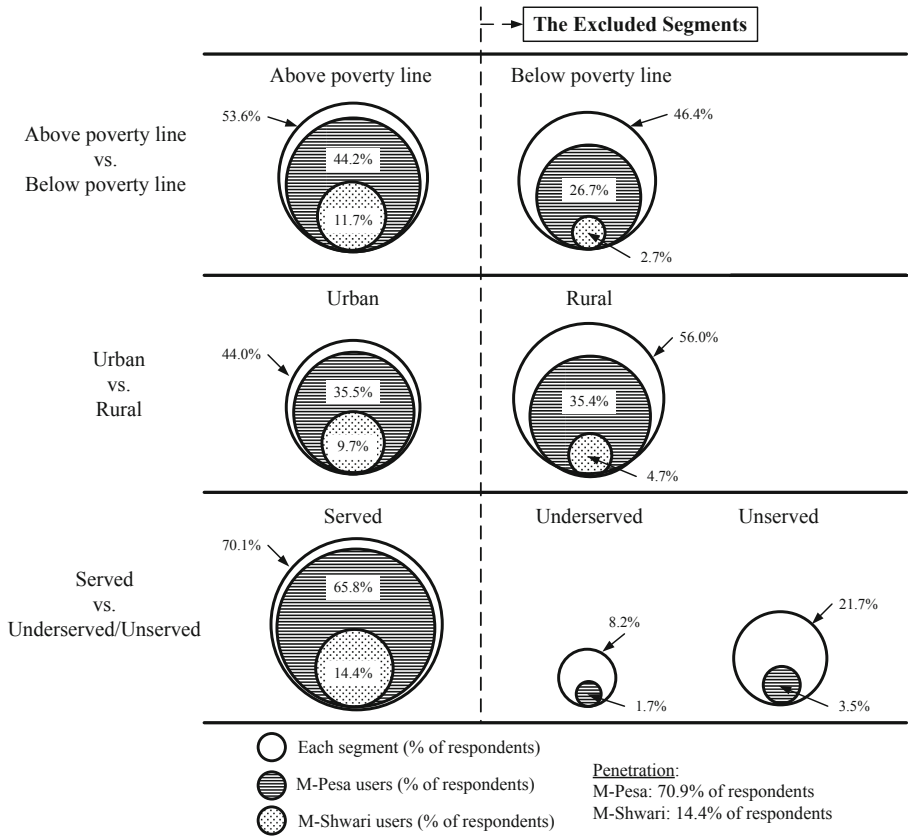


Fig. 1. M-Shwari usage among the poor, rural, and underserved/unserved segments

## 5 Discussion

Responding to the research call of Nielsen (2017), this paper contributes to the ICT4D literature by showing that a focus on excluded segments can be used to assess the real impact of an inclusive digital innovation. Despite the remarkable adoption rate of M-Shwari (about 20% of the Kenyan adults), the findings reveal that M-Shwari does not yet reach the excluded segments of the Kenyan population. This is not to argue that M-Shwari is not a good service, nor that it is commercially unsuccessful. Indeed, M-Shwari deserves credit for providing savings and credit services to those who would

otherwise have limited access to those services in an affordable, convenient, and secure way. Rather, the point here is that financial inclusion and inclusive development may *only* be fully achievable when digital innovations actually serve excluded groups.

The findings have several theoretical implications. First, we should never take it for granted that potentially inclusive digital innovations will *always* reach excluded segments, even when they build on earlier innovations that succeeded in deepening inclusion. M-Pesa in Kenya was successful in reaching the previously excluded people and in enabling socioeconomic development (e.g., Jack et al. 2013; GSMA 2015; Aron 2017). Given the massive M-Pesa user base, it is plausible to think that M-Shwari, building on M-Pesa, would achieve the similar outcomes. However, this paper provides evidence that this is not true for M-Shwari at least as of now. In evaluating the socioeconomic implications of digital innovations in developing countries, we believe, future scholars should determine the extent to which excluded groups are actually included, without being misled by impressive total adoption statistics.

Second, the findings point to the *potential unintended consequences* of inclusive digital innovations. One may argue that, as M-Shwari keeps diffusing, the gap between the included and the excluded will decrease over time and the latter will ultimately become served. However, it seems unlikely that the “better off” will stop increasing their lead or that the “worse off” will catch up to narrow the gap (van Dijk and Hacker 2003). Instead, as mobile financial services advance requiring a higher level of digital skills and financial literacy, the gap is likely to persist or even expand (van Dijk 2013). Put differently, the previously excluded segments are as likely to lag behind and remain marginalized as they were before. Set diagram analysis revealed that, whereas the previously served continue to be actively engaged with M-Pesa and M-Shwari, only a minor portion of the underserved and unserved are M-Pesa users and none of them use M-Shwari. These findings suggest the possibility that M-Shwari, without compensating interventions, might stagnate or reverse earlier gains in the Kenyan financial inclusion landscape, allowing the rich to get richer and the poor to get poorer.

Third, the findings of this paper raise an important theoretical query: *Do inclusive digital innovations provide for or divide the populations of developing countries?* Digital innovations hold the potential to be inclusive by affording users the ability to leapfrog traditional constraints and deploy previously inaccessible socioeconomic resources. In the case of M-Pesa, former excluded users are able to use e-money transfer services in a convenient, secure, and affordable way, circumventing traditional costs and risks associated with physical cash. The success of M-Pesa is partly attributable to the ease of use of the financial services (e.g., Jack and Suri 2011). However, when advanced digital innovations like M-Shwari require complicated financial knowledge (e.g., about savings and credit instruments) and digital skills, they might further marginalize excluded segments. Inclusive digital innovations might *widen* existing divisions rather than narrow them through provision.

As for future research, this paper calls for theorizing about *how* and *why* inclusive digital innovations might sometimes fail to reach excluded segments. One promising theoretical lens is provided in the digital divide literature: Households with better material, cognitive, and social resources are more able to take the lead in using ICTs, while others lag behind (e.g., de Haan and Rijken 2002; van Dijk and Hacker 2003). Instead of just focusing on differences between users and non-users, we need to focus

on the segments of developing country populations who continue to be excluded despite the hopes and expectations of the development community. Various factors could be at work here. It could be as simple as a potential M-Shwari user not having an M-Pesa account or not being aware of M-Shwari service. But it could be a deeper issue, such as not having money to save, lacking digital and financial skills, having a status quo bias, or having technology-related fear and trust issues (e.g., Kim and Kankanhalli 2009). Other factors such as technical design and user interface design (i.e., visualization, relevancy, and complexity of information and services) also deserve attention (e.g., Cotten and Gupta 2004). Obviously, as Nielsen (2017) advocated, more research is needed to address the challenges as well as the opportunities of inclusive digital innovations in developing countries.

## 6 Conclusion

In conclusion, inclusive digital innovations offer new opportunities for developing countries to achieve inclusive development. But inclusive development may only be possible when excluded segments of the population can make effective use of inclusive digital innovations. By examining a particular innovation, this paper made the case that inclusive digital innovations do not always promote greater inclusion. The findings redirect our attention toward excluded segments and toward the potential unintended consequences of digital innovations in both theory and practice.

## References

- Aron, J.: ‘Leapfrogging’: A Survey of the Nature and Economic Implications of Mobile Money, Centre for the Study of African Economies, University of Oxford (2017)
- Avgerou, C.: Information systems in developing countries: a critical research review. *J. Inf. Technol.* **23**(3), 133–146 (2008)
- Banerjee, A.V., Duflo, E.: The economic lives of the poor. *J. Econ. Perspect.* **21**(1), 141–168 (2007)
- Beck, T., Demirguc-Kunt, A., Laeven, L., Levine, R.: Finance, firm size, and growth. *J. Money Credit Bank.* **40**(7), 1379–1405 (2008)
- Cook, T., McKay, C.: How M-Shwari works: the story so far. Consultative Group to Assist the Poor (CGAP) and Financial Sector Deepening (FSD) (2015)
- Cotten, S.R., Gupta, S.S.: Characteristics of online and offline health information seekers and factors that discriminate between them. *Soc. Sci. Med.* **59**(9), 1795–1806 (2004)
- de Haan, J., Rijken, S.: The digital divide in the Netherlands: the influence of material, cognitive and social resources on the possession and use of ICTs. *Electron. J. Commun.* **12**(1/2), 1–20 (2002)
- Demirguc-Kunt, A., Klapper, L., Singer, D.: Financial Inclusion and Inclusive Growth: A Review of Recent Empirical Evidence. The World Bank, Washington (2017)
- Demirguc-Kunt, A., Klapper, L., Singer, D., Ansar, S., Hess, J.: The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution. The World Bank, Washington (2018)
- Dewan, S., Riggins, F.J.: The digital divide: current and future research directions. *J. Assoc. Inf. Syst.* **6**(12), 298–337 (2005)

- Evans, D.S., Pirchio, A.: An empirical examination of why mobile money schemes ignite in some developing countries but flounder in most. *Rev. Netw. Econ.* **13**(4), 397–451 (2015)
- Foster, C., Heeks, R.: Conceptualising inclusive innovation: modifying systems of innovation frameworks to understand diffusion of new technology to low-income consumers. *Eur. J. Dev. Res.* **25**(3), 333–355 (2013)
- George, G., McGahan, A.M., Prabhu, J.: Innovation for inclusive growth: towards a theoretical framework and a research agenda. *J. Manage. Stud.* **49**(4), 661–683 (2012)
- GSMA: 2015 State of the Industry Report on Mobile Money. GSMA (2015)
- Heeks, R., Amalia, M., Kintu, R., Shah, N.: Inclusive innovation: definition, conceptualisation and future research priorities. IDPM Development Informatics Working Papers (2013)
- Jack, W., Ray, A., Suri, T.: Transaction networks: evidence from mobile money in Kenya. *Am. Econ. Rev.* **103**(3), 356–361 (2013)
- Jack, W., Suri, T.: Mobile money: the economics of M-Pesa. National Bureau of Economic Research (2011)
- Jack, W., Suri, T.: Risk sharing and transactions costs: evidence from Kenya's mobile money revolution. *Am. Econ. Rev.* **104**(1), 183–223 (2014)
- Jack, W., Suri, T., Townsend, R.: Monetary theory and electronic money: reflections on the Kenyan experience. *Econ. Q.* **96**(1), 83–122 (2010)
- Kallinikos, J., Hasselbladh, H., Marton, A.: Governing social practice. *Theor. Soc.* **42**(4), 395–421 (2013)
- Karlan, D., Ratan, A.L., Zinman, J.: Savings by and for the poor: a research review and agenda. *Rev. Income Wealth* **60**(1), 36–78 (2014)
- Kibere, F.N.: The paradox of mobility in the Kenyan ICT ecosystem: an ethnographic case of how the youth in Kibera slum use and appropriate the mobile phone and the mobile internet. *Inf. Technol. Dev.* **22**(1), 47–67 (2016)
- Kim, H.-W., Kankanhalli, A.: Investigating user resistance to information systems implementation: a status quo bias perspective. *MIS Q.* **33**(3), 567–582 (2009)
- Madon, S., Reinhard, N., Roode, D., Walsham, G.: Digital inclusion projects in developing countries: processes of institutionalization. *Inf. Technol. Dev.* **15**(2), 95–107 (2009)
- Mahoney, J., Vanderpoel, R.S.: Set diagrams and qualitative research. *Comp. Polit. Stud.* **48**(1), 65–100 (2015)
- Mas, I.: New Opportunities to Tackle the Challenge of Financial Inclusion. Working Paper Series (40) (2010)
- Mbiti, I., Weil, D.N.: Mobile banking: the impact of M-Pesa in Kenya. *Natl. Bur. Econ. Res.* (2011)
- Mirzoyants-McKnight, A., Atfield, W.: Value-added financial services in Kenya: M-Shwari. InterMedia (2015)
- Munyegera, G.K., Matsumoto, T.: Mobile Money, Remittances and Rural Household Welfare: Panel Evidence from Uganda Tokyo. GRIPS (2014)
- Nielsen, P.: Digital innovation: a research agenda for information systems research in developing countries. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017*. IAICT, vol. 504, pp. 269–279. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_23](https://doi.org/10.1007/978-3-319-59111-7_23)
- Pralhad, C.K.: Bottom of the pyramid as a source of breakthrough innovations. *J. Prod. Innov. Manage* **29**(1), 6–12 (2012)
- Qureshi, S.: Networks of change, shifting power from institutions to people: how are innovations in the use of information and communication technology transforming development? *Inf. Technol. Dev.* **19**(2), 97–99 (2013)
- Radcliffe, D., Voorhies, R.: A Digital Pathway to Financial Inclusion. Bill & Melinda Gates Foundation (2012)

- Rutherford, S.: *The Poor and Their Money*. Oxford University Press, New Delhi (2000)
- Sahay, R., et al.: *Financial Inclusion: Can It Meet Multiple Macroeconomic Goals?*. IMF, Washington (2015)
- Saigo, H.: Comparing four bootstrap methods for stratified three-stage sampling. *J. Off. Stat.* **26** (1), 193–207 (2010)
- Sen, A.: *Social Exclusion: Concept, Application, and Scrutiny*. Asian Development Bank, Mandaluyong (2000)
- Stewart, R., van Rooyen, C., Dickson, K., Majoro, M., de Wet, T.: *What is the impact of microfinance on poor people?: a systematic review of evidence from Sub-Saharan Africa*. University of London, London (2010)
- Tilson, D., Lyytinen, K., Sørensen, C.: Research commentary—digital infrastructures: the missing is research agenda. *Inf. Syst. Res.* **21**(4), 748–759 (2010)
- Triki, T., Faye, I.: *Financial Inclusion in Africa*. African Development Bank, Abidjan (2013)
- van Dijk, J., Hacker, K.: The digital divide as a complex and dynamic phenomenon. *Inf. Soc.* **19** (4), 315–326 (2003)
- van Dijk, J.A.: *A Theory of the Digital Divide*. In *The Digital Divide*. pp. 49–72. Routledge (2013)
- Walsham, G., Sahay, S.: Research on information systems in developing countries: current landscape and future prospects. *Inf. Technol. Dev.* **12**(1), 7–24 (2006)
- Wanyonyi, P., Bwisa, H.: Influence of mobile money transfer services on the performance of micro enterprises in Kitale municipality. *Int. J. Acad. Res. Bus. Soc. Sci.* **3**(5), 500–517 (2013)
- Wright, G., Mutesasira, L.: The relative risks to poor people’s savings. *J. Small Enterp. Dev.* **12** (3), 33–45 (2001)
- Yoo, Y., Boland Jr., R.J., Lyytinen, K., Majchrzak, A.: Organizing for innovation in the digitized world. *Organ. Sci.* **23**(5), 1398–1408 (2012)



# Sinking Under Its Own Weight: Case of Aadhaar Mediated Entitlements in India

Arunima Mukherjee<sup>1,2</sup>  and Sundeep Sahay<sup>1,2</sup> 

<sup>1</sup> University of Oslo, Oslo, Norway  
{arunimam, sundeeeps}@ifi.uio.no  
<sup>2</sup> HISP India, Noida, India

**Abstract.** In this paper, we analyse through a largely conceptual analysis the application of the Aadhaar biometrics identification system in India, now assuming complex proportions, and how that facilitates or not citizen's entitlement of welfare benefits. The conceptual analysis is informed by the works of James Scott's Seeing like a State which cautions against such large scale state sponsored schemes ending up as disasters. Amartya Sen's analysis of famines informs how it is important to focus on the access to the entitlement rather than the entitlement itself, which, potentially can lead to entitlement failures. The conceptual analysis developed helps to critically analyse two case vignettes related to two welfare programmes of the midday meals and the public distribution system. The paper concludes by arguing for the need to critically discussing how Aadhaar can be made to work in practice while supporting broader development objectives, rather than arguing whether Aadhaar is inherently good or bad.

**Keywords:** Aadhaar · India · Entitlement failures · Scott and Sen

## 1 Introduction

In low and middle income countries (LMICs), an important defining condition of development is the effectiveness or not of the relation between the state and the citizen around the provision of social services like public distribution, education, public health, and various others. Citizens, by law and their national constitutions, have various social entitlements that the state is expected to deliver on. Various state various departments and ministries like of health, education, rural development, have designed various schemes to ensure that these entitlements are delivered effectively to citizens. A recent trend in many LMICs is the designing of various information systems to ensure these entitlements are effectively delivered through various means such as improved identification of beneficiaries, tracking of services delivered, monitoring of impacts such as numbers of people pulled over poverty lines and other promised benefits. These systems by virtue of being large and multi-faceted, and through their attempts to model complex social phenomenon, have the potential to become large and autonomous [25], leading to unintended consequences such as for surveillance by the state, rather than strengthening the delivery of entitlement to citizens. This begs the empirical question of “how are these information systems mediating the relationship between the state and their delivery of entitlement benefits to citizens.”



We examine this question in the context of the Aadhaar initiative implemented in India over the last 5 years or so. This large digital platform of biometrics-based database of residents of India now represents a large-scale pan-country information infrastructure with many actors involved. The Aadhaar database is large-scale containing details of nearly 1 billion people, supported by a complex infrastructure involving multiple interconnected components such as biometrics identification devices, de-duplication algorithms, central databases, and the use of authentication devices at point of registration and service delivery. This infrastructure is increasingly being used as a basis to model complex social services such as the public distribution system, mid-day meals provision, and the employment guarantee scheme. These attempts by the State to introduce Aadhaar in the delivery of citizens' entitlements has led also to a number of protests and debates amongst civil society groups and are being fought under the jurisdiction of the Supreme Court of India. There are also other voices which discuss the tremendous benefits that have accrued through the use of Aadhaar, such as in terms of cost savings. In this paper, we examine some of these debates, particularly from the perspective of the citizens and their ability to access their legal entitlements.

Conceptually, we draw upon two strands of work to inform our analysis of control as they become more complex, distributed and managed from a distance. The first strand of inspiration is Amartya Sen's [22] seminal work titled *Poverty and Famines: An Essay on Entitlement and Deprivation*. In this essay, Sen argues that starvation is the characteristic of some people not having enough food to eat and not of there not being enough food to eat. While the latter can be a cause of the former, it is but one of the many possible causes. Whether and how starvation relates to food supply, Sen argues is a matter for a factual empirical investigation of an "entitlement failure", where people are unable to access food, even though there may not be a shortage of food per se. The second strand of analysis is drawn from James Scott's *Seeing like a State* where he argues large scale state sponsored technology efforts are doomed for failure as firstly, they try to simplify complex social phenomenon in a manner which is just not possible. Secondly, they tend to be used to further an agenda of surveillance for the state, rather than of furthering welfare of the citizens. Taken together, these two strands of work helps to formulate and analyse the research question of: "does Aadhaar mediated state delivery of citizens' entitlements improve their access or not to their benefits, or do they further the agenda of state surveillance and control?"

While acknowledging this question is large and complex to answer in a conference paper, we attempt to outline the contours of a conceptual framework that can help engage in such an analysis. We believe this is an important exercise to attempt, as Aadhaar is having large-scale social consequences, with voices both for and against. A theoretically grounded framework can help making more informed and critical judgements of the issues on hand, and potentially support more informed policy and practice around Aadhaar implementation experiences.

The rest of the paper is organized as follows. In the next section, we outline our conceptual approach drawing on the two strands of research introduced above. In Sect. 3, we very briefly introduce the methods. In Sect. 4, we give a background of the Aadhaar initiative, including its technical and institutional dimensions. In Sect. 5, we present two case vignettes developed based on published public debates. In Sect. 6, we present our analysis and discussions, followed by brief conclusions.

## 2 Conceptual Framework: To Analyse the State-Citizen-Technology Relation

We draw from two large bodies of work drawing from political science, development economics and social studies of technology to formulate a conceptual perspective to analyse our case study.

### 2.1 Amartya Sen: Entitlement Failures

Amartya Sen in his classic treatise *Poverty and Famines* [22] challenged the dominant assumption that total food-availability decline is the central cause of all famines. Instead, Sen argued that famine happens through “entitlement failures,” which occurs even when there is no decline in food production. Sen changes the focus from availability to access, understood through the concept of entitlements. Entitlement of a person is defined as ‘the set of alternative commodity bundles that can be acquired through the use of the various legal channels of acquirement open to that person’ [6–24]. For example, in India, every citizen has an “entitlement” for food rations through the public distribution system. If there is a failure of a citizen’s entitlement to food, they can face starvation and famine.

In the context of food, Sen identified many other conditions contributing to entitlement failure and subsequent famine. Sen’s analysis of the Bengal Famine of 1943 identified amongst other reasons, inflation after the war to be a key reason of entitlement failure, despite food production in 1943 being 13% higher than 1941. The Bangladesh famine of 1974 was contributed to by a poor food rationing system that only focused on the urban population, adversely affecting the entitlements of rural Bangladeshis leading to one million deaths through famine. The Ethiopian famine of 1973 was contributed to by a poor system of transport between regions in overall conditions of stable food productivity. So, conditions defining access becomes crucial in shaping entitlement failures or not.

Sen also argues that a country’s political system including the checks and balances of democracy can act as a shield against famine. In a democratic system with a free press, the occurrence of a famine will inevitably reduce the popularity of the government. The fear of being voted out of power motivates democratic governments to take measures to mitigate famines. In contrast, absence of democratic systems for the same reasons may lead to famine conditions, as what happened in China in 1959-61.

In summary, Sen’s ideas help to understand the relation between the state and its citizens mediated through the notion of entitlements – what the state is legally expected to provide to its citizens, and how effectively citizens are able to access that or not.

### 2.2 James Scott: “Seeing like a State”

Scott [17], in a telling account of the use of state power in initiatives aimed at social transformation, argues that these efforts have led to large-scale tragedies. Scott’s examples of failed initiatives include the creation of permanent last names, the standardization of weights and measures, the establishment of cadastral surveys and

population registers, the design of cities, and the organization of language. A common theme across them is the failed attempts by the state to make society legible by trying to transpose complex, illegible, and local social practices onto a standard and simplified grid, to enable central recording and monitoring. Mechanisms used by the state include censuses, cadastral maps, identity cards, and statistics, which fail for two main reasons: “The proponents of these plans regard themselves far smarter and far-seeing than they really were and, at the same time, regard their subjects as far more stupid and incompetent than they really were” [17-343].

Scott, in his analysis of the workings of the state, identifies legibility as a central problem arguing that the state “always seemed to be the enemy of people who move around” [16-2]. Their central effort is to make a society legible, requiring them to rationalize and standardize, to make administration more convenient, enabling more fine-grained interventions in areas such as taxation, public health measures, political surveillance, and relief for the poor. However, in this process of simplification, the realities of a complex social world are abridged, for example:

*These state simplifications, the basic givens of modern statecraft were, I began to realize, rather like abridged maps. They did not successfully represent the actual activity of the society they depicted, nor were they intended to; they represented only that slice of it that interested the official observer. They were, moreover, not just maps. Rather, they were maps that, when allied with state power, which would enable much of the reality they depicted to be remade (ibid., p. 3)*

Scott identifies four elements that contribute to the making of large-scale failures. The first concerns the attempt to social engineering through administrative ordering and simplification. The second concerns an adherence to a highly modernized ideology, emphasizing the value of using technical and scientific progress to master nature and create natural laws to apply to social processes. The third element concerns an authoritarian state using its coercive powers to bring a high-modernist design into being. For this to happen, there is the fourth condition of an incapable civil society that is passive in resisting the design of the state. Taken together, these conditions help to create the “imperialism of high-modernist, planned social order.”

Raghvendra and Sahay [16], while not explicitly drawing on Scott, illustrate his concerns in describing an Indian state’s attempt to standardize a citizen’s household and its social processes through a 17-digit identification number. In summary, Scott alerts us that large-scale state initiatives don’t tend to work because of their inability to represent complex social phenomenon through mechanisms of simplification and standardization, and coupled with ideology of surveillance, these efforts become untenable.

### 2.3 Summarizing Our Conceptual Framework

Summarizing, the key elements from the above two sets of discussions, we propose an initial analytical framework based on the following principles:

- i. From Sen, to understand entitlement failures, we need to analyse the access of citizens to entitlements, and the conditions which enable or not this access.

- ii. Technology with its particular material features will play an important role in enabling or not this access. This role can be both material or perceptual concerning the beliefs of the citizens about what is the role of the technology.
- iii. From Scott, we will wish to understand what are intentions of the state in the use of the technology in mediating citizens' entitlements. Scott points out to four important motivating conditions – intention to simplify and modernize; desire to adhere to a high modernist ideology; the nature of the state – authoritarian or democratic and how they want to use the technology; and, are the citizens active or passive and whether they are able to mobilize actions to resist the designs of the state.

The above questions provide us a basis to understand the role of the Aadhaar initiative in mediating citizens' access to their entitlements. We now turn to briefly describing the methods before moving on elaborating the technical and institutional dimensions of the Aadhaar initiative before describing some case vignettes of its application to different citizen entitlement schemes.

### 3 Methodology

Our methods are based primarily on secondary data, including newspaper reports, articles and websites that have discussed particular examples and experiences of citizens' entitlements. In addition, since both authors are Indian citizens who are registered in the Aadhaar database, they have had some personal experiences of the use of Aadhaar in schemes such as accessing a new phone SIM card, applying for the renewal of a passport, and securing permission for a child to sit for his annual examination. For the data analysis, we examine the text of the identified documents with respect to the three sets of principles identified above as a part of the conceptual framework.

### 4 The Aadhaar Initiative: Technical and Institutional Dimensions

The Indian Parliament approved Aadhaar in 2016 making into The Aadhaar (Targeted Delivery Of Financial And Other Subsidies, Benefits And Services) Act, 2016 [9]. Primarily based on the inclusion agenda there were two important stated objectives. One, to facilitate inclusion by providing identification documents to all residents, and its lack became an important source of exclusion from the entitlement. Aadhaar was thus seen to be closely tied to improving access to government benefits. Two, Aadhaar was aimed to promote inclusion of citizens to entitlements by reducing corruption (especially duplication in databases). [13] argued that there was no disagreement on the desirability of both these objectives specified in the Act as follows:

*'to provide for, as a good governance, efficient, transparent, and targeted delivery of subsidies, benefits and services, the expenditure for which is incurred from the Consolidated Fund of India, to individuals residing in India through assigning of unique identity numbers to such individuals and for matters connected therewith or incidental thereto'.*

The Unique Identification Authority of India (UIDAI), a statutory authority, was established becoming responsible for administering this scheme, including enrolment and authentication, operation and management of all stages of Aadhaar life cycle, and developing policy to ensure the security of identity information. The Aadhaar number is a 12-digit random number issued by the UIDAI to the residents of India after satisfying the stipulated verification process. Any individual, irrespective of age and gender, who is a resident of India, may voluntarily enrol to the scheme by providing minimal demographic and biometric information. After controlling through de-duplication, a unique Aadhaar number is generated, and is positioned as the ‘identity platform of the ‘Digital India’ initiative.

The Aadhaar ecosystem includes – the Aadhaar number holder, Registration and Authentication facilities, Authentication Service Agency (ASA), Authentication User Agency (AUA), Central Identities Data Repository (CIDR), Authentication Devices (devices that collect PID - Personal Identity Data). UIDAI has published specifications for the authentication devices that form a critical link with the Aadhaar authentication ecosystem. These devices collect PID from Aadhaar number holders, prepare the information for transmission, transmit the authentication packets for authentication and receive authentication results. Examples of authentication devices range from desktop PCs, laptops, kiosks to Point-of-Sale (PoS)/handheld mobile devices (micro ATMs) and tablets.

## 4.1 Case Vignettes

We describe two case vignettes around the role of Aadhaar in mediating access of citizens to their entitlement of social benefits. The material for this is drawn from published debates in civil society around this issue. The cases are: (i) school children’s entitlement of mid-day meals; and, (ii) a citizen’s entitlement of food rations from the public distribution system (PDS).

### 4.1.1 Mid-Day Meal Scheme

*‘An 11-year-old girl in Jharkhand’s Simdega district died of starvation last fortnight, months after her family’s ration card was cancelled because it was not linked to their Aadhaar number. With no school mid-day meals available during her school holidays, Santoshi Kumari had gone with barely any food for nearly eight days before she died. (Johari 2016a).*

The family had been out of work for almost two-months, after the Aadhaar number became compulsory for getting work locally under the Mahatma Gandhi National Rural Employment Guarantee scheme. As they were not registered under Aadhaar, they could not find employment under this scheme, which denied them their daily livelihood, coupled with denial of mid-day meals to their kids at school, contributed to the 11 year old’s starvation death.

To address child nutrition, the Indian government in 2001 launched the National Programme of Nutritional Support to Primary Education (NP-NSPE). Under this, every child in every government aided primary school was to be served a prepared Mid-Day Meal (MDM) with a minimum content of 300 calories of energy and 8–12 grams of protein per day for a minimum of 200 days in a year. In 2002, the scheme was further

extended to cover also children studying under the Education Guarantee Scheme (EGS) and Alternative and Innovative Education (AIE) centres. In 2018, the MDM was covering children up to upper primary classes (i.e. up to VIII) and the name of the scheme was changed to ‘National Programme of Mid-Day Meal in Schools’.

On February 28, 2017, the Ministry of Human Resource Development, invoking Sect. 7 of the Aadhaar Act, issued a notification for the mid-day meal scheme. According to the notification,

*“any individual desirous of availing the benefit under the Scheme...are required to furnish proof of possession of Aadhaar number. ... (Someone) who does not possess an Aadhaar number or has not yet enrolled for Aadhaar shall have to apply for Aadhaar enrolment by 30th June, 2017.”*

Further, the notification states that

*“till the time Aadhaar is assigned to such beneficiary benefits shall be given to such beneficiaries subject to the production of the following identification documents.”*

*Three documents are required to be produced to prove eligibility:*

1. *Aadhaar enrolment slip or (b) copy of his/her request made for Aadhaar enrolment.*
2. *An undertaking from the parent or guardian that the child is not enrolled in any other school.*
3. *Any one of seven alternative identification documents.*

According to the notification, if the child has not enrolled for Aadhaar he/she is required to produce her enrolment slip as well as two other types of documentation to remain eligible for school meals.

“The use of Aadhaar as identity document for delivery of services, benefits or subsidies simplifies the government delivery process and enables beneficiaries to get their entitlements directly and in a seamless manner,” the HRD ministry notification said.

Not only was this a clear blow to country’s nutrition programme, which still is reeling under the pressure of reaching out to all children, but serves as an infringement of Right to Food under the National Food Security Act, 2013 [15]. Dreze and Goyal [3], reviewing the MDM, highlighted its two key achievements. First, they facilitate the elimination of classroom hunger. Many Indian children reach school on an empty stomach in the morning, either because they are not hungry at that time or because their parents are too busy to arrange for an early morning breakfast.

Making Aadhaar mandatory for ‘entitlement’, defies the idea of ‘right’ and ‘entitlement’ and creates a bigger dent by pushing needy children away, for whom this was probably the only meal of the day. Drèze and Khera [5] questions this linking: First, in the current form of the Aadhaar Act, forcing children to enroll means subjecting them to lifelong tracking (without consent, as they are minors), without the possibility of opting out later in life (there is no such provision the in Act). Second, there is little or no role for Aadhaar in the MDM programme, and the government only wants to expand the coverage of Aadhaar enrolment, which in itself does not seem to improve the effectiveness of the MDM. The children who eat at government schools are currently enrolled there and should not have to provide any additional proof. Aadhaar,

contrary to its stated promise of reducing barriers to access, is potentially creating barriers.

The government argues that Aadhaar will halt corruption, as there have been some reported cases of schools showing non-existent students on their rolls to claim additional funds from the MDM scheme allocation. As the ministry notification said, ‘Aadhaar will expose ‘ghost students’ in schools’. There are other known and effective means to reduce such corruption through community monitoring, social audits, decentralised grievance redressal systems, public display of information on beneficiaries and menus. These means need to be encouraged rather than expect children to carry the burden of corruption, transparency and accountability [1, 2]. Khera [12] further argues, that not only, will this push towards enrolment be hugely disruptive both for MDM programme, but also educational activities in schools as teachers and the (over-stretched) school administration will be forced to make arrangements for Aadhaar enrolment.

#### 4.1.2 Public Distribution System

The public distribution system (PDS) plays an important role in the lives of poor people in India. They tend to keep their ration cards safely, go to the local ration shop every month without fail, and get basic monthly supplies of rice, wheat, kerosene and other sanctioned supplies for their families. They get angry when the basics are ‘out of stock’, and may accuse the dealer of corruption and selling the supplies in the open market. Their anger is not difficult to understand: in their fragile and uncertain lives, the PDS provides a modicum of food and economic security [4].

In September 2013, Parliament passed the National Food Security Act [15] making the right to food a legal entitlement by providing subsidized food grains to nearly two-thirds of the population [26]. The Act relies on the existing Targeted Public Distribution System (TPDS) mechanism to deliver these entitlements through a multi-level process in which the central and state government share responsibilities for the provision of food. In 2016, government introduced Aadhaar-based Biometric Authentication (ABBA) in the PDS, ostensibly to enhance “efficiency” [6]. The NFSA confers the legal right to subsidised foodgrains for “eligible households.” While eligibility is a household characteristic (ration cards are made for households, not individuals), entitlements are determined on a per capita basis [23]. This requires their Aadhaar number to be seeded onto the PDS database and added to the household ration card. The PoS machine is a handheld device installed at every PDS outlet (“ration shop”) and connected to the Internet [4]. The list of ration cards attached to that outlet, and their respective entitlements, are stored in the PoS machine and updated every month. When a cardholder turns up, the PoS machine first “authenticates” her by matching her fingerprints with the biometric data stored against her Aadhaar number in the Central Identities Data Repository (CIDR). The machine then generates a receipt with the person’s entitlements, which are also audible from a recorded message (if the machine’s voice-over facility is functional and the dealer activates it, which is not always the case). The transaction details are entered by the dealer in the person’s ration card. Meanwhile, the PoS machine generates electronic transaction records that are automatically uploaded on the state government’s PDS website—hereafter the “Aadhaar website.” The PDS outlets are built around a set of “fragile technologies” [6] that

need to work simultaneously for successful transaction. These are: (1) Seeding of Aadhaar numbers in the PDS database which is then added to the household ration card; (2) Point of Sale (PoS) machines are used by the dealer to enter the ration card number of the beneficiary's household in it; (3) Internet connection is required for the successful working of the PoS machine for verification of the ration card number and the beneficiary's biometric identification; (4) Remote Aadhaar servers verify the ration card number and initiate fingerprint authentication; and, (5) Fingerprint recognition software is used for the beneficiary to prove her identity by submitting to fingerprint recognition in the PoS machine, and upon verification, the PoS machine indicates that the beneficiary is genuine and eligible for foodgrains.

Even though the technological solution sounds very good, but in practice, however, there are a number of possible hurdles [4]. Dreze [6] explains that the process of "seeding" Aadhaar numbers into the list of ration cards is far from trivial: it involves not only entering Aadhaar numbers into the ration-card database, but also "verifying" them (to avoid errors or fraud), and dealing with possible inconsistencies between the Aadhaar and PDS databases (e.g., differences in the spelling of people's names). The limited battery life of PoS machines is a serious problem in areas without stable electricity connections. Internet connectivity is an even more widespread and recurring hurdle, as large areas are still bereft of it, intermittently or permanently. The PoS machine itself is sometimes out of order. Even when all these fragile technologies are functional, the PoS machine may not recognise someone's fingerprints. For many poor people, this technological infrastructure is contributing to many people being denied access to the PDS.

## 5 Analysis

We present our analysis in this section, drawing upon our three sets of questions presented in the conceptual framework related to access, materiality of technology, intention of the state and associated response of the citizens.

### 5.1 Aadhaar's Role in Mediating Access, Including Materiality of Technology

As Aadhaar is linking up with different welfare schemes and their respective institutions, the resulting infrastructure is becoming out of control of any single department or entity. There are existing historical conditions under which schemes like the Midday Meal and PDS are functioning, and are fraught with institutional challenges of governance, corruption and apathy of those responsible for its implementation. There is the tendency of these institutional challenges being redirected to the technology. Institutional limitations find blame on the technology, which in practice is beyond the control of the implementing department.

During its introduction, the stated aim of Aadhaar was only expected to authenticate the identity of a person by answering the question of "if X is X?", and this information was not to be shared. It was supposed to help a citizen not having to provide identity documents repeatedly for various welfare schemes. Aadhaar comprises



of an elaborate technological paraphernalia, including software solutions (such as de-duplication algorithms capable of searching millions of records), equipment to conduct biometric tests of fingerprints and iris scans, the central database (CIDR) where all data would be stored supported by advanced cyber security means, and the need for high speed and reliable internet to enable the remote locations (where the identification is needed to be done) to send an encrypted message to the CIDR and receive an answer to the identification question. With this increasing complexity, control is transferred to a distance (for example, to the central CIDR database from the ration shop owner), with many intermediary pieces (POS, internet, Ration card, Aadhaar number etc.) standing between the person and his/her entitlement, such that exact reasons for an entitlement failure can never be accurately determined. As the plethora of application areas for Aadhaar are increasing from school admissions to phone connections to public distribution and many more, Aadhaar tends to become the hammer looking for the nail.

An important question which are analysis reveals is “access for what does Aadhaar enable?” The aim of the Midday meal scheme was to enable hungry students to access food and not support the state to identify ghost students and enhance the coverage of Aadhaar enrolment. Same is the case of the PDS where the aim of the scheme was to enable a household to get their monthly rations to maintain their routine livelihood. By focussing on the access to Aadhaar rather than the benefits of the original scheme (strengthening nutrition or enabling monthly food rations), we tend to lose the purpose of the question of access to what the original scheme was aimed for? Citizen’s legal entitlements such as the National Food Security Act, tend to be challenged by the requirements for Aadhaar such as under the PDS. Should our question of analysis then relate to access to the National Food Security Act or to the enrolment in Aadhaar?

## 5.2 Intentions of the State and Associated Response of Citizens

The initial stated intention of the state with Aadhaar was merely to provide a technically effective way of identifying Indian residents. However, as the infrastructure has become more widespread and sophisticated, various government departments and schemes have started to adopt it with other intentions of identifying ghost students or weeding out corruption. Standardization, simplification and foolproof identification of residents, representing key modernizing ideologies, are at the heart of these legitimizing arguments to weed out corruption and remove duplications. From being a vehicle to enable access, the use of Aadhaar seems to be supporting, in Scott’s words, the strengthening of the State’s surveillance gaze over its citizens. Aadhaar represents modern technology and ideology and further draws upon and also feeds into high profile and politically charged development discourses such as Prime Minister’s Digital India. As the modern infrastructure becomes increasingly available and its use legitimized by politicians, media and technology vendors, the State finds a willing vehicle to enhance its gaze. For example, by making access to pensions to be based on the Aadhaar card, which may deny access of a leprosy suffering patient unable to access her pension.

As pointed out by Khera [12], the eligibility for various welfare programmes requires a person to satisfy conditions of these schemes: e.g., for social security pensions such as old age or widow pensions, the elderly are required to produce proof of

age and a widow a death certificate of her husband. A widow with, say, an Aadhaar number, but without her husband's death certificate will continue to be excluded. Scott raises the question of is everyday social life inherently too complex to be standardized and simplified through technological means, taking examples of identification, cadastral schemes and others. Complexity of social phenomenon comes from the everyday practices of daily life, people's culture, values and various others. The Midday Meal scheme is not only about identifying whether a child is eligible or not for his/her meal, but has to be taken into context of the size of the house they come from, whether their parents have guaranteed employment, how far do kids travel to reach school, what diseases and fatalities does malnutrition lead to, and various other conditions, which by definition may be impossible to reduce to a number or represent on a map. As discussed earlier, Raghvendra and Sahay [17] described the futility of trying to impose a static identification of a family which is highly dynamics including births, deaths, marriages, joint family etc. About the response of citizens to the use of Aadhaar, we could argue that most of the people who tend to rely on state delivered entitlements would come from backgrounds of poverty, illiteracy, and suffer from forms of social exclusion of caste, gender and others. By design, the power asymmetry between them and the state would be extreme to mount a credible resistance. As the use of the Aadhaar becomes increasingly embedded, legitimized and taken for granted within the institutional fabric of government welfare schemes, the ability to resist will become even more marginal. This lack of resistance then provides the state with more power to expand the scope and coverage of the schemes. Having said that, our reading of the literature in the area indicates that there various ongoing debates, and pointing to the use of Aadhaar leading to entitlement failures. We do not want to promote a story of gloom and doom about Aadhaar, but instead try to emphasize that it provides a massive technology infrastructure which provides the potential to strengthen the development agenda, provided it is applied sensitively and innovatively. Madon et al. [13] have investigated new processes of governance that emerged for distributing subsidised fertiliser based on Aadhaar to low income farmers in an Indian district. They empirically show how this centralized Aadhaar initiative was complemented by knowledge and expertise of local institutions to strengthen fertiliser dispersal to low-income farmers while also providing various value added services. Their study helps to explore the question of how can Aadhaar be made to work in local context and provide added-value.

## 6 Discussion

In the cases and analysis discussed, Aadhaar is used as a legitimizing device by the state machinery to deal with issues such as of corruption which tend to be historically situated, enabled through unholy alliances between the government and local implementing agencies, and built upon power asymmetries created through issues of gender, caste, money, land and various others. Can technology do away with these deep rooted social and cultural (mal)practices or do they enhance the scope of the same? While we are not able to definitively answer the same, we can argue in its current form they are tending to challenge access of citizens to their entitlements. For example, the mid-day meal scheme was designed to address the endemic problem of malnutrition in the

country by providing poor children with at least one square meal, while the state is using the Aadhaar scheme to identify ghost students. From the programme side, we could argue that even if a “ghost” student gets a meal, it is still okay, as it is helping to address the problem of malnutrition which is the larger aim of the scheme. Also, why should the onus of an efficient and corrupt bureaucracy be placed on the citizens? And should not these be addressed through other forms of institutional reforms?

It has been said that the British invented the bureaucracy in India, and the Indians perfected it. The bureaucracy is already punishing in India, as exemplified beautifully by the set of essays by Sainath in his classic book “Everybody loves a good drought” [27]. He provides interesting narratives from 10 poorest districts in the country of how a heartless bureaucracy uses all forms of techniques to exclude the poor. For example, one story is of a person from a backward caste who could not avail entitled benefits over his lifetime because the name of the caste was spelt wrongly in the official records. And this was without any mediation of technology. The contemporary technology intervention through Aadhaar should be guarded against further alienation of citizens and human values from the State. Entitlement failures have much larger social consequences, pushing already deprived people into worsening human conditions of hunger, illness, loss of employment and even death. Aadhaar, positioned as a development initiative, should help prevent this from happening, and help move in the opposite direction.

## 7 Conclusion

The Aadhaar scheme is not necessarily problematic, but questions around the intentions and methods used by those implementing it need to be critically discussed and revised where needed. We will conclude by arguing the focus of debates should need to shift to what “needs to be done to make Aadhaar work effectively in practice to support broader development objectives?” The example cited by Madon et al. [13] is a step in that direction highlighting the importance of local governance and the enabling of value added services. The criteria for discussing the success or not of Aadhaar should not be primarily in terms of cost savings but in relation to contributing to the human development index. Cost saving figures tend to obscure more than what they reveal. For example, Drèze and Khera [4] describe a World Bank report, 2016, claiming a USD 11 billion saving through Aadhaar as “skating on thin ice,” as the underlying reasons may be due to the use of digital technology more broadly in subsidy transfers, many of which do not involve Aadhaar at all, like the use of smart cards. In many projects, Aadhaar is only one component of a larger infrastructure, making it flawed to attribute the savings only to Aadhaar. In summary, whether we like it or not, Aadhaar is here to stay, and we all need to engage with the question of how can it strengthen citizen entitlement.

## References

1. Bhatt, K., Saraf, R., Gupta, V.: Out-of-school children. *Econ. Polit. Wkly* **52**(49), 69 (2017)
2. Dreze, J., Goyal, A.: Future of mid-day meals. *Econ. Polit. Wkly* 4673–4683 (2003)
3. Khalid, N., Drèze, J., Khera, R., Somanchi, A.: Aadhaar and food security in Jharkhand. *Econ. Polit. Wkly* **52**(50), 51 (2017)
4. Drèze, J., Khera, R.: Recent social security initiatives in India. *World Dev.* **98**, 555–572 (2017)
5. Dreze, J., Sen, A.: *Hunger and public action*. Oxford University Press on Demand (1989). *Econ. Polit. Wkly*, 9 December 2017
6. Dreze, J.: The Aadhaar coup. *The Hindu* **15** (2016)
7. Economic Times: Aadhaar mandatory for MGNREGS work from April, PTI (2017). [http://economictimes.indiatimes.com/articleshow/56402579.cms?%20utm\\_source=contentofinterest&utm\\_medium=text&utm\\_campaign=cppst](http://economictimes.indiatimes.com/articleshow/56402579.cms?%20utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst). Accessed 08 Jan 2017
8. Government of India Gazette March 2016. [https://uidai.gov.in/images/targeted\\_delivery\\_of\\_financial\\_and\\_other\\_subsidies\\_benefits\\_and\\_services\\_13072016.pdf](https://uidai.gov.in/images/targeted_delivery_of_financial_and_other_subsidies_benefits_and_services_13072016.pdf)
9. Bhatt, K., Saraf, R., Gupta, V.: *Econ. Polit. Wkly* (2017)
10. Khalid, N.: Aadhaar, biometric authentication and the public distribution system. [ideasforindia.in](http://ideasforindia.in)
11. Khera, R.: UID project: does evidence matter, *Yojana*, July 2014 (2015)
12. Khera, R.: UID: from inclusion to exclusion. *Seminar* (2015)
13. Madon, S., Ranini, C.R., Krishnan, K.K., Babu, A.: Can Aadhaar help improve the delivery of social welfare programmes in India? A focus on local government. In: Working Paper, LSE, UK (2018)
14. National Food Security Act (NFSA) (2013). <https://dfpd.gov.in/nfsa-act.htm>
15. Narayan, S.: Why India is losing its war on hunger. *Oxfam Policy Pract. Agric. Food Land* **11**(3), 15–24 (2017)
16. PTI: Mid-Day Meal Rules, 2015 Under National Food Security Act, 2013 Notified. Press Information Bureau Government of India, Ministry of Human Resource Development (01-October, 2015 11:59 IST) (2015). <http://pib.nic.in/newsite/mbErel.aspx?relid=128354>
17. Raghvendra, C.R., Sahay, S.: Computer-based health information systems: projects for computerization or health management? Empirical experiences from India. In: Tan, J. (ed.) *Information Communication Technologies and Human Development: Opportunities and Challenges*, pp. 266–292. Idea Group Publishing, Hershey (2006)
18. Scott, J.C.: *Seeing Like a State: How Certain Schemes to Improve the Human Condition have Failed*. Yale University Press, New Haven (1998)
19. Scroll.in: Denied food because she did not have Aadhaar-linked ration card, Jharkhand girl dies of starvation. *Scroll.in*, 16 October 2016. <https://scroll.in/article/854225/denied-food-because-she-did-not-have-aadhaar-linked-ration-card-jharkhand-girl-dies-of-starvation>
20. Scroll.in: Why have only 64% public schoolchildren enrolled for Aadhaar when it is mandatory for midday meals?. *Scroll.in*, 06 October 2017. <https://scroll.in/article/853021/why-have-only-64-public-schoolchildren-enrolled-for-aadhaar-when-it-is-mandatory-for-midday-meals>
21. Sen, A. (2017). <https://thewire.in/government/aadhaar-card-jharkhand-mgnrega>
22. Sen, A.: *Poverty and Famines: An Essay on Entitlement and Deprivation*. Oxford University Press, Oxford (1981)
23. Somanchi, A., Bej, S., Pandey, M.: Well done ABBA? Aadhaar and the public distribution system in Hyderabad. *Econ. Polit. Wkly* **52**(7) (2017)

24. The Wire.in: No Good Will Come From Linking Aadhaar to Mid-Day Meals, Reetika Khera March 2017 (2017). <https://thewire.in/government/aadhaar-mid-day-meals%20-%20Reetika%20Khera>
25. Winner, L.: *Autonomous Technology: Technics-out-of-Control as a Theme in Political Thought*. MIT Press, Cambridge (1978)
26. Balan, S.: *Functioning of the Public Distribution System an Analytical Report*. PRS Legislative Research (2013)
27. Sainath, P.: *Everybody loves a good drought* (1996)



# Design Science Research Strengthened: Integrating Co-creation and Co-design

Calkin Suero Montero<sup>1</sup>(✉)  and Alsen Florian Kapinga<sup>2,3</sup>

<sup>1</sup> School of Educational Sciences and Psychology,  
University of Eastern Finland, Joensuu, Finland  
calkins@uef.fi

<sup>2</sup> College of Business Education, Dar es Salaam, Tanzania  
kamingila@yahoo.com

<sup>3</sup> School of Computing, University of Eastern Finland, Joensuu, Finland

**Abstract.** Design science research (DSR) is a well-known methodology that uses design as a tool for the development of both practical research resulting in an artefact solution, and theoretical scientific knowledge resulting in improved design processes. In this paper, we advocate strengthening the DSR methodology by including elements of co-creation and co-design in order to produce meaningfully contextualised solutions and to foster a stronger sense of ownership and social acceptance of a developed technological artefact solution within ICT4D. In our work, the inclusion of co-creation and co-design within DSR takes place in all of the stages of the design cycle, influencing also the relevance and rigour cycles as well as the impact of the artefact in the broader socio-technical context. Here we illustrate the practical implementation of these ideas through the involvement of women entrepreneurs from rural Tanzania in the development of a mobile application. This paper contributes to the body of research on the meaningful application of DSR processes to ICT4D.

**Keywords:** Design science research in ICT4D · Co-creation · Co-design

## 1 Introduction

Design science research (DSR) has guided the development of numerous ICT-based solutions in emerging economies within the ICT4D field [1]. As a multi-paradigmatic research arena, DSR fits well with the interdisciplinary nature of ICT4D. Thus, from this fusion, several richly developed research endeavours have been reported. For instance, Van Biljon and Marais [2] employed DSR to the creation of an open knowledge repository for research collaboration in South Africa; Smith and Turpin [1], complemented DSR with activity theory to highlight uncovered social and political issues during the creation and deployment of an ICT platform in a rural community; and Islam and Grönlund [3] described the general use of DSR in ICT4D research, putting forward the realisation of a mobile information service. These examples reveal the applicability of the DSR framework to the ICT4D research field. However, as Islam and Grönlund [3] pointed out, DSR within ICT4D “needs an integrated research approach with well-coordinated activities throughout the development process”. We

take these considerations a step further and look into strengthening and enhancing the DSR methodology through the inclusion of a coordinated participatory design approach. That is, co-creation and co-design activities used as anchors that facilitate the application of DSR to the ICT4D realm.

The direct involvement of end-users as active partners through participatory design during the development and deployment of DSR in ICT4D has been briefly mentioned previously, albeit it is a rare practice. For instance, Grobler and De Villiers [4] reported using human-centred design thinking with DSR as a way to enhance and boost the DSR to create an artefact, the community shaping solutions framework, CSSF. It is well accepted in the ICT4D community that when developing technological solutions to real-world contextualised problems, a human-centred design approach is useful. It is fundamental to look at what people actually want to have and/or use instead of what is technologically feasible to create [4]. Therefore, Grobler and De Villiers in their work used a design thinking iterative process, where the community was directly involved to “co-create frameworks, solutions, opportunities and prototypes” [4]. This, in fact, seems to fall beyond the user-centred approach to the premises of viewing ‘users as partners’ with direct participation in the research practice and development [5].

The participatory design approach to developing technological solutions pioneered in Scandinavia, starting in the 70’s and has steadily being established widely, in the information systems (IS) community and elsewhere, as the preferred and more sustainable approach to achieve meaningful creations and solutions [6–8]. With participatory design, *co-creation* and *co-design* come to life. According to Sanders and Stappers [5], co-creation refers to collective creativity produced for instance by researchers, expert designers and end-users working together. Co-design refers then to that collective creativity applied to the entire design process. It is important to notice that co-creation and co-design go beyond the user-centred design approach in that the former approach sees end-users as *active partners* (e.g., having the users participate and voice their ideas and concerns to guide the design process) whereas the latter approach sees users as passive participant in the study (e.g., observing users doing tasks, collecting questionnaires, etc.). In our work, we embrace these concepts to put forward a stronger DSR framework that reflects aspects of co-creation, and co-design in order to achieve contextually meaningful interventions. Although few reported research indicates the use of co-creation activities alongside a DSR methodology (see for instance [9]), a concrete framework is yet to be established.

Addressing this research gap, here we present our strengthened DSR framework and its preliminary implementation as part of our ongoing research work. This work has been realised in partnership with women entrepreneurs in rural Tanzania, striving to achieve the meaningful creation of a technological artefact suitable for supporting their business development through an online market platform accessible with mobile devices. Our contribution highlights the benefit of using participatory design concepts within DSR to go a step beyond the human-centred approach, where end-users are seen as passive elements for observation, towards making end-users active partners in the development of appropriate and contextualised solutions. Furthermore, we invite open discussion from the ICT4D community on issues related to the practical use, refinement and deployment of our framework strengthening DSR.

## 2 Background

### 2.1 Concept of Design Science Research

Design science research (DSR) is a research methodology that invents or builds new, innovative artefacts (new reality) for solving problems or achieving improvements, i.e. DSR creates new means (knowledge) for achieving some general goal as its major research contributions [10]. The contributions of DSR are observable in the combined novelty and utility of constructed artefacts. The essential principle of DSR is that knowledge and understanding of a design problem and its solution are required in the building, application and deployment of an artefact. In DSR, new knowledge is created through rigorous evaluation [11]. The outcome of a DSR project could be then highlighted through its contribution towards designing and creating new technological artefacts, theories or processes as well as through the impact of the project [12]. In practical terms, DSR is viewed as a methodology that seeks to reduce the gap between theory and practice but maintains the necessary amount of rigour to ensure the reliability of results [13]. According to Gregor and Hevner [14], DSR aims at generating solutions that are more efficient, leading to more effective products, procedures, services, technologies, or thoughts.

The activities within the DSR methodology are embodied into several closely linked cycles that iterate between the core activities of building and evaluating the designed artefact. According to Hevner [15], these cycles include the *relevance cycle*, the *design cycle* and the *rigour cycle*. Drechsler and Hevner [16] also propose a fourth cycle of DSR, *change and impact*, to capture the impact in time of the artefact in the wider socio-technical system context where it is utilised. The design cycle is the central part of the DSR methodology, which improves the environment (relevance cycle) through the building and introduction of new and innovative artefacts thus generating new knowledge (rigour cycle), adapting to contextual changes and evolving with time (change and impact cycle). The design cycle iterates rapidly within itself, between creating an artefact, its evaluation and its subsequent feedback to refine the design further. In our work, we consider strengthening the design cycle to accommodate elements of co-creation and co-design in order to achieve meaningfully contextualised artefacts. During a practical implementation of these ideas, we developed a mobile phone application (artefact) contextualised to women entrepreneurs (WEs) for selling and marketing their products, fully involving them in all stages of the design process in order to foster a strong feeling of ownership and to facilitate the social acceptance of the solution for use in real-life settings.

### 2.2 System-Centred, Human-Centred and Participatory Design

The system-centred design (SCD) focuses on technology models that regard the artefact or system as primary, having the notion that developers and inventors of the technology know what is best for its design, dissemination and intended use [17]. Overall, “system-centered view holds that the technology, the humans, and the context within which they reside are perceived as constituting one system that operate in a rational manner toward the achievement of predetermine goals” [17]. In the system-



centred technology, there is no need for the end-users to be involved with the system or artefact during its development. This perspective streams from the standing point that because the system is too complex it should be designed and developed by experts who know what is most appropriate in the system design. The system is created through the process of prototyping and iteration redesign that is primarily controlled by the designers [17]. This approach has been successfully implemented to put forward large technological developments that go beyond the needs of contextual end-users, for example increasing information processing speed of machines with more powerful processing cores or pushing forward the development of massive memory storage capabilities in the computing domain.

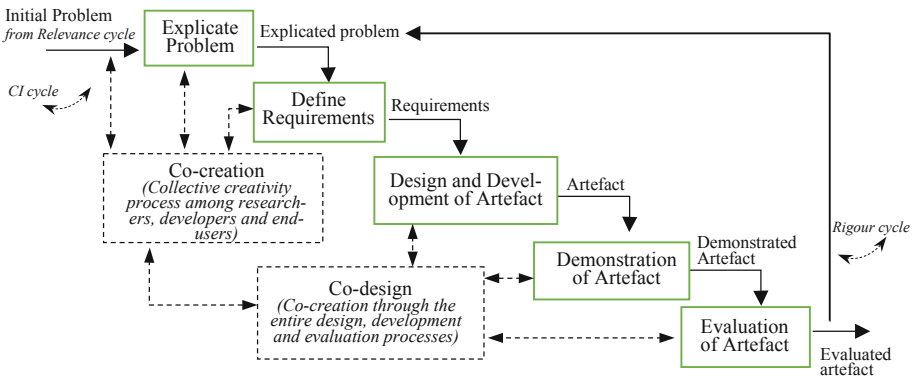
The SCD approach might not be, however, successful when it comes to contextualising solutions based on the particular needs of the end-users. Thus, system-centred design shifted to user-centred design (UCD) of technology. UCD involves end-users in the product or artefact development through observations and interviews within the environment in which they would use the product or artefact being designed [18]. The aim is to make intuitive artefacts that require minimum effort from the user to learn how to use them – designing *for* users [19]. Moving a step further, participatory design (PD) advocates the collective, joint value creation, and collaborative process between researchers, designers, developers and end-users – designing *with* users [19, 20]. This brings with it a shift from UCD merely observing end-users as passive actors towards end-users becoming interactive partners in the design process.

In our work, participatory design is deployed as an end-user-centric tactic putting women entrepreneurs (end-users) first and recognising them the starting point of the experience from problem explication and user requirements definition through artefact design and development, to the evaluation of an artefact for enhancing their business performance (see examples of similar practices in [21]). Furthermore, since PD is value-based and focused on relationships and distribution of responsibilities between researchers, designers and WEs during the DSR process, it thus improves synergies for co-creation. Our work strengthens the DSR methodology by acquiring the value of co-creation and co-design for sustainable innovation.

### 2.3 Co-design and Co-creation in Design Science Research

Participatory design through co-creation and co-design offer a significant contribution towards facilitating and improving DSR processes in ICT4D. According to Sanders and Stappers [5], co-creation refers to any act of collective creativity, shared by two or more people, for instance researchers and end-users. Co-design refers to the application of the collective creativity (co-creation) across the entire a design process. Co-creation is akin to a customer-centric approach based on the principles of putting customers first and recognising them as the starting point of the value creation experience (see, for instance, Ramaswamy and Ozcan's *value-in-interactional creation* concept, which poses value creation as a co-creation, with interactions across systems as locus [22]). A co-design and co-creation approach involves collaboration between researchers and end-users from the beginning, in problem framing and research design and delivery, which influences the research process and implementation strategy from conception (e.g., see [23]).

We argue that the integration of co-creation and co-design in DSR methodology for ICT4D is of vital importance as it highlights end-users’ participation in the solution-making activities, which could result in a more sustainable sense of ownership and acceptance of the created artefact. Furthermore, since the process of co-design and co-creation tend to yield unexpected benefits, the research results may change the implicit assumptions of researchers by gaining new ideas from the participants in DSR process [24]. Drawing from the experiences of business ventures, co-creation and co-design enhance customer’s commitments, create offerings that are more competitive, foster faster time to market, and build brand awareness [25]. Similar results could be expected from the perspective of users’ sense of ownership and acceptance of artefacts created through DSR within ICT4D, having the end-users as partners in development. Thus, in our work we view co-design and co-creation as integral parts in all DSR design cycle activities. Therefore, end-users are involved in the entire design process from the iterative problem explication and definition of requirements, to the design and development of the artefact and to its demonstration and evaluation, until a satisfactory outcome is reached between researchers, designers and the end-users (see Fig. 1).



**Fig. 1.** Our framework for strengthening DSR with elements of co-creation and co-design (adapted from Johannesson and Perjons [26], p. 77)

### 3 Strengthening DSR

Figure 1 highlights our ideas regarding strengthening the DSR framework (design cycle) through accommodating co-creation and co-design. We build upon the DSR framework proposed by Johannesson and Perjons [26].

From the starting point of identification of the initial problem, co-creation and co-design play a prominent role in leading the design process. During the problem explication, end-users and researchers through exploratory group discussions elucidate the challenges encountered to which they would like to find a solution (practically, this is discussed within the scope of the specific goal of the project). In our case, in doing business effectively, for instance, lack of capital, lack of skills, and unreliable market were identified as hindrances. The identified challenges are then assessed through

brainstorming technological solutions to improve the situation from the perspective of the end-users. Following this, through the process of co-creation, user requirements of the practical implementation of the technological solutions are brought forward. The aim is to clearly identify what solution would provide a meaningfully contextualised artefact to tackle the problem under analysis. The end-users requirements are the cornerstone for the design and development of artefact. During the design and development of the solution artefact, there is a continuous iterative interaction with end-users through co-design workshops in order to pool together the collective creativity and to redefine the original problem and user requirements to fit the needs to satisfactory level. During the demonstration and evaluation, end-users use and give their feedback on the implemented artefact. This feedback is used for improvements or changes in the solution in order to meet the users' needs and to realise its full potential of intended usage.

Although several applications and adaptations of the DSR methodology have been proposed in the information systems research arena (see for instance [27] and [28]), our framework is intended to facilitate the successful implementation of the DSR methodology in the ICT4D realm, through the integration of co-creation and co-design to foster the meaningful contextualisation solutions.

## **4 Strengthened DSR Framework in Action**

In the implementation of DSR, the elements of co-creation and co-design are employed in order to put forward a meaningful intervention and to create acceptance of the design artefact by the end-users (i.e., women entrepreneurs, WEs, in rural Tanzania). Through this, we aim at increasing the potential value chain activities and efficiencies of the DSR methodology [25]. The processes of co-creation and co-design as described in Fig. 1 were implemented alongside WEs in the food processing business in rural Tanzania. One hundred and eighteen WEs and five customers participated in the study, distributed in the different stages of the DSR design cycle process.

### **4.1 Explicate Problem**

The problems that affects women entrepreneurs (WEs) in doing business were investigated and analysed through a co-creation strategy between the researchers, designer and WEs in order to ascribe a specific social problem. During this stage, 80 WEs participated, data were gathered through face-to-face informal interviews, focus group discussions and researchers' participation on the daily activities of the end-users in order to gain insights of the socio-cultural challenges and other issues that the WEs deal with in rural Tanzania. The co-creation activities involved participation of the end-users to elucidate their inner challenges in doing business. During these activities, several challenges that hinder business performance and expansion were highlighted, including lack of market information and lack of capital. As the use of mobile devices is becoming widespread even in rural areas, this pointed towards the need for a mobile technology application for empowering the WEs during their business development.

## 4.2 Define Requirements

Understanding end-users requirements is fundamental for devising solutions to the explicated problem in the form of an artefact. It involves transformation of the problem into an artefact with functions, structure and operating environment. During the fieldwork, 33 WEs participated and focused on problem clarifications and requirements definitions together with researchers in order to identify and represent opportunities and potential technological solution. During the co-creation process, data was collected through semi-structured interviews and exploratory focus group discussion using mockups and drawings to aid in defining the problem, the user requirements and a viable solution precisely. This process was continuous and iterative in order to refine ideas, until a consensus between researchers, developers and WEs was reached. The involvement of the end-users in requirements definition in this manner enabled to sketch a possible artefact that could address the problem of accessing market information, and boosted the artefact's acceptance from the onset.

## 4.3 Artefact Design and Development

The artefact was designed and developed fulfilling the end-users requirements that addressed the explicated problem (33 WEs were involved). The participants agreed that the most suitable artefact would be a mobile application that enable them to market their products (e.g., a virtual market). The users were invited to create suitable design interfaces for the application together with the researchers and developers. The main purpose of these activities was to produce prescriptive knowledge by designing and creating the artefact together. During the process of design and development, researchers, developers and WEs were fully involved in describing the artefact functionalities and structure; justifying the artefact components that address the identified requirements; and illustrating how the artefact and its components were to be used in its intended context of accessing or sharing market information (e.g., through storytelling the WEs described everyday scenarios where they could use the artefact at home while attending other tasks). The co-creation and co-design process enabled the sharing of swift feedback about the functionalities of the artefact through visualising its contextualisation in WEs everyday life environments and activities. In turn, this facilitated a continuous process of re-defining important user requirements and design corrections until reaching a satisfactory outcome taking into consideration a suitable balance between the available resources and the end-users' needs. With this, features such as audio descriptions and voice recording through the interface to make it accessible for less literate end-users were implemented.

## 4.4 Artefact Demonstration

The use of the artefact, the mobile application, was demonstrated to show its practical deployment in a real-life scenario with end-users. During the demonstration, a training workshop was arranged with five WEs and five of their customers to establish the mobile application usefulness. During the workshop, the participants learnt to open their mobile devices and browse; download the application; understand the functions of

different icons; operate the application by posting new products and viewing existing products within the virtual market. Participants were given two days to familiarise with the mobile application by themselves in their real-life settings to ascertain whether they understood how to use the application as well as its suitability to address the problem of accessing and sharing market information. The end-users had the opportunity to voice their concerns and questions regarding the application as part of the co-design process.

#### **4.5 Artefact Evaluation**

The mobile application was qualitatively evaluated through co-design group discussions in order to determine how well the application facilitated the access to market information and whether it fulfilled the requirements after a 21-day in-the-wild testing with five WEs and their 5 customers. The WEs reported that the mobile application performed well, allowing access to market information by fostering and facilitating the interaction between them and their customers. The application also helped them save resources in terms of time and costs of travelling to market, allowed easy access of data from all devices that connect to internet, linked them to customers, and helped them increase their market size through sharing the app within their network. However, WEs pointed out the challenge of airtime costs (bandwidth) as a hindrance to the use of the application, since many could not afford to have their phone consuming bandwidth at all times. The 2018 GSMA report for sub-Saharan Africa [29] shows insights on the current connectivity challenges of the region. Nevertheless, the report also indicates that future growth opportunities will be concentrated in rural areas. Moreover, since the number of mobile subscribers and service providers is increasing, the costs of airtime and handsets are expected to decline rapidly as to keep a competitive advantage in the free market economy. This could facilitate the wide intake and use of the proposed co-created solution.

## **5 Reflections and Future Work**

Integrating participatory design (PD) into a DSR framework for ICT4D is not trivial and does not come without its challenges. As reported in the literature, there are many reasons why PD faces opposition in research work, chiefly related to the costs and risks associated with PD implementation [23] – it is a resource-intensive, delicate process to bring in researchers, designers/developers and end-users together to develop innovative solutions to problems. In our work, we observed that the reluctance of participants to engage in group discussions, especially when they do not see an immediate incentive for their personal use, was challenging. In addition, if the participants or their communities have taken part in research projects before but they did not see how their voices were heard, how they influenced the process or how they made an impact, they could be discouraged to engage into a mutual solution-seeking endeavour like the one presented here. Although we encountered these challenges, through community leaders who are working at the grassroots level, e.g., church leaders, we could recruit WEs to participate in the study and build trust, a fundamental step in order to uncup the benefits of participatory design and foster the social acceptance of the solution. Through this

trust, WEs were in a position to voice their grievances in doing business and felt empowered as they could see that their input made a difference throughout the co-creation and co-design of a solution. The future work will explore the mid-term benefits of this approach through verifying the sense of ownership and acceptance of the co-created artefact.

## References

1. Smith, R., Turpin, M.: Design science research and activity theory in ICT4D: developing a socially relevant ICT platform for elderly women in remote rural South Africa. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) ICT4D 2017. IAICT, vol. 504, pp. 345–356. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_29](https://doi.org/10.1007/978-3-319-59111-7_29)
2. van Biljon, J., Marais, M.: Social mapping for communal sensemaking: the case of development informatics researchers in South Africa. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) ICT4D 2017. IAICT, vol. 504, pp. 280–291. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_24](https://doi.org/10.1007/978-3-319-59111-7_24)
3. Islam, M.S., Grönlund, Å.: Applying design science approach in ICT4D research. In: Helfert, M., Donnellan, B. (eds.) EDSS 2011. CCIS, vol. 286, pp. 132–143. Springer, Heidelberg (2012). [https://doi.org/10.1007/978-3-642-33681-2\\_11](https://doi.org/10.1007/978-3-642-33681-2_11)
4. Grobler, M., De Villiers, C.: Designing a more effective way of surface the information needs of people in developing communities. *Electron. J. Inf. Syst. Dev. Countries* **82**(1), 1–25 (2017)
5. Sanders, E.B.N., Stappers, P.J.: Co-creation and the new landscapes of design. *Co-design* **4**(1), 5–18 (2008)
6. Schuler, D., Namioka, A. (eds.): *Participatory Design: Principles and Practices*. CRC Press, Boca Raton (1993)
7. Muller, M.J., Kuhn, S.: Participatory design. *Commun. ACM* **36**(1), 24–28 (1993)
8. Pihlainen, K., Suero Montero, C., Kärnä, E.: Fostering parental co-development of technology for children with special needs informal learning activities. *Int. J. Child-Comput. Interact.* **11**, 17–27 (2017)
9. Mramba, N., Tulilahti, J., Apiola, M.: Bookkeeping for informal workers: co-creating with street traders. In: Parsons, J., Tuunanen, T., Venable, J., Donnellan, B., Helfert, M., Kenneally, J. (eds.) DESRIST 2016. LNCS, vol. 9661, pp. 97–113. Springer, Cham (2016). [https://doi.org/10.1007/978-3-319-39294-3\\_7](https://doi.org/10.1007/978-3-319-39294-3_7)
10. Liveri, J., Venable, J.R.: Action research and design science research—seemingly similar but decisively dissimilar. In: *ECIS Proceedings* (2009)
11. Hevner, A.R., Chatterjee, S.: *Design Research in Information Systems*. Springer, New York (2010). <https://doi.org/10.1007/978-1-4419-5653-8>
12. Baskerville, R., Baiyere, A., Gregor, S., Hevner, A., Rossi, M.: Design science research contributions: finding a balance between artifact and theory. *J. Assoc. Inf. Syst.* **19**(5), 358–376 (2018)
13. Lacerda, D.P., Antunes, J.A.V., Dresch, A.: *Design Science Research: A Method for Science and Technology Advancement*. Springer, Cham (2015). <https://doi.org/10.1007/978-3-319-07374-3>
14. Gregor, S., Hevner, A.R.: Positioning and presenting design science research for maximum impact. *MIS Q.* **37**(2), 337–355 (2013)
15. Hevner, A.R.: A three cycle view of design science research. *Scand. J. Inf. Syst.* **19**(2), 4 (2007)

16. Drechsler, A., Hevner, A.: A four-cycle model of IS design science research: capturing the dynamic nature of IS artifact design. In: 11th International Conference on Design Science Research in Information Systems and Technology (DESRIST), St. John, Canada (2016)
17. Johnson, R.R.: *User-Centered Technology: A Rhetorical Theory for Computers and other Mundane Aartefacts*. State University of New York Press, New York (1998)
18. Abras, C., Maloney-Krichmar, D., Preece, J.: User-centered design. *Enycl. Hum.-Comput. Interact.* **37**(4), 445–456 (2004)
19. Sanders, E.B.N.: From user-centered to participatory design approaches. In: *Design and the Social Sciences* (2003)
20. Cova, B., Dall'i, D.: Working consumers: the next step in marketing theory. *Mark. Theory* **9** (3), 315–339 (2009)
21. Neuhofer, B.: Innovation through co-creation: towards an understanding of technology-facilitated co-creation processes in tourism. In: Egger, R., Gula, I., Walcher, D. (eds.) *Open Tourism*, pp. 17–33. Springer, Berlin (2016). [https://doi.org/10.1007/978-3-642-54089-9\\_2](https://doi.org/10.1007/978-3-642-54089-9_2)
22. Ramaswamy, V., Ozcan, K.: What is co-creation? An interactional creation framework and its implications for value creation. *J. Bus. Res.* **84**, 196–205 (2018)
23. Goodyear-Smith, F., Jackson, C., Greenhalgh, T.: Co-design and implementation research: challenges and solutions for ethics committees. *BMC Med. Ethics* **16**(1), 78 (2015)
24. Steen, M., Manschot, M., De Koning, N.: Benefits of co-design in service design projects. *Int. J. Des.* **5**(2), 53–60 (2011)
25. Frow, P., Nenonen, S., Payne, A., Storbacka, K.: Managing co-creation design: a strategic approach to innovation. *Br. J. Manag.* **26**(3), 463–483 (2015)
26. Johannesson, P., Perjons, E.: *An Introduction to Design Science Research*. Springer, Cham (2014). <https://doi.org/10.1007/978-3-319-10632-8>
27. Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S.: A design science research methodology for information systems research. *J. Manag. Inf. Syst.* **24**(3), 45–77 (2007)
28. Vaishnavi, V.K., Kuechler, W.: *Design Science Research Methods and Patterns: Innovating Information and Communication Technology*. CRC Press, Boca Raton (2015)
29. Global System for Mobile Communications Association: *The Mobile Economy - Sub-Saharan Africa*. GSM Association (2018)



# Institutional Shaping of Affordances: Implications on Information Use in Global Humanitarian Organizations

Marta Maria Vila-Pozo<sup>1,2</sup>  and Sundeep Sahay<sup>1,3</sup> 

<sup>1</sup> Department of Informatics, University of Oslo,  
Gaustadalléen 23B, 0373 Oslo, Norway  
martavila@gmail.com

<sup>2</sup> MSF Spain, Nou de la Rambla 26, Barcelona, Spain

<sup>3</sup> HISP India, Noida, India

**Abstract.** To support global humanitarian organizations in carrying out interventions in project sites, information is needed that is situationally relevant and timely, while also being relevant to the HQs. The macro-level formal institutional conditions of the HQ and informal constraints at the project sites shape the design and content of Humanitarian Health Management Information Systems (HHMIS), and we focus in the paper on the aspect of information use. We use an ensemble view of the HHMIS, comprising of paper, the computerized system based on DHIS2, and other tools like Excel, to understand how these different components have varying affordances and are influenced differently by the formal and informal institutional conditions. Our theoretical perspective is thus shaped by the notion of “institutional affordances” which we draw upon to understand the affordance actualization of the HHMIS. We identify through our empirical analysis based on a project site in South Sudan, three key affordances relevant to the use of data – operationability, accountability and contextuality. Our analysis makes two key contributions: One, the different affordances of the components in the ensemble have interaction effects, sometimes positively influencing actualization and at other times is limiting. Two, we identify 4 sets of institutional (both formal and informal) influences on actualization coming from availability of information, existing maturity in the use of information, unique features of the humanitarian setting and technical features. We believe this paper makes an overall contribution in helping to situate the informational challenges faced by humanitarian organizations more firmly in the ICT4D agenda.

**Keywords:** Institutional logics · Affordances ·  
Health management information system · Humanitarian organizations

## 1 Introduction

In humanitarian interventions, information is needed that is situationally relevant, timely, and at a level of detail to understand the current health status of the people affected, their locations, associated risks and resource needs [1].



While humanitarian organizations are making systematic efforts to strengthen their supporting health management information systems, these benefits have not materialized in practice [2]. To understand why is the case and what can be done about it, this paper addresses the following specific research question: *How do constraining and enabling institutional influences shape the actualization of HMIS affordances within the context of global medical humanitarian organization?*

Our empirical site is the Doctors Without Borders Spain/Médecins sans Frontières Spain (MSF-E). We adopt an “institutionalized affordance” approach to analyse how and why are Humanitarian HMIS (HHMIS) contributing to strengthening MSF’s interventions in South Sudan.

In the next section, we discuss our theoretical framework drawing from institutional and affordance theories and develop a synthesized analytical framework. Section 3 describes research methods and Sects. 4 and 5, we present our case analysis and discussions respectively, followed by a brief future work plan in Sect. 6.

## 2 Relevant Literature

This section includes 4 sub-sections. The first describes our conceptualization of the HHIMS. In the second, we discuss affordance, and conceptualize HHIMS from this perspective. In the third, we discuss the influence of institutional conditions on affordances. Finally, we present our analytical framework.

### 2.1 Conceptualizing HHIMS: An Ensemble Perspective

Orlikowski and Iacono [3] describe an ensemble view of the IT artefact to include the “ensemble of equipment, techniques, applications, and people that define a social context, including the history of commitments in making up that ensemble, the infrastructure that supports its development and use, and the social relations and processes that make up the terrain in which people use it (p. 122)”. The HHMIS under study similarly represents an ensemble including multiple inter-connected components of both paper and a recently introduced technology platform, and the work practices around both of them. An ensemble view helps to capture the different techno-social aspects associated with the overall system and their inter-linkages.

### 2.2 An Affordance Perspective Around an Ensemble View of Technology

Drawing from ecological psychology, Gibson [4] describes affordance as how a goal-directed actor perceives an object in terms of how it can be used without a cognitive analysis. Affordances reflect a relational property emerging from the animal-environment system [5] with a key focus on the relationships [6] between the users and the technology [7].

Affordance Actualization (AA) theory [8] describes affordance as “the potential for behaviours associated with achieving an immediate concrete outcome and arising from the relation between an artefact and a goal-oriented actor (p. 69)”. AA theory is relevant to our analysis of how the HHMIS strengthens or not the use of information

[9]. From an ensemble view, emphasizes how different components of the HHMIS responds to specific needs of users in varying ways, representing a multiplicity of affordances. Actualization of affordances is shaped by various conversion factors [10], such as personal, social and environmental. We conceptualize these as institutional conditions. We adopt an expanded form of AA by emphasizing a multiplicity of interacting affordances which are shaped by different institutional conditions. Understanding the institutional-affordance linkages is the focus of our analysis.

### **2.3 An Institutionalized Perspective on Affordances**

Institutional theory is relevant to understand the implementation dynamics of health information systems in developing countries [11] by understanding the nature of institutions and their influences [12]. Concepts of the organizational field [13, 14] and institutional logics [15] inscribe the organizing principles that guide individual behaviour [16]. Institutional logics are multiple and could be simultaneously in play and not in synch, often contributing to institutional contradictions [16]. Piotti et al. [17] also include the role of ICT and formal rules and informal practices surrounding their use.

The ensemble perspective allows to discern the formal and informal practices surrounding the sub-components of the system, and their enabling and constraining conditions. The organizational field perspective helps to understand the different influences and how they interact and sometimes create contradictions.

### **2.4 Proposed Analytical Framework**

We conceptualize the HHMIS as an institutionally ensembled system comprised of ICTs, paper, associated protocols in use, infrastructural limitations and existing work practices of users. The affordance perspective helps to analyse the relationships between different components of the system for interaction effects with users, to understand to what extent they are able to make expected use of it - to actualize the affordances. This framework helps us to analyse the relation between institutional conditions, affordances, and their actualization and trajectory.

## **3 Research Methods**

### **3.1 Case Context**

Médecins Sans Frontières (MSF) is an international, non-profit, self-governed, member-based organisation that delivers emergency aid to people affected by armed conflict, health epidemics and natural disasters [18]. Our research focuses on the operational directorate of MSF Spain, who during 2017 worked in 25 countries, with 43% of emergency interventions and 57% long-term missions [19]. Specifically, we analysed MSF's HHMIS implementation in their South Sudan Mission (SSM), including coordination office in Juba, two projects in the Greater Upper Nile Region, north of the country. The first project runs 2 hospitals, 4 mobile clinics and community

health promotion activities. The second project runs 1 hospital, 2 mobile clinics and community health promotion activities. The HHMIS project was launched in MSF headquarters in 2013 and was deployed in South Sudan in 2015.

### 3.2 Data Collection

Our research covered two sets of data collection methods: one, at MSF Spain HQ where the HHMIS was first designed. This helped to understand the HQ's institutional influences on projects. The second concerns the field site in SSM to understand how micro-level dynamics around affordances are shaped and actualized.

#### Headquarters

This research builds upon 4 years exploratory period (2013–2017) in which the first author was leader of the MSF Spain HHMIS team. She later left MSF to start a PhD programme in 2017 under a formal research agreement between MSF and the University of Oslo. For this reason, she is positioned as an “insider” researcher [20] and the second author an “outsider”, collaborating on analysis, interpretations and theory development. Moving from insider to researcher helped in developing sharper insights of the HHMIS phenomenon [21]. Between July 2017 and February 2018, she made 3 visits to the HQ for data collection, in addition to regular emails and skype calls.

#### Field Engagement

Field engagement included a visit to the South Sudan Mission in February 2018. In MSF interventions, each country has a mission, with an office which coordinates the different projects in the country (usually 2–5). Projects have sub-offices which manage health facilities.

Data was collected primarily through interviews, observant participation, and informal conversations with staff. Some interviews were conducted in Spanish and others in English. As the first author is a native Spanish speaker, she experienced no problems in switching between these two languages. A semi-structured protocol guided the 22 interviews conducted, including of field staff (21) and medical profiles (20). Interviews ranged from 15 min to an hour, and they were recorded after obtaining explicit consent from the respondents.

Participant observation was ongoing and integrated with project activities like coordination and weekly medical meetings. Visits were made to 3 hospitals and 2 facilities to observe the data collection flow and have informal discussions with staff about their experiences. Notes were made of each interaction. All the recordings and notes were subsequently transcribed, and the raw data was ordered and made ready for analysis.

### 3.3 Data Analysis

Data analysis involved both qualitative and quantitative methods. Qualitative analysis involved a process of iterative coding, while quantitative analysis included aggregating the frequency of codes and ranking them to interpret their salience. The most salient codes were then interpretively analysed to understand their underlying meanings.

Interviews were transcribed by the first author, and then shared with the second author. Both then independently read the transcripts and developed first level codes to help answer the research questions. Following this, both had face to face discussions to discuss the respective codes and resolve disagreements, which were limited. A total of 408 raw codes were identified, such as difficulty to find information, lack of time, data used for accountability, data quality problems and the predominant use of paper. For example, quotes leading to the code “Data is highly valued” were: “*data is important because we care about results*”, “*Having access to HHMIS makes us autonomous*”, “*use of HHMIS should be available for all staff*”. After this followed a second-round of higher-level analysis in which codes were combined and grouped in more generic themes, such as different use of data, perceptions of data, challenges in work practices, challenges in the use of the system. Example in the development of a theme: **Theme:** Mature use of information and good perception of data. **Codes:** Data highly valued, Use of heuristics, Collaborative analytical process.

The developed themes provided the analysis basis for a third level of analysis, were they were linked to predefined theoretical concepts of affordances and institutions. 75 of the 408 codes were classified as affordances (18.5%), 162 as institutional conditions (39.7%), 162 as resulting influences (39.7%). Remaining 9 codes were not matched.

## 4 Case Study and Analysis

We present an analysis of affordances, followed by a description of relevant institutional conditions. Next, we present our analysis of the impact of institutional conditions on affordances actualization.

### 4.1 Affordances and Their Actualization

Affordances refers to the relation between the users and the system and their capacity to use it to support their everyday actions, in our case related to the use of information. Within an ensemble perspective, we focused on both the paper and computer-based components of the HHIMS, their interactions and implications on actualization. The 3 most important affordances identified were: operationability (62.7% salience), accountability (12%) and contextuability (8%). These contributed to 82% of overall salience.

#### Operationability

Drawing from MSF’s use of the term operational as related to the field intervention, we describe operationability as “*the possibility to use data to follow up trends and identify alerts for constant response and adaptation of activities*”.

Respondents, both the medical and management staff, saw this affordance as significant given that they were operating in a dynamic environment requiring constant follow up of day-to-day project management and organizing of health service delivery at the facilities, including decisions related to logistics, budget, capacity building and human resources.

Predominantly, staff saw paper-based data to be more operationally useful than computers, and they reverted to the paper clinical files to routinely provide patient care. To analyse trends and incidence of diseases, most doctors would directly use data from the paper forms or their own personal note books and diaries. They saw HHMIS data as not always available or sufficient: *“I don’t have the information in HHMIS to follow up the community health workers, I have made my own records”*. Another doctor said: *“I do check my data, but I do it at data entry for current data. I do not build charts or follow trends (...) paper is always there”*. The higher-level follow-up from the mission coordination office was based on HHMIS data and through email communication. Access to the paper records was not possible there, and so its use was not an option.

### **Accountability**

We describe accountability as *“the possibility of data to be accountable for day to day activities and operational decisions”*. This was especially relevant for mid-range coordination positions, and for reporting and justifying operational decisions cross different levels by both medical and management staff. At the health facility, the laboratory technician and the medical officers were aware of the importance of having their work reflected in numerical values, for example: *“you need your data to prove your work to others”*, *“if I have empty records, means that that day I have not worked.”*

The clinical officers at the facility always interacted with paper, which was their primary source for accountability, as they did not have access to the system. For expatriates and higher-level positions, the HHMIS was used when information was available to generate their reports. When unavailable, they used parallel tools (like Excel) that allowed for sharing reports to higher levels as a temporary solution. However, they were conscious of the importance of having data in the “official” channel. We saw a nurse to be collecting data on the number of deliveries in paper. She had asked for a maternity service in the system, which was not offered at that moment in the facility. She realized only when data on deliveries went through the HHMIS would her request for a maternity service be heard by the higher ups.

### **Contextuability**

We describe contextuability as *“the possibility to know and analyse context when you are new to the situation”*. This was relevant when users needed access to medical data from the previous periods when they were new in a project or mission. When new staff arrived to the project, they requested access to HHMIS to follow up data on daily basis: *“when I just came to the project, data was my daily bread”*. This prior data helped them understand the context and how to readjust their interpretation of data. A very descriptive example of this was: *“Now when I arrive to DRC, with the same population, the number of malaria cases is 200 per week, and for me that was a normal situation... and the Medical Coordinator was surprised of why was I not raising an alarm... because was increasing... 200, 250, 300... but for me was normal... I was actually focussing on Cholera, because in my country (Niger) one case of cholera is an outbreak and we had 10 cases, and no one was talking about it... so I was like... what happens here?”*.

## 4.2 Institutional Conditions and Their Influences

We identified 4 institutional conditions reflecting pre-existing aspects which influence the interaction of the users with the HHIMS: (i) mature use of information and positive perception of data (29.6% salience); (ii) limitations of information available (24.7%); (iii) humanitarian setting characteristics (20.4%); and, (iv) technical features (16.7%). Together, they comprised more than 90% of the total salience. These are now discussed.

### Mature Use of Information and Positive Perception of Data

Most users perceived the important role of data in shaping their everyday work and the overall effectiveness of the project and of the HQ. Despite the limitations of existing data and systems, the value of data was universally recognized. Some illustrative quote: *“data is important because we care about results”, “Having access to HMIS makes us autonomous” “use of HMIS should be available for all staff”*.

The medical teams had weekly meetings where they discussed service by service important events of the week, and the underlying reasons. There was a generalized use of heuristics and experience-based knowledge to analyse data and follow up on particular diagnosis. A doctor said: *“Numbers tell me the workload of staff and the treatments that I could need based on diagnosis. If there have been many diarrhoeas, I know I will need ORS (...) I also see if treatment consumption matches diagnosis.”*

The mature use of information and positive perception towards data was an enabling condition for affordances actualization and promoted the use of the paper and parallel tools to predominate over the use of the new technical solution. For example, to enable operationability, in weekly meeting all doctors had the numbers that they wanted to share in their notebooks, copied from the manual system. For accountability, they used the parallel excel files to show their numbers. For contextuability, they complemented the computer system data with a printed version of the past reports. Overall, we see a positive affordance actualization of the ensemble system.

### Limitations of Unavailable Information

The institutional condition of unavailable information is related to the technological component of the HHMIS, specifically its configuration in terms of content, metadata and logic. The system is configured to collect certain data points from each health service and calculate a set of indicators. This configuration is standard for all interventions, across settings, and often is inadequate to cater to local specificities.

The available data was described by the user as, paradoxically, extensive and limited at the same time: *“there is a huge amount of data collected in HHMIS that is not used”, “too much data, but yet important data not collected”*. While users recognise the value of using standard systems, they also see their limitations *“using standard systems is needed but it will not work for those in the extremes”*.

Having limited information available affected negatively the actualization of all three affordances. In the case of operationability and accountability users had to find alternative ways to collect and manage their data, such as through paper or parallel tools. For contextuability, the lack of information limited actualization of the affordance and users tried to find alternative sources of information, but since data is studied retrospectively, it did not result in the creation of parallel channels.

Paper and parallel tools are components of the ensemble system, and it is planned for the technical component to gradually replace them. Paper is inherently limiting to the quality of data as it leads to data loss and impedes the creation of historical trends. Use of parallel tools also creates multiple flows and potential duplications. In the long run, the use of paper and parallel tools negatively impacts user's motivation for data tasks: *"time dedicated to data collection does not compensate if you don't use data"*.

### **Humanitarian Setting Characteristics**

The atmosphere in the project office is of intense activity. The working day is long and there is no clear distinction between work and personal spaces as also the project office and residences are co-located. In addition, medical staff are on call at night and on weekends. In the interview records, there was always a lot of background noise, with sounds of radios and walkie-talkies, and many interviews were frequently interrupted. All users talked about the lack of time: *"I don't have time to sit and look at data"*.

There is also a high staff turnover, the average time an expatriate medical staff in one field location was 2 to 12 months. Since field staff are working with sustained high intensity, they find difficult to be responsible for teaching newcomers. One field staff said: *"high intensity makes you rely on the ones who know instead of teaching the newcomers"*. Users do not find the time to train themselves: *"Paper is always there, and you don't need to learn"*. And the same is the case with Excel files.

The institutional conditions of the humanitarian setting tend to be restrictive to the actualization of all affordances as users are unable to dedicate quality time for learning, and their transitory mindset makes them rely on shortcuts and local improvisations.

### **Technical Features**

Institutional conditions inscribed in technology were both enabling and constraining. While the technical system is centralized and web-based on the District Health Information System platform [22], the architecture includes offline servers which store all collected data from each project and synchronize with the central instance when internet is available. Having data integrated from the field, directly into one centralised system contributes to the actualization of operability and accountability, specially at coordination level, where data is available almost in real time. It also improves data quality in contrast with other means of data collection.

The centralized offline-online architecture enables data to be entered and modified only from the field project, which was not the case before. This improves data ownership by field users, which will have a positive influence in the long term. On the other hand, offline deployment limits content updates to once a year, contributing to a perceived rigidity and complexity which constrains the actualization of operability at the project level and limits availability of data.

Regarding the user experience, all users without exception were able to enter data, but only a few could use the analytic tools for generating charts or tables, generally the ones in management positions. It was common practice to extract data from the HHMIS as a simple table, and then create more elaborate tables or charts in Excel, because *"I already know it"*. The complex user interface of DHIS2 prompted users to use Excel.

### 4.3 Summarizing Analysis

The paper sought to answer the research question: *How do constraining and enabling institutional influences shape the actualization of HMIS affordances within the context of a global medical humanitarian organization?*

Firstly, we have identified through our empirical analysis three key affordances relevant to the use of data – operationability, accountability and contextuality. Operationability refers to the ability to work with data in routine use, accountability concerns the ability to show the value of a user’s work to the higher levels, and contextuality reflects the ability to get historical data to guide current use of data in an unknown environment. All these affordances are particularly relevant to a humanitarian setting given the high importance of data, the challenge of people in the field in isolated settings to make their work visible to the coordination levels, and the dynamic nature of the humanitarian setting where it is challenging to access historical data.

Secondly, while we find the actualization of affordances to be shaped to different degrees by the features of the paper and the computer-based system, our ensemble view also helps to understand how these individual affordances interact with each other. For example, with respect to operationability, paper allows the affordance of quick local availability of data found in local diaries of the staff, which enables the use of data combined with experiential knowledge of the staff. With respect to the same operationability, the HHMIS designed with an integrated database helps build perceptions of sounder data quality, which encourages data use. These individual affordances have interaction effects. In some cases, the easy access to paper-based data discourages users from using the computer-based system, in other cases the paper printouts are used in conjunction with the computer reports of aggregate data.

Thirdly, we have identified four key institutional influences on the actualization of affordances towards data use. These are an existing maturity in the use of information, limited availability of information, the unique features of the humanitarian setting, and the technical features. While some of these conditions, such as technical features of the system can be seen as formal institutions defined by the HQ for the project level, others such as the hectic nature of the humanitarian setting resulting in high staff turnover can be seen as informal institutional constraints. These formal and informal institutions are not isolated, they influence each other enabling and constraining the actualization of affordances. For example, the centrally defined technical architecture is enabling as it is seen as heightening accountability. The same architecture, for operationability, is seen to be rigid and difficult to change which then encourages the use of paper to fill the gaps. A summary of the impact of institutional influences in the actualization of affordances can be found in the table below (Table 1).



**Table 1.** Institutional influences in affordances actualization

Operationability	Accountability	Contextuability
<i>Information limitations</i>		
Constraining: increases use of paper and parallel tools	Constraining: increases use parallel tools	Constraining: limits retrospective analysis
<i>Mature use of data</i>		
Enabling: origin, fuel of all affordances. Results in the use of paper or parallel tools which makes benefits of new system explicit		Enabling: origin, fuel of all affordances
<i>Humanitarian setting</i>		
Constraining: impacts the actualization of all affordances as results in the combination of a continuous loss of capacities with lack of time for training		
<i>Technical features</i>		
Enabling: increases data quality, enables for integrated analysis, enhances ownership of data, and gives almost real time access to information Constraining: rigid data model, complex analytic tools		Enabling: increases data quality, enables for integrated and retrospective analysis Constraining: complex analytic tools

## 5 Discussion

Humanitarian organization settings by principle are complex because of them having to intervene in dynamic and unstable situations, where project locations are in environments which are remote, politically charged and having sub-optimal infrastructure. For these very reasons, they need robust information support to guide their interventions, especially related to using information for local action. This as our case study has described is a non-trivial challenge.

We have examined these challenges from the lens of “institutional affordances.” Our point of departure and contribution is primarily twofold. One, we have conceptualized the artefact from an “ensemble” view to highlight the artefact is not one monolithic entity but comprised of different components, in our case including the technology, the paper-based records, parallel tools like Excel, and the idiosyncrasy of the humanitarian environment. These components have varying affordances, they are differently influenced by the institutional conditions and have interaction effects – enabling or constraining, which shape the overall actualization of the affordances. Two, we have examined the institutional influences on affordance actualization both with respect to the formal rules of the game (such as the HQ defined technical configuration and metadata) and informal constraints (such as the work practices or the hectic and unstable environment of a humanitarian setting). These influences are also enabling in some cases and constraining in others.

Arguably, our paper makes some notable contributions to the important and emerging field of humanitarian assistance, and the role which ICTs can play in this domain. Till date, the study of humanitarian systems has received scant attention in IS

research. And as Walsham [23] has argued, this represents an important domain for ICT4D research and strengthens our quest to make a better world with ICTs.

## 6 Conclusion and Future Work

What we have presented in this paper is part of a larger and ongoing work at MSF Spain, where the commitment is to make a real difference in data use for project settings through the use of ICTs. In future, we seek to explore the potential of using mobile devices to bring the technology closer to the user to improve data collection processes. We will be guided by our understanding of institutional affordances to examine how data can be got “closer” to end users, and by supporting local action taking will enhance affordance actualization. The mobile technology will be introduced and analysed as a component of the ensemble system, including the evolution of the trajectory of affordances over time.

The paper contributes to the conference theme by examining how the current north-south (HQ-mission) networks are problematic. The institutional affordance lens helps to understand these challenges and identify approaches to address them. These solutions can subsequently be taken to other projects and missions, and effectively implemented to south-south driven collaborations.

**Acknowledgments.** We would like to explicitly express our recognition to the headquarters and field staff who are working to provide quality medical care to population in the most remote and inhospitable settings. We are deeply grateful and appreciate the efforts made by Cristian Casademont, Alejandro Casado, Martha Kihara, Conor Prenderville and Maria Jose Sagrado, and make this field visit possible, and the time dedicated from field staff from their spare time to contribute to this research project.

## References

1. Thieren, M.: Health information systems in humanitarian emergencies. *Bull. World Health Organ.* **83**(8), 584–589 (2005)
2. ALNAP: The State of the Humanitarian System. ALNAP, London (2015)
3. Orlikowski, W.J., Iacono, C.S.: Research commentary: desperately seeking the “IT” in IT research - a call to theorizing the IT artifact. *Inf. Syst. Res.* **12**(2), 121–134 (2001)
4. Gibson, J.J.: *The Ecological Approach to Visual Perception*. Houghton Mifflin, Boston (1979)
5. Stoffregen, T.: Affordances as properties of the animal-environment system. *Ecol. Psychol.* **15**(2), 115–134 (2003)
6. Chemero, A.: An outline of a theory of affordances. *Ecol. Psychol.* **15**(2), 181–195 (2003)
7. Chemero, A., Turvey, M.: Complexity, hypersets, and the ecological approach to perception-action. *Biol. Theory* **2**, 1–14 (2007)
8. Strong, D.M., et al.: A theory of organization-EHR affordance actualization. *J. Assoc. Inf. Syst.* **15**(2), 56–85 (2014)
9. Lanamäki, A., Thapa, D., Stendal, K.: When is an affordance? Outlining four stances. In: Introna, L., Kavanagh, D., Kelly, S., Orlikowski, W., Scott, S. (eds.) *IS&O 2016. IFIPAICT*, vol. 489, pp. 125–139. Springer, Cham (2016). [https://doi.org/10.1007/978-3-319-49733-4\\_8](https://doi.org/10.1007/978-3-319-49733-4_8)

10. Hausvik, G., Thapa, D.: What you see is not what you get” - challenges in actualization of EHR affordances. In: International Conference on Information Systems Proceedings, Seoul (2016)
11. Sahay, S., Mekonnen, S.M., Gizaw, A.A., Sæbø, J.I.: Interplay of institutional logics and implications for deinstitutionalization. *Inf. Technol. Int. Dev.* **6**, 1–19 (2010)
12. North, D.C.: *Institutions, Institutional Change and Economic Performance*. Cambridge University Press, Cambridge (1990)
13. Powell, W.W., DiMaggio, P.: The iron cage revisited: institutional isomorphism and collective rationality in organizational fields. *Am. Sociol. Rev.* **48**, 147–160 (1983)
14. Orlikowski, W.J., Barley, S.R.: Technology and institutions: what can research on information technology and research on organizations learn from each other? *MIS Q.* **25** (2), 145–165 (2001)
15. Alford, R.R., Friedland, R.: *Powers of Theory: Capitalism, the State and Democracy*. Cambridge University Press, Cambridge (1995)
16. Alford, R.R., Friedland, R.: Bringing society back in: symbols, practices, and institutional contradictions. In: *The New Institutionalism in Organizational Analysis*, pp. 232–263 (1991)
17. Piotti, B., Chilundo, B., Sahay, S.: An institutional perspective on health sector reforms and the process of reframing health information systems. *J. Appl. Behav. Sci.* **42**(1), 91–109 (2006)
18. MSF Web site: About us. <https://www.msf.org>. Accessed 17 Oct 2018
19. MSF-Spain: MSF Spain Annual Report 2017. MSF Spain, Barcelona (2018)
20. Walsham, G.: Interpretive case studies in IS research: nature and method. *Eur. J. Inf. Syst. Proc.* **4**(2), 74–81 (1995)
21. Vila-Pozo, M.M., Sahay, S.: Humanitarian health information systems: different challenges and responses. In: *European Conference on Information Systems Proceedings* (2018)
22. DHIS2: Health Information Systems Programme (HISP) - University of Oslo. <https://www.dhis2.org/>. Accessed 17 Oct 2018
23. Walsham, G.: Are we making a better world with ICTs? Reflections on a future agenda for the IS field. *J. Inf. Technol.* **27**, 87–93 (2012)



# Towards Holistic Mobile Climate Services for Farmers in Tambuu, Tanzania

Ville Myllynpää<sup>1</sup>(✉), Ezra Misaki<sup>2</sup>, Mikko Apiola<sup>1</sup>,  
Jaakko Helminen<sup>1</sup>, Moammar Dayoub<sup>1</sup>, Tomi Westerlund<sup>1</sup>,  
and Erkki Sutinen<sup>1</sup>

<sup>1</sup> University of Turku, Turku, Finland

{ville.myllynpaa,mikko.apiola,jaakko.a.helminen,  
moammar.dayoub,tomi.westerlund,erkki.sutinen}@utu.fi

<sup>2</sup> College of Business Education (CBE), Dar es Salaam, Tanzania

e.misaki@cbe.ac.tz

**Abstract.** Climate change and changing climate variability are pressing problems that need urgent solutions, now! Climate change has global consequences, and is already being experienced, mainly by the most vulnerable groups of people in the global south. Research shows that farming activities in the global south are being complicated by added uncertainties in weather. To mitigate the effect of weather uncertainties, there is a need for holistic mobile climate services. We have taken the first step towards the service by finding out the local information needs and current mobile usage patterns in Tambuu village, Tanzania. The results show that climate change is already complicating farmers' lives and therefore they have urgent need for information on how to prepare and adapt to changing conditions. From the technology perspective, the domination of voice calls and short messages in the current mobile usage limits the adoption of new services. However, modern uses of smart devices for farming activities were also found. Building on this ground, we propose designing climate service prototypes together with local farmers and other relevant stakeholders.

**Keywords:** Climate services · Climate change · Small scale agriculture · Mobile technology

## 1 Introduction

Climate change is one of the most serious problems of the world today. It may cause uncontrolled sequences of fatal harms, and it directly threatens the future existence of humankind. The negative effects of climate change are already being experienced globally, but particularly in the Global South, mainly by the most vulnerable groups of people. Climate change and related change in climate variability already has a significant negative impact to small scale farming [5, 11, 14, 19]. This is important because small scale farming produces 70% of the world's food, and generates income and employment for a large number of people [13].

In dealing with climate change, two main tracks of response can be identified; The first and more important is preventing climate change from happening, to the maximum

possible extent. The second is to determine actions that need to be taken in order to adapt to changing climate conditions. This paper reports the first stage of a project, which designs and develops climate services that assist smallholder farmers in adapting to climate change and will help steer their development in a sustainable direction. In the first phase, the priorities and concerns are examined in a Tambuu community. This paper concentrates on answering two questions: What are the acute information needs of the Tambuu community? What are the current mobile usage patterns of farmers in Tambuu community? Regarding the first question, it is essential to determine the priorities of the Tambuu community. The second question is needed to design future mobile technology use cases.

**Characteristics of Tambuu.** Tambuu village is located in Lundi ward, Matombo division, Morogoro district, in Morogoro region. Tambuu community is engaged mainly in farming related activities. The major farming activities include crop production; maize, rice, cassava, banana, sesame, potato, peas, pepper, cloves and oranges, among others. Tambuu and other villages in Matombo division, to some extent, feeds also the residents of Morogoro and some parts of Dar es Salaam region. According to the village chairman report, Tambuu village has a total population of 2,684. Morogoro region had a total population 2,218,492 in 2013, with a total land area of 70,624 km<sup>2</sup>.

**Project Collaborators.** This project is implemented in collaboration between University of Turku (UTU), Turku, Finland; Sokoine University of Agriculture (SUA), Morogoro, Tanzania; College of Business Education (CBE), Dar es Salaam, Tanzania; and an NGO called Tanganyika Christian Refugee Service (TCRS), Tanzania<sup>1</sup>. All of the above mentioned Higher Education Institutes share a common research interest towards various aspects of the mobile applications for agriculture (ICT4Ag). TCRS is working on education of local villages and steering their development in a sustainable direction by building wells and houses among other things. The Tambuu village is one of the focus villages of TCRS, which means that TCRS prioritizes many of its development activities to Tambuu. However, the need for help and assistance is always initiated by people of Tambuu.

## 2 Background and Related Research

Climate services can be defined as a set of tools which provide climate knowledge from information producers (e.g. meteorological agencies) to end users (e.g. farmers). With the help of the climate services, end users can make better informed decisions and actions based on climate information, which often also includes expert advices on how to react to that information [22]. Crucial success factors for climate services can be defined as follows: understanding end-users demands, bringing climate forecaster closer to sector experts, co-producing the information to match user needs, reaching the last mile, and continuous assessment and re-assessment [22]. Climate services have many possible target sectors, such as agriculture, health, and disaster reduction. In

<sup>1</sup> <http://www.tcrs.or.tz>.

designing climate services, one needs to pay attention to seamless and timely information flow between information providers and end users. This requires streamlining the traditional way on how information flows between different parties, since weather forecasts may take weeks to pass through various actors, such as meteorological agencies, regional experts, and district councils until reaching the end user [25].

We can utilize learning's about the suitable content for climate services from many current climate service projects that have been launched, for instance, in Kenya, Uganda and Tanzania. In Tanzania, a project operating under the Global Framework of Climate Services was using participatory methods to train intermediates, which would spread climate information to rural farmers<sup>2</sup>. In Uganda, a project called Climate Change Adaptation and ICT (CHAI) reached 120 000 farmers, which receive weather forecasts and locally tailored agricultural advises by SMS. CHAI uses various technologies to collect weather data from 22 sub-country weather station<sup>3</sup>. The results of another project in Kenya revealed that farmers who received climate information were better in crop management and got higher yields, as compared to farmers in the control group [20].

Other relevant studies about information needs of the farmers especially in Tanzania are [3, 6, 12]. Bernard et al. studied the information needs of the rice farmers in Kilombero interviewing in total 80 people in four villages [3]. Lwoga et al. studied the information needs of the rice farmers in seven districts, interviewing in total 181 farmers [12]. Coulibaly et al. presented in [6] climate information needs of the farmers in the Longido and Kiteto districts based on interviewing in total of 360 households. A relevant study to comprehend local needs, understanding of climate change and availability of different information sources in Tanzania is the latest Afrobarometer [21], which interviewed 2400 Tanzanians in May 2017. Out of the 2400 interviewees, 2/3 were rural residents, out of which 71% where farmers and 5% were from Morogoro region.

### 3 Methods and Data

There is a constant change in crucial systems such as cultivation practices, agricultural education, technologies in the local communities, climate, and climate variability. Therefore, to address the growing need for resilience and agility in development work, we use the System Action Design Research framework (SADR) and Epistemic Implementation Delphi model (EID) [8] in project implementation. SADR is an extension to Design Science Research (DSR) [10, 16]. EID is a scientific model for project implementation that is based on building a mutual agreement between stakeholders [8]. DSR is different from “routine design”, where existing knowledge is applied to solve problems by using “best practice” knowledge and theory [9]. In SADR and EID, rigorous research methodology is brought to back up the design process in situations, where the end-user demands, contextual and sociocultural factors, and

<sup>2</sup> <https://www.wfp.org/stories/climate-services-farmers>.

<sup>3</sup> <https://www.fhi360.org/projects/climate-change-adaptation-and-ict-chai>.

many other important issues in the design process are not understood well enough to use a linear design process [8]. SADR and EID are specifically designed to fit well into the developing country contexts [8].

### 3.1 Data Collection Protocol

The data was collected in a two-week period in April 2018. The actual interviews took place in three different days during which the researchers interacted with farmers in the Tambuu village. The first two days were dedicated to qualitative data collection. In total, 17 farmers participated in the research. From these 17, deep interviews were arranged with a total of 13 farmers (6 males, 7 females).

The recruitment of interviewees was done with the help of our local NGO cooperation partner TCRS, which has been operating in the Tambuu village for nearly a decade, and therefore have good connections to village elders/leaders and local farmers. TCRS selected suitable farmers to participate in the project. We requested that half of the interviewees would be women and half men, and that they would also represent different ages, education and mobile literacy levels. TCRS also ensured that interviewees were present on the right day in the village house, where we conducted the interviews. This selection process naturally affected the final outcomes of the interviews, and therefore full range of views and ideas of the local farmers might not be reflected in the results. However, we believe that the selected group represented well the village and that the selected interviewees were free to express their thoughts without outside monitoring or other limitations. Considering the local context, such as trust and communication barriers, this method was the most feasible way to arrange the interviewees' selection.

The interviews were conducted using the interviewee's mother tongue, Swahili. We had two interview teams, each of which had one Swahili speaker and two researchers from UTU. Each interview lasted between 40 to 70 min and they were also video-recorded. In each interview, we used a set of beforehand agreed questions. The questions were originally written down in English and then translated into Swahili during the interviews. During the interviews, interviewees answers were summarized in English, so that the UTU researchers could also get an idea on the answers and have change to ask additional questions. This practice was noted to be working well in this kind of context. Later the interviews were also transcript in Swahili and then translated into English, in order to make more detailed data analysis. This paper reports a preliminary analysis of the collected data.

## 4 Information Needs

### 4.1 Socioeconomic Characteristics

The socioeconomic characteristics of the interviewed farmers were found to be as follows. (1) out of the 17 farmers, 10 were males, and 7 females; (2) the household sizes ranged from 3 to 9, with an average household size of six (6) persons, and average age of 42 years (min = 23, max = 58); (3) the main sources of income for all of the interviewed people were farming, and farming-related activities. Work in agriculture

ranged from growing crops to managing livestock, as well as related production services and agricultural marketing. Fourth, the most commonly grown crops were maize, cassava, rice, banana, vegetables, potatoes, tomatoes, and oranges. The livestock included chickens, goats, and cows. Also, ponds were actively used for growing fish for nutrition. Fifth, the typical total farm plot size was around 2.5 acres per family. Only very limited amount of active co-operation with extension agents was reported. The reading and writing skills of people in Tambuu varied, but in general it was found that most were able to read distinct words and short sentences.

## **4.2 Impacts of Climate Change in Tambuu**

During our discussion with the farmers it became obvious that they have experienced significant changes in the local climate during the last few decades, and those changes have affected their lives and agricultural practices. The farmers also reported to have received training about the impacts of climate change; how to identify the impacts and how to partly mitigate to them. The local farmers have witnessed changes mainly in temperature and rainfall. In regards of temperature, there have been an increase of hot days and nights, but also increase of periods when temperature is lower than usual. Rainfall variability has also increased: heavy rains at one moment and prolonged dry periods in the next, as well as increased variability of the starting day of the seasonal rains. Regarding to that, farmers reported a need for more credible weather information and skills to use such information for more productive agricultural practices.

## **4.3 Good Agricultural Practices**

Farmers reported that they need better information about productive agricultural practices. The most urgently needed agricultural practices in the Tambuu community were found to be techniques for cultivation of maize and rice crops. Information about agricultural practices includes knowledge on planting the right crops on the right soils, how to use fertilizers, how and when to irrigate, how to control pest, and how to harvest efficiently.

## **4.4 Production Inputs and Other Issues**

Farmers in Tambuu suffer from a lack of production inputs: improved seeds, and proper fertilizers and pesticides. Farmers reported that they use locally grown seeds which are low in productivity and are obtained from the stock of the previous year, neighbors or other nearby people. Chemical fertilizers are typically not available at the local markets, and if they are, they might be counterfeit, expired or otherwise spoiled.

Other issues revealed from the interviews included the following: (1) timing of harvesting was found to be a challenge. For each different crop, there is an optimal time for planting, sowing, and harvesting. Credibly documenting these in a crop calendar was reported to be sometimes challenging; (2) proper marketing after the harvesting to get the best value, was found to be a challenge; (3) insufficient financial services were reported to be a major concern for all the members of the Tambuu community. Lack of education, conflicts between farmers and pastoralists, and forest fires were also reported



as challenges; (4) in relation to fertilizer use, soil management was found to be a concern. Proper soil test could help to insure the proper application of fertilizer, by considering the nutrients already present in the soil, as well as the pH level and the salinity of the soil.

#### 4.5 Sources of Information

It was found that Tambuu community depends on a number of sources for farming information. These include extension workers, radio, television, film shows and agricultural pamphlets. However, it was found that access to agriculture information in regards of the available sources was constrained. The study revealed that a significant portion of information was domestic, and based on indigenous knowledge, such as inferring from the appearance of certain species of birds on the field. A small amount of information was reported to be gained through television, radio, and internet. In regards of weather information, sources included radio and television. However, those methods were not regarded as fully trustworthy. In addition, proper interpretation of the available weather information was perceived as a challenge. Intuition was reported as a common method for decision making.

#### 4.6 Information Needs Matrix

Table 1 summarizes the findings by listing the acute information needs of the Tambuu community. In regards of near future, taking into account the climate change and change in climate variability, credible and trustworthy weather information is extremely important, but currently only available to some extent. In addition to future climate services, general agricultural education, seed information, marketing data, soil management tips, soil testing service, financial services, and marketing skills are of extreme or high importance.

**Table 1.** Information needs of Tambuu

<b>Acute information and other needs</b>
Credible and trustworthy weather information
Knowledge in best uses of weather information
Education about best farming practices
Farming inputs (seeds, fertilizers, equipment)
Soil management tips and soil testing service
Financial services and marketing skills

## 5 Mobile Device Usage in Tambuu

### 5.1 Ownership of Mobile Devices

Out of the total 17 study participants, 14 owned a basic phone and 3 owned a smartphone. Study participants explained that each one owned the mobile phones they used, and that they were typically not sharing mobile phones with others (Table 2). On

the other hand, some participants were unable to distinguish the difference between a basic mobile phone and a smartphone. Smartphones were sometimes referred as “Touch”, and feature phones as “Sim”. Regarding the mobile internet connectivity, we found that out of three largest operators in Tanzania, only one had G3 mobile data coverage in Tambuu, which was also rather weak. Two other network operators had G3 mobile data coverage around 5 km away from Tambuu.

## 5.2 Usage Patterns of Mobile Devices

Several usage patterns for mobile devices were found. First, it was found that the most common smartphone applications used were short messaging services (SMS), and voice calls, followed by calendar, clock, and calculator applications. In regards of other, currently unused smartphone applications, some study participants were unaware of how to use them. One participant noted: *“I see those applications but when I touch the features icon, I cannot go to the next steps because I do not know what the next outcome shall be and sometimes, I feel like stopping the use of most applications.”* In regards of information domains, the participants explained to use smartphones for communicating with relatives, friends, and other groups about social, economic, but not for political aspects. The leading practice was explained to be social inquiries, followed by economic information seeking. Social inquiries included, in typical cases, family affairs that are geared in traditional taboos. Inquiries for markets in regards of product prices were common. For example, one study participant said: *“I am coming from faraway (pause) the hilly areas (pause) and before coming along the roadsides (Main road) with my product, I must communicate with my relatives and friends to know the prevailing market price of a bunch of a banana, peas, yams.”*

In all these cases, short messages, voice calls, calendar, clock, and calculator were the most used features. In addition, rare usage of WhatsApp, internet, camera, and Facebook for communicating with relatives was mentioned. For example, one respondent was taking photos of a crop plant affected by insect and sent them to more experienced relative for advices on how to use pesticide to safe-guard the plant. Thus, more “modern” information technology usage patterns were also found (Table 2).

## 5.3 Cost of Using Mobile Devices

The question of how much money farmers spend for usage of their mobile devices was also one part of the interview questions. We found out that interviewed farmers were spending between 1000 TSh to 2000 TSh (from 0,45 USD to 0,9 USD) per week on buying phone credits for their phones. Smartphone users were also buying data credits for their phones, however in small quantities since relatively high cost of data limited their willingness to use mobile data. One other important aspect is the charging of the phones. Since there is no connection to electrical grid at the Tambuu village, people use generators and small solar panels, which are becoming more affordable and thus more common. Few of the interviewed farmers owned their own solar panels, rest where paying for their neighbors or friends to charge a phone. Common charging fee was between 200 TSh to 300 TSh (from 0,09 USD to 0,13 USD) per charge (Table 2), and farmers where charging their phones between every few days to once a week.

## 5.4 Challenges Encountered

The challenges in mobile usage were divided to the following six categories. First, weak network coverage was found to prevent effective smartphone usage. One study participant noted: *“I rarely use my touch because of poor coverage and weak signal.....”*

*My ordinary mobile phone has very strong signal and powerful than touch almost everywhere in the village, even if I am in the field work (farming business activities) I still communicate fluently. I enjoy using my touch when in town than being in the village.”*

Second, technical competence was regarded as limited. One respondents said, *“I am not familiar with many features and operations that make touch not very usable to me, I do not know anything on them, some of them have nice pictures and music that attract my young daughter when crying.”*

Third, high prices of smartphones was reported as a problem. Although the village produces farming related products, the market price was low compared to city centers; sometimes prices could be even six times higher in the cities. In regards to smartphone prices, based on the researchers visit to a local mobile phone retailer in Morogoro, common low end smartphone models were costing between 85 000 to 90 000 TSh (37 to 39 USD). When taking into account that Tanzania per capita GDP was 2 131 299 TSh (934 USD) in 2016<sup>4</sup>, and our interviewees were reporting relatively low incomes, ranging from 95 000 to 650 000 TSh (41,6 to 284,7 USD) (however these figures should be taken with certain uncertainty, because of issues relating to lack of bookkeeping, memorizing and differences on what is counted as an income). Therefore, it can be noted that these smartphone prices would represent a big part of their income. As one respondent noted: *“We produce a lot of farm products, but the prices are too low, the middlemen traders are exploiting us, we cannot afford transportation costs (Too high) to municipalities. I bought my touch on performing extra duties (Building construction) apart from farming.”*

Fourth, usability was reported as a challenge. For example, the touch screen in smartphones was explained as too delicate thus inconvenient to handle with farmers' hands that are constantly at work holding farming equipment and tools and doing rough work in nature. Thus, participants said touch screen was unfavorably to users. One respondent noted: *“While in my fish pond feeding the fish my phone was ringing and I could not pick it up because the touch screen does not like wet and rough fingers, does not like water on the screen and my daily activities involve touching water throughout.”*

Fifth, language was found to be an issue. Participants noted English language was discouraging as it was a strange and were not ready to adopt a new language (Table 2).

Sixth, education and training was found to be an important issue. During the sessions the participants noted that paying for any training and education is impossible. One participant noted: *“I have five children, two in secondary school, two in primary school and the last born is yet to start school. That is headache to me.”* Participants

<sup>4</sup> [https://nbs.go.tz/nbs/takwimu/na/National\\_Accounts\\_Statistics\\_of\\_Tanzania\\_Mainland\\_2016.pdf](https://nbs.go.tz/nbs/takwimu/na/National_Accounts_Statistics_of_Tanzania_Mainland_2016.pdf).

**Table 2.** Table of mobile usage patterns and challenges

<b>Ownership</b>
14 out of 17 owned a normal featurephone Mobile phones are typically not shared 3 out of 17 of participants owned a smartphone
<b>Usage patterns</b>
Voice calls, short messages, calendar, clock, calculator Social and economic inquiries Some WhatsApp, Internet, camera, and Facebook usage Both typical and modern information usage patterns
<b>Money usage patterns</b>
1000 - 2000TSh per week for airtime (0.43 - 0.86USD) Batteries are charged by using generators and solar panels Charging cost between 200 - 300TSh (0.09 - 0.13USD)
<b>Challenges</b>
Weak mobile network, Technical competence, High prices Usability: too delicate touch screen, English language

were also unaware of any of the existing mobile-based agricultural information services. However, participants were interested about possible future services.

## 6 Discussion

Tambuu community has a number of positive aspects including good soil quality, favorable climate, variety of fruit trees that can grow in the area, and availability of water. Therefore, Tambuu is a suitable area for further agricultural development. However, a number of challenges are still blocking the prospering of Tambuu farming community. Unpredictable climate variability, caused by climate change, is probably the most serious challenge for the near future.

### 6.1 Information Needs

It was found that in the Tambuu community, the impacts of climate change have been experienced by farmers, and that they are also knowledgeable about climate change. The farmers' observations of changing climate patterns are well backed up by measurements and analysis done by both the Tanzanian Meteorological Agency (TMA) [5], and Berkeley Earth<sup>5</sup>. Farmers regarded their climate information needs as urgent and something with a high impact to their crop yields. Findings are rather similar to those reported by Coulibaly et al. [6]; in both cases farmers express mistrust to current weather forecasts and where requesting weather information to be connected with agricultural tips on how to adapt to those changing conditions.

These results can also be compared to findings of the latest Afrobarometer, where 32% of the surveyed rural Tanzanians had heard about climate change and 52% of respondent thought that conditions for farming where: "worst" or "much worst" due to climate change now than ten years ago, while 26% thought that they very either

<sup>5</sup> <http://berkeleyearth.lbl.gov/regions/tanzania>.

“better” or “much better”. However, same figures for respondents in Morogoro region where 39% and 40% respectively, stating that they see their region agricultural conditions being slightly better in terms of climate change effects compared to the whole Tanzania [18].

In regards of rainfall, future scenarios concerning it vary a lot. Rainfall may increase or decrease in the future [23]. What is certain is that the uncertainty will increase. This uncertainty is related to a starting times of the rains, duration of the rains, and durations of dry spells between the rains. The uncertainty will make it hard for farmers to make decisions about when to start planting or when preparing for drought period. There is also a rather strong variety in annual and monthly rainfall year by year and month by month [5].

Several other information needs were found as well. The most important ones are the knowledge of agricultural practices, such as techniques for cultivation of maize and rice crops, and need for production inputs, not to mention general agricultural education and training needs. In regards of information sources, it was found that current means for weather information was not regarded as that trustworthy or reliable. Typical sources were extension officers, radio, television, pamphlets, friends, relatives, and neighbors. These results are mostly in line with the findings of Benard et al. [3] and Lwoga et al. [12].

## 6.2 Current Mobile Usage Patterns

In regards of the current mobile phone usage patterns, it was found that the most popular applications are voice calls, short messages, calendar, and clock. However, more “modern” uses were also found, when, for example, farmers took photos of insects and sent them for analysis to a relative. Smartphone ownership was found to be relatively low, but estimated to increase. Social inquiries and economic information seeking were found to be the typical smartphone usage patterns. Usage of short messaging services and social media applications was also found, to a relatively small extent, though. Although for some smartphone owners, the main reason for the purchase seemed to be the access to WhatsApp, which would reduce the communication costs when compared to using airtime credit for calling or sending SMS.

A number of technical challenges were revealed also. These included weak network coverage, low technical competence, high prices of mobile devices and airtime and data credit, usability issues of smartphones, especially relating to the touchscreen, and English language. These observations are similar to the findings of Medhi et al. [15], Wyche et al. [24] and Aker et al. [1] about the usability issues of phones in the rural areas of developing countries.

An important technological aspect is the user experience of the proposed service. Therefore, we conducted technology prototyping and icon design session, which results will be presented in other conference paper [17]. Future phases of this research will include developing advanced prototype based on the user needs and our experiences, which would allow us to test how users respond to different layouts, navigation and information presentation types. Final aim of the project is to conduct through user-test to verify the benefits of the climate service app.

## 7 Conclusions

In developing countries, the impact of climate change is already being experienced as uncertain weather patterns, which seriously complicate the life of small scale farmers. How to provide farmers with accurate predictions to assist them in farming decision making is a crucial problem. However, smartphone ownership is rapidly increasing in developing countries, and smartphones provide an excellent platform to run future climate service applications that may assist small scale farmers in their daily practices.

However, as multiple research [2, 4, 7] have pointed out, is not only about providing the information, but also providing infrastructure related developments (such as improving road quality and access to electricity), that can improve farmers livelihoods. Based on our findings, we can fully agree on that statement.

Limitations of our study was the rather small sample of 17 farmers, in a village with 2 684 inhabitants. Also, when generalizing results from one village to be fit for population of Tanzania (around 55 million, out of which 75–80% are related to farming), it is clearly that they are not representing all the various issues that the farmers encounter in different climate areas and cultural contexts.

## References



1. Aker, J.C., Ghosh, I., Burrell, J.: The promise (and pitfalls) of ICT for agriculture initiatives **47** (2016). <https://doi.org/10.1111/agec.12301>
2. Aker, J.C., Mbiti, I.M.: Mobile phones and economic development in Africa **24** (2010). <https://doi.org/10.1257/jep.24.3.207>
3. Benard, R., Dulle, F., Ngalapa, H.: Assessment of information needs of rice farmers in Tanzania; A case study of Kilombero District, Morogoro (2014)
4. Burrell, J., Oreglia, E.: The myth of market price information: mobile phones and the application of economic knowledge in ICTD. *Econ. Soc.* **44**, 271–292 (2015)
5. Chang'a, L., Kijazi, A., Luhunga, P., Ng'ongolo, H., Mtongor, H.: Spatial and temporal analysis of rainfall and temperature extreme indices in Tanzania. *Atmos. Clim. Sci.* **7**(4), 525–539 (2017)
6. Coulibaly, Y., Kundhlande, G., Amosi, N., Tall, A., Kaur, H., Hansen, J.: What climate services do farmers and pastoralists need in Tanzania? Baseline study for the GFCS Adaptation Program in Africa (2015)
7. Donovan, K.: Anytime, Anywhere: Mobile Devices and Services and Their Impact on Agriculture and Rural Development. [https://doi.org/10.1596/978-1-4648-1002-2\\_Module3](https://doi.org/10.1596/978-1-4648-1002-2_Module3)
8. Helminen, J., Myllynpää, V., Apiola, M., Dayoub, M., Westerlund, T., Sutinen, E.: Community climate services for small-scale farmers in Tanzania. In: 2018 IST-Africa Week Conference (IST-Africa) (2018)
9. Hevner, A., Chatterjee, S.: *Design Science Research in Information Systems*. Springer, Boston (2010). [https://doi.org/10.1007/978-1-4419-5653-8\\_2](https://doi.org/10.1007/978-1-4419-5653-8_2)
10. Hevner, A., Salvatore, M., Jinsoo, P., Sudha, R.: Design science in information systems research. *MIS Q.* **28**(1), 75–105 (2004)
11. Komba, C., Muchapondwa, E.: Adaptation to climate change by smallholder farmers in Tanzania. Environment for Development Discussion Paper Series (2015)
12. Lwoga, E.T., Stilwell, C., Ngulube, P.: Access and use of agricultural information and knowledge in Tanzania. *Libr. Rev.* **60**(5), 383–395 (2011)

13. Maass, K.D.: Coping with the food and agriculture challenge: smallholders' agenda. In: Preparations and Outcomes of the 2012 United Nations Conference on Sustainable Development (Rio+20). Food and Agriculture Organization of the United Nations (2013)
14. Magehema, A.O., Chang'a, L.B., Mkoma, S.L.: Implication of rainfall variability on maize production in Morogoro, Tanzania. *Int. J. Environ. Sci.* **4**(5), 1077–1086 (2014)
15. Medhi, I., Patnaik, S., Brunskill, E., Gautama, S.N., Thies, W., Toyama, K.: Designing mobile interfaces for novice and low-literacy users. *ACM Trans. Comput.-Hum. Interact.* **18** (1) (2011). <https://doi.org/10.1145/1959022.1959024>
16. Mullarkey, M.T., Hevner, A.R.: An elaborated action design research process model. *Eur. J. Inf. Syst.* **28**, 6–20 (2018)
17. Myllynpää, V., et al.: Research in progress: holistic climate service prototypes for farmers in Tambuu, Tanzania. In: To Appear in Proceedings of IFIP WG 9.4 The 15th International Conference on Social Implications of Computers in Developing Countries, Dar es Salaam, Tanzania (2019)
18. Mwombela, S., Mboghoina, T.: Only one in three Tanzanians aware of climate change. *Afrobarometer Dispatch No. 227* (2018)
19. Paavola, J.: Livelihoods, vulnerability and adaptation to climate change in Morogoro, Tanzania. *Environ. Sci. Policy* **11**(7), 642–654 (2008)
20. Rao, K., Hansen, J., Njiru, E., Githungo, W., Oyoo, A.: Impacts of seasonal climate communication strategies on farm management and livelihoods in Wote, Kenya. In: CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS), CCAFS Working Paper no 137 (2015)
21. REPOA: Summary of results. *Afrobarometer Round 7- Survey in Tanzania* (2018)
22. Tall, A.: What do we mean by climate services? *WMO Bull. (Special Issue)* **62** (2013). <https://public.wmo.int/en/bulletin/what-do-we-mean-climate-services>
23. Tanzania Ministry of Agriculture: *Agriculture Climate Resilience Plan 2014–2019*. Government of Tanzania (2014)
24. Wyche, S., Steinfield, C.: Why don't farmers use cell phones to access market prices? Technology affordances and barriers to market information services adoption in rural Kenya. *Inf. Technol. Dev.* **22**(2), 320–333 (2016)
25. Yanda, P.Z., West, J.J., Daly, M.E.: Institutional analysis for climate services development and delivery in Tanzania. *CICERO (Center for International Climate Research) Report 02* (2015)



# Anti-corruption Efforts in National ICT Policies

## A Study of Policy Environments in Sub-Saharan Africa

Cecilia Strand<sup>1</sup>  and Mathias Hatakka<sup>2</sup> 

<sup>1</sup> Uppsala University, 753 13 Uppsala, Sweden  
cecilia.strand@im.uu.se

<sup>2</sup> Örebro University, 701 82 Örebro, Sweden  
mathias.hatakka@oru.se

**Abstract.** Many countries in Sub-Saharan Africa suffer from endemic corruption, which disrupts development efforts. Although ICTs is no magic wand, several studies indicate that ICT can serve as an important tool for combatting corruption by increasing transparency, and enable citizens to hold public officials accountable. Anti-corruption efforts are however dependent on strong political will and rule of law to be successful. A policy typically contains description of government intentions formulated into concrete objectives, as well as the rationale behind government targets. Furthermore, policies guide programmatic responses. The aim of this study is to explore how ICTs' anti-corruption potential have been understood at the policy level over time in ICT policies from nine Sub-Saharan African countries between 2000 and 2018. The study concludes that although there are signs of a growing understanding of ICTs as a multi-purpose tool for anti-corruption towards the end of the period, most policies fail to produce a comprehensive and explicit narratives as well as statements affirming political will. The policy environment's development trajectory, albeit positive, thus leaves room for improvement in terms highlighting ICTs potential contributions.

**Keywords:** Corruption · ICTs · Transparency · Accountability · Sub-Saharan Africa

## 1 Introduction

The past decade has seen a growing consensus amongst governments across Africa and development partners that corruption threatens to undo past development gains. Corruption, defined as “the misuse of a public or private position for direct or indirect personal gain” (p. 23) in The United Nations Convention against Corruption [1], makes future development targets outlined in the Sustainable Development Goals unattainable. It is estimated that nearly 148 billion USD a year is lost to corruption in Sub-Saharan Africa [2]. At the macro level, corruption threaten economic growth [3] and is a key deterrent for investors and a major constraint to business operations [4]. Furthermore, corruption disproportionately hurt the poorest citizens as they are more



dependent on publicly funded services [5]. Corruption erodes societies by moving away resources from its intended purposes and no sector or actor is immune to its adverse impact on daily life. However, despite strong consensus amongst donors, business and political leaders concerning the negative effects of corruption, as well as impressive legal reforms with many countries adopting key international anti-corruption conventions, corruption levels remain high in most of Sub-Saharan Africa [6]. It has even been suggested that corruption deepens with efforts to curb it. Finally, Person et al. argue that failures of anti-corruption reforms is the result of an implementation deficit, which can be attributed to lack of political will.

As the particular drivers of corruption to a degree is both context dependent and a result of perspective in the sense that the political, historical, social, cultural and/or institutional lenses color the analyses; the knowledge base on effective anti-corruption measures is still incomplete. A key constraint in research on corruption is that many studies have low general applicability, as different disciplines places different weight on different drivers, and thus advocate for different ways to address corruption. Despite these caveats, this study aligns with research that argues that political will and political commitment [4, 7–9] is of an overriding importance to the success of any measures and its implementation. Addressing systematic misuse of power is only possible with resolute political will. Establishing and sustaining political will is paramount and supersedes other often referred to counter-measures, such as strengthen media institutions for greater accountability [10], legal and law enforcement reforms [11] and international reform pressure [4, 9].

It has been repeatedly argued that Information and Communication Technologies (ICTs), can be an important tool for anti-corruption efforts. ICTs main contribution, lies in their ability to address the traditional information asymmetry within government's legislative and executive branches, as well as between government and citizens [12–14]. Access to relevant government information is essential for citizens' awareness and mobilization to hold officials accountable for lack services or requests for unlawful fees. Citizens equipped with not only knowledge of the government's service contract, but corruption as a topic in general, significantly increase the risk of detection of corruption [13]. Furthermore, mobiles can facilitate citizens' mobilization around poor service delivery, as well as make reporting of mismanagement and corruption easier and affordable [15]. In short, ICTs support multiple important processes, which combined could create a non-conducive environment for corruption.

With most of Sub-Saharan Africa continuing to display high corruption levels, this study aims to *explore how ICTs' anti-corruption potential have been understood at the policy level over time, as well as if the policy texts contain an explicit declaration of political will to explore ICTs for anti-corruption purposes*. As a policy is a set of principles and strategies developed to guide actions [16], they are suitable for analyzing intent. Policies traditionally also contain description of the rationale for policy direction, and as such, suitable for gauging policy makers' understanding of ICTs over time. Furthermore, policies play a key role in informing and guiding programmatic priorities.

### 1.1 ICTs Potential Role in Anti-corruption Efforts

ICTs in general and mobile phones in particular, can be instrumental in addressing a key corruption enabler - the lack of government information. It has repeatedly been suggested that one of ICTs primary contribution to anti-corruption efforts, is its ability to spread information and thus increase transparency. In a study of 70 countries, Internet adoption was found to cause corruption levels to go down, but the effect was small, arguably because Internet's potential was yet to be fully realized [12]. Gaskin [15] comes to a similar conclusion and argues that access to Internet can have a significant impact on corruption by increasing transparency, and that although mobiles also have a statistically significant impact on transparency, it is weaker [15]. Goel, Nelson, and Naretta [13] study on web-searches suggests that access to information that leads to greater corruption awareness reduces both corruption perceptions and corruption incidence. They suggest that greater corruption awareness and overall understanding of the phenomenon is pivotal for bringing down corruption levels.

The fast proliferation of mobiles has been of particularly interest, as they offer opportunities for by-passing government-controlled channels and open up for citizen-led horizontal crowd-sourcing of information, as well as a way to easily and affordably mobilize around corruption. Mobiles can support anonymous reporting of absences of a service or if the public officials requested an unlawful fee. Kanyam, Kostandini and Ferreira [17] argues, in their study of 44 countries in Sub-Saharan Africa, that mobile phones in particular can be instrumental for raising the level of corruption awareness, and be an effective tool for reporting corruption. They conclude that although it is difficult to assert the causal linkage in the midst of a myriad of interacting factors between corruption and mobile phone penetration; the "empirical findings suggest that mobile phone penetration is a powerful tool in combating perceived corruption" (p. 279).

Bailard [18] finds a significant correlation between higher mobile phone penetration and lower levels of perceived corruption in 46 African countries. Bailard suggest that mobile's main contribution lies in the ability to directly challenge government's traditional information monopoly. It is argued that "corruption prefers the shadows and abhors transparency" (p. 337). Mobiles poses a direct threat to corruption as they decentralize the control over information, and decrease the opportunities to commit corrupt acts undetected.

ICTs contribution to citizens' efforts to hold public officials accountable for their actions is another reoccurring theme. While mobiles by no means automatically turn into an anti-corruption tools, even in corrupt-ridden contexts; there are multiple empirical cases of mobiles being used to that particular end. Zanello and Massen [19] finds in their study that there are enough data to conclude that mobile can be a useful tool for pushing authorities to improve service delivery, and when given the opportunity, mobiles become an important tool for strengthening citizen agency.

Other studies have however cautioned against techno-optimistic and wishful thinking when it comes to ICTs as an anti-corruption tool. Without an independent judiciary and strong law enforcement agencies, detected corruption will go unpunished, or even worse, be silently endorsed by the same institutions. Sassi and Ali [11] conclude, in their study of 47 African countries, that there is a "high corruption inertia in Africa" (p. 662). The study

finds that although transparency is an important aspect to anti-corruption efforts, the rule of law is the strongest factor determining the level of corruption.

With political will accepted as a necessary condition for successful of anti-corruption measures, what policy priorities should be made based on the literature? First of all, as corruption thrives in contexts with high information asymmetry, where citizens and business are largely ignorant of the government’s service contract; increased transparency constitute an key component in anti-corruption efforts [20, 21]. With improved transparency, citizens become aware of what type of laws and regulation that govern a particular sector, as well as what services they are entitled to and to what cost. Lindstedt and Naurin [22] argues that transparency indeed is an effective tool for combating corruption, but not enough, which inevitably introduces a second key concept; that of accountability. Just making government information available will not prevent or deter corruption, if there is no one to hold governments accountable such as a free press or free general elections where citizens hold government’s accountable for their action [22]. They conclude that reforms targeting increasing transparency are unlikely to be effective unless they are “accompanied by measures for strengthening citizens’ capacity to act upon available information if we are to see positive effects on corruption” (p. 301). In short, greater transparency does not automatically lead to citizens holding their public servant and politicians accountable, but it is a necessary precondition for accountability. In addition, although greater transparency is a prerequisite and enabler for citizens’ empowerment, it does not alone bring about a culture of accountability. Furthermore, as suggested by Goel et al., [13] an accountability readiness amongst citizen, is dependent on not only an awareness of the government’s service contact, but a understanding of corruption as a phenomena, as well as context appropriate responses to corruption.

With the input from the literature review, we constructed a conceptual framework that revolves around the two mutually reinforcing concepts – transparency and accountability (see Fig. 1). The framework served two purposes. Firstly to create an overview of ICTs anti-corruption potential by increasing transparency and enabling accountability, as well as the concepts’ inter-dependence. Secondly, the framework informed and guided the analyses of ICT policies.

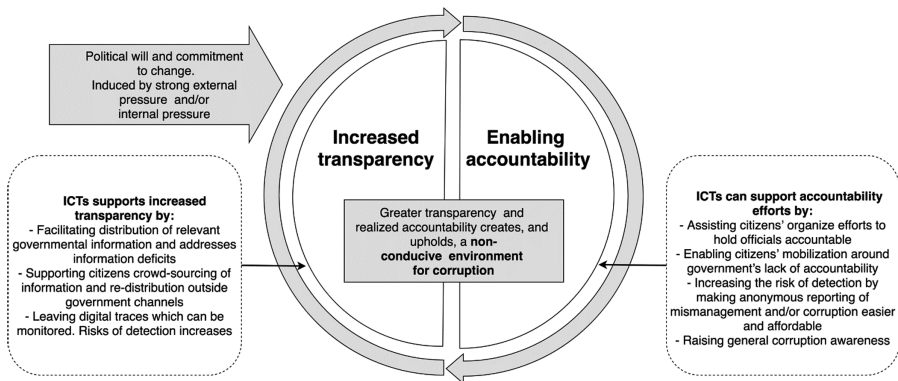


Fig. 1. ICT/anti-corruption framework

## 2 Method

With an aim to explore how ICTs' anti-corruption potential have been understood over time in Sub-Saharan Africa as well as assess political will to explore ICTs for anti-corruption purposes ICT policies and strategy documents were identified to be the most appropriate sources. An initial cursory review of the potential material found that documents labeled national "ICT strategy", was not markedly different from what other countries labeled policy. Both document types were thus included. While most of the 46 countries in Sub-Saharan Africa have ICT policies, we chose to limit the selection of included policies based on the following criteria: (1) The country should display a minimum level of political will and commitment to fight corruption by having ratified at least one of the main international legal documents (AU Convention against corruption, SADC Protocol: against corruption, or UN convention Against corruption). (2) A limitation in time was set. The growth in access and affordability of the ICT, as well as mobile phones becoming affordable can be roughly dated to early 2000s. The majority of Sub-Saharan countries launched their first ICT policies in the first few years of 2000s and the collection period was set from 2000 to 2018. (3) In order to ensure that policy-environment were equivalent in terms of it being a reflection of government priorities, sample countries needed to display a commitment to continued policy development. Over an 18-year period it is reasonable to have developed a minimum of five ICT related policies. Countries with five or more policies or strategies were included. (4) As e-government began to be adopted and grow into a separate policy area during the selected timeframe, we deemed it likely that an exploration of ICTs as a potential anti-corruption tool could potentially move from a generic ICT policy into e-government policies. Consequently, the latest e-government policy was also included.

The data set came to consist of two generic ICT policies per country and the country's latest e-government policy (if it exists). In total, 18 generic ICT policies were analyzed and six e-government policies (see Table 1).

**Table 1.** Policy documents

Country	Policy documents
Botswana	2004 - National ICT Policy - Legislative Framework & Change Report 2011 - Botswana's National e-Government Strategy 2011–2016 * 2012 - Parliament of Botswana - ICT Master Plan
Kenya	2006 - National Information & Communications Technology (ICT) Policy 2016 - National Information & Communications Technology (ICT) Policy
Malawi	2003 - Malawi Information and Communications Technology (ICT) Policy 2013 - National ICT Policy 2014 - Public Service ICT Standards *
Namibia	2002 - Information and Communication Technology Policy 2014 - e-Government Strategic Action Plan of the Public Service (2014–2018) * 2009 - Strategic Plan of the MoICT in the Rep. of Namibia 2009 to 2013
Nigeria	2001 - Nigerian national policy for information technology (IT) - 'use it' 2012 - Nigerian information communication technology (ICT) policy

(continued)

**Table 1.** (continued)

Country	Policy documents
Rwanda	2001 - ICT-led Socio-Economic Development Policy and Plan 2001–2005 2015 - ICT Smart Rwanda 2020 Master Plan
South Africa	2001 - The Digital Future - A Public Service IT Policy Framework 2017 - The National e-Government Strategy and Roadmap * 2016 - National Integrated ICT Policy - white paper
Tanzania	2003 - National Information and Communications Technologies Policy 2013 - Tanzania e-Government Strategy * 2016 - Ministry of Works, Transport and Communication National ICT Policy
Uganda	2003 - National Information and Communication Technology Policy 2011 - National Electronic Government (e-Government) Policy Framework * 2014 - National Information and Communications Technology Policy

\* E-government/governance policies

## 2.1 Document Analysis

The document analysis commenced with identifying all instances where the key concepts: corruption, corrupt, transparency, transparent, accountable and accountability, occurred in the policies and strategies. Relevant texts excerpts were copied into a spreadsheet. After the text collection, a content analysis informed by our ICT/anti-corruption framework began. The initial content analysis explored the existence of the key concepts and their interdependence in relation to anti-corruption efforts, as well as if and how ICTs were identified as a means to curb corruption. Through this qualitative content analysis, differences in terms of how key concepts were referred to became discernable and was later grouped into three categories depending on the texts' interaction and level of acknowledgement of ICT as a potential multi-purpose tool against corruption. After refining the category descriptions, all country's policies were identified as belonging to one of the following types: *under-developed*, *nascent* or *comprehensive* (see Table 2).

**Table 2.** Categories - under-developed, nascent or comprehensive

The under-developed approach	The nascent approach	The comprehensive approach
ICTs are not directly linked to transparency, and accountability or corruption, although one or several of the concepts may be textually present as generic concepts	Transparency and accountability are referred to as ideals that should guide state and non-state actors ICTs (and e-government) are referred to as a tool to increase transparency, and/or accountability in generic terms ICTs are not directly identified as anti-corruption tools, although corruption may be mentioned as a development barrier	ICTs are understood as a multi-purpose tool against corruption, where ICTs contribution lies in their ability to increase transparency and diminish information asymmetry between state and non-state actors, which enables non-state actors' to exercise oversight, i.e., to hold the state accountable. ICTs are explicitly identified as a tool against corruption

Policies were also separately reviewed for explicit statements declaring political will to explore ICTs for anti-corruption purposes.

### 3 Results

The studied countries are all signatories to international and regional instruments to combat corruption [2], and thus recognizes corruption as a development barrier best addressed through reforms. The persistent high corruption levels, with the notable exceptions of Botswana and Rwanda, does however indicate that political rhetoric has not been followed up by necessary reforms (Fig. 2).

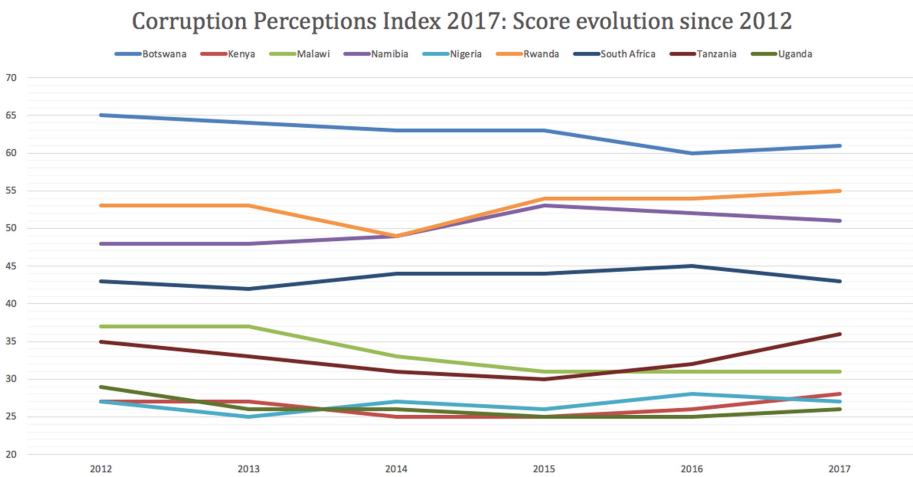


Fig. 2. Case countries’ corruption perception trajectory over time (higher value is connected to lower corruption perception levels). TI data ranking 2012–2017 [6]

#### 3.1 Transparency, Accountability and Corruption

Almost all policies include a reference to *transparency/transparent*, and the concept is more frequently featured to than accountability or accountable. The text references are however often general in nature or in conjunction with accountability and then often without a clear distinction between the two terms. The Namibian E-government policy (2014) will serve as example when it lists the following objectives in relation to its ambition to developed a citizen-centric service delivery: “To enable transparency and accountability in governance and promote civic engagement through greater access to information” (p. 17). The surrounding text does not shed further light on how the two concepts are “enabled” by ICTs or how they are inter-related. Nigeria (2000/2001), similarly identifies transparency and accountable as important aspects of services delivery, without providing details on the envisioned virtual forums.

“Bringing Government to the doorsteps of the people by creating virtual forum and facilities to strengthen accessibility to government information and facilitating interaction between the governed and Government leading of transparency, accountability and strengthening of democracy” (p. 40).

If the concept of transparency is vague in the policies, *accountability* is even more so. Accountability typically refers to the expectation that governments are liable and are accountable for its actions. Accountability is closely related to the concept of being held accountable by someone, for example a citizen. As described earlier, access to relevant and up-to-date government-related information is a prerequisite for citizens being familiar with their government’s service contract and when necessary, hold those in power responsible for deviations. There are hints on how this should be achieved in some of the policies, e.g., In the Botswana ICT master plan (2012) they state that ICT can be used to:

“[s]trengthen transparency and accountability by using an information system which monitors and tracks government assurances and helps to hold the Executive branch of government accountable” (p. 23)

Accountability often appears in the material as an ideal, rather than as an active verb, as in “being accountable” or “held accountable”. The Namibian 2009 policy refers to accountability as a value “our [The Ministry of I&CT’s mission] behaviour is ruled by a set of core values. These values are: Openness, Responsiveness, Integrity, Caring, Accountability” (p. 7). Accountability is later described as “MI&CT keeps the nation informed on existing and future Government policies, projects, programmes and activities and openly provides information on the use of the resources at our disposal” (p. 19). Accountability, in this instance, however appears to be synonymous to transparency. Furthermore, accountability is often featured as an aspect of governance, which cannot be assumed to include anti-corruption efforts, unless it is clearly stated

Even if few policies explores the linkage between the transparency and accountability, as well as how ICTs could increase transparency and enhance accountability, which jointly could have an impact on corruption levels; there are a few exceptions. With incomplete narratives around the three key concepts, transparency, accountability and corruption being the norm, two out of the nine policies were however labelled as comprehensive. The two policies - Tanzania’s National ICT policy (2016) and Uganda National Electronic Government (e-Government) Policy Framework (2011), were categorized as comprehensive as they included not only references to transparency and accountability, but also linked them to *corruption*. The policies also outlined how ICTs can support efforts to increase transparency around governance processes and government services; and thus enable accountability, which combined creates a non-conducive environment for corruption. The Tanzanian ICT policy also problematize ICTs, which signal critical awareness. That is, ICTs is not a magic wand.

“ICT offers concrete opportunities for local and central governments to improve their performance in terms of transparency, accountability, citizen participation and decentralization. At the same time, it offers citizens to know the services they are supposed to/or receive from their contribution through taxes. The mainstreaming of ICTs within planning and design of development strategies helps to strengthen the establishment of efficient, effective and transparent governance systems. Online tools can significantly improve the rendering of services and

information flows from administrations to their constituencies; communication between administrations and citizens can be enhanced and ICTs offer unique opportunities for broadened citizen involvement and participation in the decision making process. Various endeavors were made by the Government to ensure that ICT support good Governance. These include provision of online services, which increases transparency, accountability, citizens' participation, and reduced corruption. However, there are challenges that need to be addressed which include mainstreaming the use of ICT in government operations in order to increase government accountability, transparency and reducing corruption" (p. 32)

While not as explicit, the Uganda e-government policy, signal an understanding of ICTs as a tool for increasing citizens' access to relevant information, and ability to hold government accountable:

"The GOU believes that ICT should be utilized in this era of e-Government aimed at; providing greater access to government information; promoting civic engagement by enabling the public to interact with government officials; making government more accountable by ensuring its operations are more transparent and thus reducing the opportunities for corruption (p. 19).

It should however be noted that although both policies were categorized as comprehensive, they both fell short of explicitly articulating ICTs as a multi-purpose tool as presented in our proposed framework (Fig. 1). The framework does attempt to highlight that ICTs could, or even needs to support parallel and multiple government driven and citizens-initiated processes, to be fully effective in terms of creating a non-conducive environment for corruption.

### **3.2 Main Findings: Positive Trend Despite Silence Around Corruption**

Our analysis generated three main findings. Firstly, there is an overall positive trend in terms of how policies engage with the topic in the 18 years under study (see Table 3). Later policies show a greater understanding of how ICTs could be used to create a non-conducive environment for corruption, and in particular ICTs usefulness for increasing transparency. The main reason for earlier policies being categorized as under-developed is their near total absence of references to corruption or how ICTs could contribute to increasing transparency and enhancing accountability, even in instances where the two later terms are present in the policy texts. This finding is closely related to the second finding; the absence of references to corruption and acknowledgment of corruption as a development challenge. The silences around corruption in noteworthy in policies where other development challenges are both identified and discussed. Indeed, most policies contain both background sections outlining key barriers to development, such as, lack of basic infrastructure, education and skills deficits amongst policy makers, public officials and the public to utilize ICTs, and sections outlining development aspirations. A third finding is that e-government policies, which typically addresses governance issues and the systems which public services gets delivered; did not replace the generic ICT policy as the preferred space to explore ICTs as a multi-purpose tool against corruption. Nor does e-government policies appeared to have sparked a greater interest in the topic. Most e-government policies failed to demonstrate a clear understanding of the inter-dependence of transparency and accountability, as well as how ICTs can contribute to greater transparency and accountability.



Finally, referring back to our framework (Fig. 1), we maintain that anti-corruption efforts needs to be guided by a clear understanding that transparency and accountability are inseparable and only jointly will they create a non-conducive environment for corruption. In the policies analyzed, however, only two of them expressively linked all three constructs (transparency, accountability and corruption). Indeed, most policies in the sample, even when containing multiple references to all three concepts, transparency, accountability and to a lesser degree, corruption, have incomplete narratives of the three concepts' interconnectedness. The inter-dependence of transparency and accountability, as well as how ICTs contribution is vague at best. A somewhat harsh summary would be; ICTs are perceived to be useful for a range of sectors and processes, but anti-corruption is seldom one of them. Table 3, summarizes the findings.

**Table 3.** Summary of the policies

Country	“Old/Early” policy	“New/latest” policy	E-gov policy
Botswana	Under-developed	Nascent	Under-developed
Kenya	Under-developed	Nascent	N/A
Malawi	Under-developed	Nascent	Under-developed
Namibia	Under-developed	Under-developed	Nascent
Nigeria	Nascent	Under-developed	N/A
Rwanda	Under-developed	Nascent	N/A
South Africa	Under-developed	Nascent	Nascent
Tanzania	Nascent	Comprehensive	Nascent
Uganda	Under-developed	Nascent	Comprehensive

## 4 Discussion

The analysis of the policies suggests an overall positive development in the sense that the understanding of how ICTs could be useful by addressing the traditional information asymmetry has increased, and that by ensuring access to government-related information, citizens become better equipped to hold public servants accountable. In Sub-Saharan Africa, where corruption levels have been consistently high, policy-makers' improved understanding and tentative willingness to explore new tools to address citizens' lack of information is a welcomed change. However, only two policies were labeled as *comprehensive* along the lines of our proposed framework (see Fig. 1). Although Tanzania and Ugandan policies should be given credit, they did not include all aspect of the proposed framework. While we recognize that the generic ICTs policies may have another primary purpose and thus approach ICTs from a general development perspective; we argue that in contexts with high levels of corruption, policies should reflect corruption as part of the overall package of development challenges. Furthermore, we find it quite worrying that most policies, and e-government policies in particular failed to acknowledge corruption as a key development barrier and consequently explore ICTs' potential contribution to anti-corruption efforts. The reviewed policies' almost compact silence around corruption, or cursory mentioning at

best, could be argued to indicate unwillingness to acknowledge the issue. The fact that we failed to find a single instance where policy makers explicitly pledged to explore ICTs as a multi-purpose tool to fight corruption, would lend further support to this interpretation. The general lack of details outlining how and which ICTs are to be explored for increasing transparency and enabling accountability could be taken as another indication of reluctance to utilize ICTs to increase transparency and thus equip citizens with at least one of the necessary conditions for holding official accountable.

A more benevolent interpretation of the results is that the non-existing or incomplete narratives around ICTs' anti-corruption potential reflect a knowledge gap as opposed to unwillingness to engage with the topic. The fact that all countries in the study have signed international anti-corruption conventions and/or protocols, could lend some support to this hypothesis. But if that was indeed the case, other reforms should have made a dent in corruption levels, and that is not the case in most of the studied countries (Fig. 2).

Our study cannot provide a definite answer as to why ICTs are not more prominently featured. But we did find it worrying that e-government polices did not explore ICTs as part of a toolbox against corruption. After all, an e-government policy is tasked with mapping out how the use of ICTs can improve governance, increase efficiency and effectiveness in the delivery of public service as well as facilitate citizens' and businesses' general interaction with the Government. Indeed, it is hard to envision how a credible e-government policy can ignore one of the major barriers to area-related outcomes. We thus come back to our initial tentative conclusion. Anti-corruption efforts, even at the most elementary level, in the shape of policy document is hampered by a lack of genuine political will and general anti-corruption inertia.

Finally, although, the paper's geographic focus is limited, it is our hope that the proposed framework which guided the analysis of policy environments can contribute to and inform development partners' critical dialogue with partner policy makers. With political will being pivotal to change, international partners may have an important role to play here. It has been suggested that political momentum for change may not always have to be of domestic origins. Instead, international community, i.e., business community and development partners who understands the specific drivers of corruption as well as knows the context-specific values and moral environment, can play an important role in exerting significant pressure on partner governments [4] to start exploring the Terra incognita of ICTs as tool for anti-corruption efforts.




## References

1. United Nations: United Nations Handbook on Practical Anti-Corruption Measures for Prosecutors and Investigators, United Nations, Vienna (2004)
2. Barkley, D., Maduka, C.: The impact of anti-corruption conventions in Sub-Saharan Africa. In: Falola, T., Odey, M.O. (eds.) *Poverty Reduction Strategies in Africa*, 1st edn, p. 300. Routledge, Abingdon (2017)
3. Gyimah-Brempong, K.: Corruption, economic growth, and income inequality in Africa. *Econ. Gov.* **3**(3), 183–209 (2002)

4. Søreide, T.: Drivers of Corruption: A Brief Review. The World Bank, Washington, D.C. (2014)
5. Justesen, M.K., Bjørnskov, C.: Exploiting the poor: bureaucratic corruption and poverty in Africa. *World Dev.* **58**, 106–115 (2014)
6. Transparency International: Corruption Perceptions Index 2017 (2018). [https://www.transparency.org/news/feature/corruption\\_perceptions\\_index\\_2017](https://www.transparency.org/news/feature/corruption_perceptions_index_2017). Accessed 8 Aug 2018
7. Abdulai, A.-G.: Political will in combating corruption in developing and transition economies: a comparative study of Singapore, Hong Kong and Ghana. *J. Fin. Crime* **16**(4), 387–417 (2009)
8. Brinkerhoff, D.W.: Assessing political will for anti-corruption efforts: an analytic framework. *Public Adm. Dev.: Int. J. Manag. Res. Pract.* **20**(3), 239–252 (2000)
9. Gray, C.W., Kaufman, D.: Corruption and development (1998)
10. Camaj, L.: The media's role in fighting corruption: media effects on governmental accountability. *Int. J. Press/Politics* **18**(1), 21–42 (2013)
11. Sassi, S., Ali, M.S.B.: Corruption in Africa: what role does ICT diffusion play. *Telecommun. Policy* **41**(7–8), 662–669 (2017)
12. Lio, M.-C., Liu, M.-C., Ou, Y.-P.: Can the internet reduce corruption? A cross-country study based on dynamic panel data models. *Gov. Inf. Q.* **28**(1), 47–53 (2011)
13. Goel, R.K., Nelson, M.A., Naretta, M.A.: The internet as an indicator of corruption awareness. *Eur. J. Polit. Econ.* **28**(1), 64–75 (2012)
14. Strand, C., Hatakka, M.: Mobile phones as a citizen-controlled anti-corruption tool in East Africa - a literature review. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J. E. (eds.) *ICT4D 2017*. IAICT, vol. 504, pp. 753–764. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_61](https://doi.org/10.1007/978-3-319-59111-7_61)
15. Gaskins, L.E.: The effect of information and communications technology (ICT) diffusion on corruption and transparency (a global study). Texas A&M International University (2013)
16. Andersson, A., Hatakka, M.: Victim, mother, or untapped resource? Discourse analysis of the construction of women in ICT policies. *Inf. Technol. Int. Dev.* **13**, 15 (2017)
17. Kanyam, D.A., Kostandini, G., Ferreira, S.: The mobile phone revolution: have mobile phones and the internet reduced corruption in Sub-Saharan Africa? *World Dev.* **99**, 271–284 (2017)
18. Bailard, C.S.: Mobile phone diffusion and corruption in Africa. *Polit. Commun. Article* **26**(3), 333–353 (2009)
19. Zanello, G., Maassen, P.: Strengthening citizen agency through ICT: an extrapolation for Eastern Africa. *Public Manag. Rev.* **13**(3), 363–382 (2009)
20. Sturges, P.: Corruption, Transparency and a Role for ICT? (2005)
21. Garcia-Murillo, M.: The effect of internet access on government corruption. *Electron. Gov. Int. J.* **7**(1), 22–40 (2009)
22. Lindstedt, C., Naurin, D.: Transparency is not enough: making transparency effective in reducing corruption. *Int. Polit. Sci. Rev.* **31**(3), 301–322 (2010)



# Integrating Electronic Medical Records Data into National Health Reporting System to Enhance Health Data Reporting and Use at the Facility Level

Bigten R. Kikoba<sup>1</sup> , Ellen Kalinga<sup>2</sup> , and Juma Lungo<sup>2</sup> 

<sup>1</sup> College of Informatics and Virtual Education, University of Dodoma, Dodoma, Tanzania

bigtenkikoba@gmail.com

<sup>2</sup> College of Information and Communication Technologies, University of Dar es Salaam, Dar es Salaam, Tanzania

ellenakchale@gmail.com, jlungo@udsm.ac.tz

**Abstract.** A well organized and coordinated health reporting system is critical for improved health system and health care services delivery. For a long time, the Tanzanian Government has been committed to support global efforts to improve the quality of health data for increased accountability and evidence-based decision-making by introducing electronic medical records (EMR) systems at facility level and computerize a national reporting system (district health information system (DHIS2)). It is also committed to ensure decision makers have access to high quality routine data from providers of services at health facilities to those responsible for running health programmes at the health ministry (MOHCDGEC, 2017). However, data collection and reporting at facility level is error prone and task demanding due to the manual processes of collecting, aggregating, and sharing data, as a result rarely data are used to monitor programmes and make decisions beyond individual patient care. With the introduction of electronic medical records system, the goal of the paper is to ensure decision-makers have access to high-quality health data that are generated at the facilities, and they value and routinely use the data for decision-making. In doing so, the paper envisages improved practices around data collection, reporting and use and institutionalization of data through integrations of EMR and DHIS2.

**Keywords:** Data integration · Data use · District health information system · Health data reporting · EM-DHIS2 integration

## 1 Introduction

In sustainable development era, evidence-based planning and decision making receives higher recognition in global health agenda. A need to promote sustainable outcomes, demands better use of resources through better planning and practices. Better health systems performance and outcomes require availability and use of quality health data systems. In most developing countries the collection, compilation [1] and [2].

According to Toohey et al. [3] one of the causes of poor data use is fragmentation of health information systems and uncoordinated and integrated health information across distributed, heterogeneous and disparate information systems.

Over the past 10 years, Tanzania had undergone several efforts to strengthen Health Information System (HIS) and Health management information systems (HMIS) so as to improve quality of data reported and enhance data use and information lead decision making in all levels. HMIS is responsible for collecting, recording, storing and processing routine health data for policy-making, planning, implementation and evaluation of health programs. To strengthen HMIS interventions in the country with the focus is on the use of electronic information systems to facilitate data collection, analysis, interpretation and use in the health sector [4]. In so doing, the ministry in collaboration with the National Health Information System Project (HISP) team of the University of Dar es salaam, introduced District Health Information System version two (DHIS2) as a tool for collecting, analyzing and visualizing health data electronically. Through the DHIS2, the ministry links all health systems and health related data at one point.

Also, there have been hospitals initiatives to adopt and use Electronic Medical Records systems (EMRs) for clinical and service managements at the facility level. Normally, health institutions adopt the electronic medical records with the expectations that data collected as part of routine practice will be available for service delivery and data quality improvement within hospitals.

Despite these efforts, data use practices are very limited at lower levels of the health system, especially at community and facility level, data collection and reporting at facility level is error prone and task demanding due to the manual processes of collecting, aggregating, and sharing data, as a result rarely data are used to monitor programmes and make decisions beyond individual patient care.

The goal of the paper is to ensure decision-makers have access to high-quality health data that are generated at the facilities, and they value and routinely use the data for decision-making. In so doing, the paper envisages improved practices around data collection, reporting and use and institutionalization of data through integrations of EMR and DHIS2. According to [5] integrating EMR data to routine system of health data reporting is realistic and produce a valuable clinical practice platform to improve service evaluation and delivery outcomes [6].

## 2 Literature Review

### 2.1 Data Reporting and Use at the Facility Level

According to the Performance of Routine Information System Management (PRISM) analytical framework of health information system performance that identifies three main determinants of the use of health information: The technical aspects of data processes and tools, the behavior of individuals who produce and/or use data, and the system/organizational context that supports data collection, availability and use [7]. According to [8] technical determinants of data use relate to technical aspect of data collection, analysis, interpretation and workers skills gap to use data. Organizational determinants relate to the availability/absence of organizational context that supports

data use, such as clear roles and responsibilities related to data use; operating procedures, guidelines tools that support data use and adequate financial support for data use. [9] and [10] reported that behavioral constraints relate to poor attitudes towards the decision-making process, such as attitudes towards data and information, motivation to use data in the decision-making process, and incentives and disincentives to using data to make decisions.

This paper draws its focus on technical constraints of data use. Technical constraints refer to the technical aspects of data use addressing challenges of data collection, reporting, analysis and interpretation, human capacity (in terms of numbers and skill sets), and the existence of quality data [8].

## 2.2 HIS Integration Technologies

According to IBM report 2002, data integration is defined as the combination of technical and business processes used to combine data from disparate sources into meaningful and valuable information [11]. Data integration is about coordinating data from different sources and make it meaningful available for decision makers. Information use is made easier if its use is ritualized and routines are set up as part of the “information culture” [11]. One strategy of improving HIS is to use simple automated analysis tools at facility level to allow local data use [12] Moreover, there is significant relationship between availability of data systems and data use the need for integration of health systems [13, 14].

In order to support different perspective of HIS integration, various approaches have been proposed. These include data exchange standards and protocols [15], middleware technologies, unified models [16], domain specific standards and medical coding [17]. These approach goes with the contemporary approaches such as semantic integration. Toohey [3] state that despite of these distinct approaches, interoperability relies on the common agreement between the participating information systems and the components (boundaries) involved. There are several technical HIS integration solutions developed under those approaches, which are: Message-Oriented Integration, Application-Oriented Integration, Middleware-Oriented Integration and Coordinated-Oriented Integration.

The message-oriented integration, the one adopted in this study, refers to the use of different messaging standards to exchange data between health information systems [18]. This involves the use of text messages or multimedia message protocols through HIS databases, for instance in using APIs and EDI [3]. Toohey [3], argue that messaging integration approach provide effective way to solve the basic integration challenges. Also, the implementation still varies and is vendor dependent. Examples of message-based approach integration in HIS is seen in the use of the Digital Imaging and Communication in Medicine (DICOM) messages, HL7 (the American National Standards Institute (ANSI) accredited Standards and XML DTD and HL7 documents.

### 3 Methodology

#### 3.1 Research Design

The study adopted sequential exploratory design approach by involving first gathering qualitative data to explore a phenomenon and then collecting quantitative data to explain relationship found in the qualitative data [19, 20] as indicated on Fig. 1.

Qualitative data was collected during situational analysis to capture detailed information on reporting practices at facilities that are using EMR system. The assumption was that facilities with EMR report differently to facilities that a manual oriented. Therefore, qualitative data informed the study about reporting approaches used by hospitals with ERM system, availability of data into ERMs, type of ERM systems used by facilities and their reporting challenges and opportunity where by data were collected through semi-structured interview, document review, observation and review of software systems.

Statistical data were given as comparison, demonstrating how two systems differ in figures on similar dataset/indicator and so justify the need to integration to solve the problem of data use due to data accuracy and availability at the facility level. Questionnaires were used during evaluating the integration. Vertical integration approach was used.

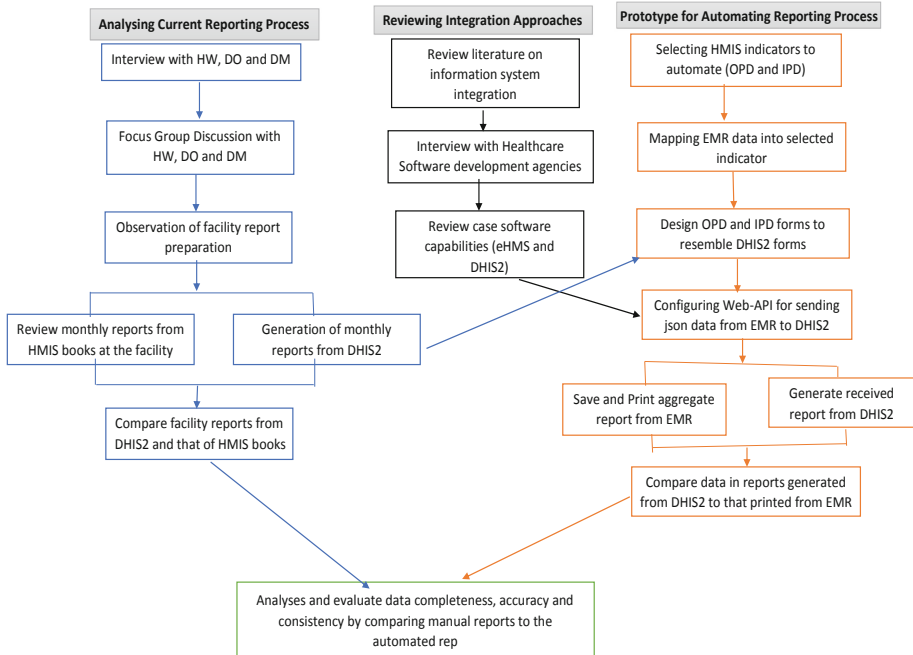


Fig. 1. Research methods

### 3.2 Study Area

Five hospitals: Amana, Muhimbili, Tumbi, Morogoro and Mnazi mmoja hospitals selected for review. The selection criteria based on the availability of both EMR and DHIS2 systems. Since the study intended to design an integration prototype. The study collected data through semi-structured interview with open-ended questions, document review, Observation and review of software systems. Questionnaire were applied during evaluate of the prototype's integration. A total of 43 people was involved: 27 (62%) were from Health Facilities, 8 (19%) from software development organizations, and 8 (19%) management personnel.

### 3.3 Development Approach

As a starting point, current HMIS data collection and reporting practices at facilities that are using EMR system were analyzed. This included knowing hospital using ERM system, availability of data into ERMs, type of ERM systems used by facilities and their reporting procedures and tools. The study investigated different integrated and interoperability approaches as well as HIS Integration Technologies. It investigated integration approaches applied by health information developing companies in Tanzania.

On HIS integration technologies, the study adopted the messaging-oriented approach through the use of defined Web API. The DHIS2 system is designed with multiple Rest APIs that allow easy integration with other systems. Point to point (peer to peer) integration method to implement EMR – DHIS2 integration prototype was as well adopted because of the nature of HMIS reporting processes, where by a focal person at the hospital is the one who forward data into the DHIS2. So, the integration does not change the process, it only improves the reporting circle.

The development was done by coding the OPD and IPD reporting module into the eHMS through summarizing and mapping 500 eHMS data elements to resemble the DHIS2 forms (OPD and IPD data elements). PHP were used to programme a Web API, which fetch data from MySQL database into a json report. The study implemented a HMIS report template for OPD and IPD that query the aggregate data from the eHMS into json format, then transferred into DHIS2 through REST web API.

The evaluation was done using quantitative methods i.e. questionnaire and report reviews to see their effectiveness and usefulness of the EMR – DHIS2 integration. The developed OPD and IPD data set forms was adopted into the eHMS system used at Amana Region Referral Hospital. But the interoperability was developed into the local machine not fully implemented at the facility. Therefore, the effectiveness evaluation was based on the OPD and IPD forms designed and implemented into eHMS and GoT-HOMIS in relation to DHIS2 reporting.



## 4 Case Description

### 4.1 HIMS Reporting Tools

Despite efforts to introduce data systems in Tanzania, the review noted a number of challenges are still hindering data reporting and their data use. This was echoed the key challenges include; inadequate coordination on ICT matters among ministries, departments, and agencies (MDAs), as well as partners, etc., a fragmented landscape of e-Health pilot projects and stakeholders, numerous data and health information systems (HIS) silos thus lack of interoperability/data exchange among the systems, lack of ICT infrastructure such as computers, network and internet services to access the systems, lack of ICT workers to properly develop, implement and support the systems, inadequate training for data users, lack of guidelines on research and use of data and information, and poor data quality such as inaccessible, incomplete, missing or untimely data.

There are Fifteen (15) HMIS books/registers for collecting and analyzing different pieces of health information. HMIS books are subdivided into five main groups as indicated in Table 1. At the level of each hospital, departmental registers are used to collect data.

**Table 1.** HMIS manual reporting tools

Reporting tool	Tool description
<b>HMIS Guideline</b> Book 1	It is used as an instruction manual and reference to other books/registers
<b>Data Collection Books</b> Books No. 3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, and 15	These books are used to collect data on different aspects of health
<b>Tally Sheet Forms</b>	Each HMIS register/book should have a tally sheet These forms are used to track data for analysis which will be used jointly with each register. This is then used in report writing
<b>Monthly Report Forms</b> Book No. 10	The HMIS uses monthly report forms to collect data each month. The forms are in duplicate, one copy is sent to the district while the other is kept at the health facility
<b>Facility and Hospital</b> Record Book. No. 2	This is used to document important records of the facility or hospital. It has various charts or tables with information about the facility

Author's visits to health facilities identified that the health workers filled out the OPD and IPD registers carelessly and the higher-level clinicians did not care at all about filling out these books; so, may be themselves do not trust these data. As the key players, we came to know this and did integration of the two systems as the interventions to address this.

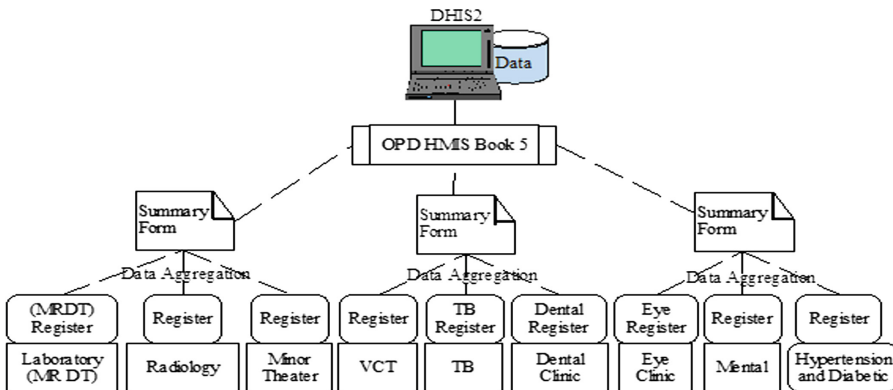
### 4.2 Reporting Procedures

The finding shows that, each of the health facility visited has its own type of ERM system used as shown in Table 2. Existing HMIS data Reporting processing at the hospitals using EMR systems varies one another depending on EMR type. Each facility has a unique way of aggregating data from different sources before entry to DHIS2. Some are semi manual like Amana with eHMS system and Mnazi mmoja with CTC2 database. Considering health facilities under this study, no hospital fully utilizes EMR data to produce HMIS report. There are some hospital management systems which implemented HMIS module, however they do not rely full on these systems when preparing monthly reports. Most of the time manual registers are used especially for the IPD and OPD data.

**Table 2.** Types of EMR systems used by health facilities

S/N	Institution/organization	EMR type
1.	Muhimbili Hospital	Jeeva
2.	Amana Hospital	eHMS and CTC
3.	Mnazi mmoja HC	CTC
4.	Tumbi Referral Hospital	GoT-HoMIS and CTC
5.	Morogoro Reg. Hospital	AfyaPro and GoT-HOMIS
6.	Mbeya Ref. Hospital	Care2x
7.	HISP Tanzania	DHIS2

In most cases, the patient data are recorded into registers and every month aggregate data are recorded manually into summary forms and submitted to DHIS2 office. At the DHIS2 office the reported summary forms are compiled into general HMIS book (OPD Book) before data entry into the DHIS2 system as shown in Fig. 2. Other, Hospitals are doing semi-manual reporting, for example, reports depend on the monthly provisional and diagnosis report printed from the EMR system called electronic Hospital Management System (eHMS). As illustrated on Fig. 3, each reporting



**Fig. 2.** The current HMIS data reporting at the facility level

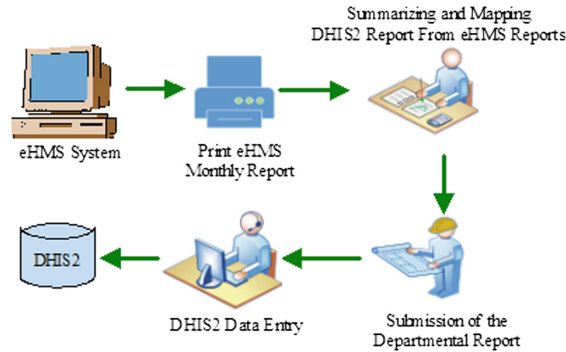


Fig. 3. Diagrammatical EMR to DHIS2 reporting procedure at the health facility

department print and summarize the provisional and diagnosis report from EMR into corresponding paper – based MTUHA book. Which later, is sent to DHIS2 office for data entry into DHIS2.

## 5 EMR – DHIS2 Integration Design

The prototype of EMR – DHIS2 integration was developed in a local machine using DHIS2 version 20 hosted in a local testing server to be connected with the local eHMS systems. The integration phases were *Data mapping*, *Report forms design* and *API Configuration*.

During *data mapping phase*: The data elements in eHMS was mapped against DHIS2 data model which is organized into three parameters: Dataset, Period and Organizational unit. The Dataset is a collection of data elements to be reported for example OPD, IPD, and Dental. The Period specify the routine/frequency of reporting, example monthly, quarterly or annual. Also, period shows when the data is reported example January report, February report etc. The organization unit show the source of data, in hierarch identify what facility is reporting example Amana Hospital from Ilala district, in Dar es Salaam region.

*Designing report form phase*: involved coding the OPD and IPD reporting module into the eHMS by summarizing and mapping 500 eHMS of the provisional data elements to resemble the DHIS2 forms (OPD and IPD data sets). PHP and SQL were used to programme a query, which fetch data from MySQL database into a json report.

*API configuration*: After data mapping and report forms design, then next was to think on how data is going to be shared from eHMS to DHIS2. Therefore, Rest Web API using basic authentication was chosen for sending data. DHIS2 API makes external systems to access and manipulate data stored in DHIS2 instance. The API provide a programmatic interface to exposed data and service. Methods for applications like third party software clients to access. Based on Rest API, an OPD json data file for sharing was designed.

## 6 Evaluation

### 6.1 Enhancement of Data Availability

According to PRISM framework, data availability is a factor toward data use. After eHMS – DHIS2 integration, the designed OPD and IPD reporting form into the eHMS was reduced to three steps as demonstrated in Fig. 4, now report can be generated direct from the EMR system, printed and forwarded to the DHIS2 system.

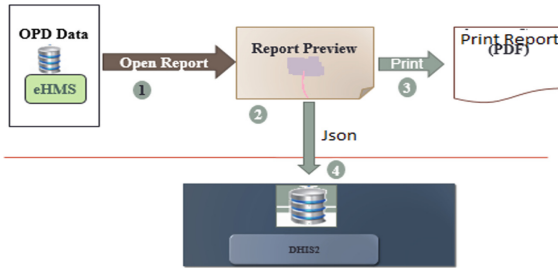
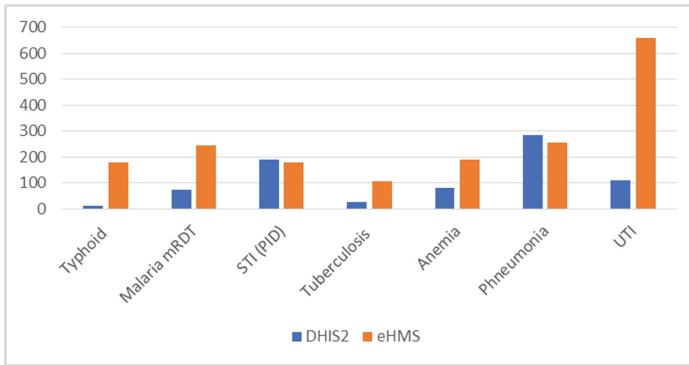


Fig. 4. Reporting process after eHMS – DHIS2 integration

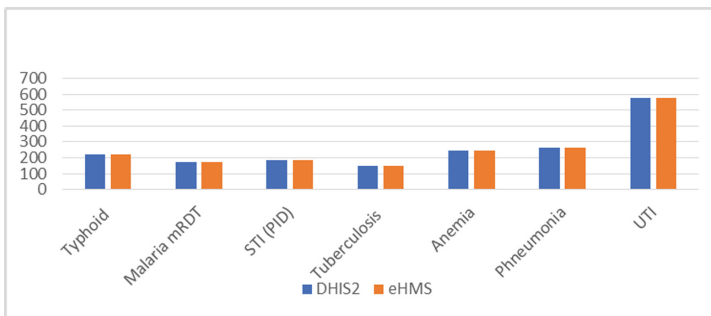
### 6.2 Data Quality Improvement

The effectiveness of EMR – DHIS2 integration on terms of data quality was evaluated by comparing OPD and IPD dataset reports from EMR and DHIS2 of the same month. The results show miss-match of reports between the two systems especially before the use of EMR reporting module. The EMR reports was based on the implemented HMIS report form that are in DHIS2 formats. Before integrating eHMS and DHIS2 (that is before using eHMS as data source for OPD and IPD reporting) the values in DHIS2 were not matching with values in eHMS. As shown on the Fig. 5 a graph showing selected data elements from OPD report on December 2017 at Amana Hospital. There is miss-matching of data values in DHIS2 and eHMS, where by the system were under and over reporting of data in different data element.

After the integration somehow, data consistency was observed. Figure 6 indicates data values extracted from DHIS2 and eHMS on March 2018 after using eHMS as a HMIS data source. The reports show matching of data values in both systems. Though little data entry error was observed with slightly mismatching.



**Fig. 5.** Data values in DHIS2 and eHMS OPD reports on December 2017 before integration



**Fig. 6.** Data values in DHIS2 and eHMS OPD reports on March 2018 after integration

## 7 Discussion

The study shows that, although hospitals are more paper less on clinical operations, but the truth is, they are operating manually on data reporting to DHIS2 that challenges the technical constraints to data use. Since EMRs carries actual value from service providers, there little use or not used at all when preparing monthly or quarterly HMIS data reports impose a question to where data reported into DHIS2 comes from? The qualitative review reviled that in most cases data from EMR are written first (which is not always the case) in the HMIS reporting books and then re-entered into the DHIS2. This process has cited out to be error prone due to missing values during aggregation or data entry error.

As per [10], poor data (in terms of quality) is not normally used, and because it is not used, it remains of poor quality. Although, data quality and information usage are closely linked, it is only through the use of data close to its source, that data quality may be improved. The integration of EMR – DHIS2 serves Health Workers with task to compute and compile report based on manual register, which is error prone. The approach to EMR-HMIS integration should not distort a well-established HMIS report

mechanism as review of the HMIS in Tanzania. With the DHIS database aimed at empowering health managers at district, region and national level to use information to improve health services, the integration should align together with procedures and processes, so will clearly contribute to a strengthens the existing hierarchy of reporting.

It's not only about EMR and DHIS2 data sharing, but the quality of data reported should be of a concern. Data entered into the EMR inaccurately renders even the most technologically sophisticated integration leading to failure or little use of integration. Data quality concerns may affect decisions about the integration process. For example, in this case data values from EMR are not matching with the values in the DHIS2. So, before integrating data must checked. Is data integrated upon entry or does it require approval and or cleaning first? The findings show that, DHIS2 can easily accept json, xml and csv files for importation Therefore technology is not a problem when it comes to HIS integration and so is EMR – HMIS integration should not primary be perceived as a technical problem, rather a complex operational issue. These operations will affect the perceived benefits of integration, so they need to be sorted out first before striving for integration.

Integrating EMR data to routine system of health data reporting is realistic and produce a valuable information needed for clinical practice and improve service evaluation and delivery outcomes. To improve facility HMIS data reporting and use, the EMR system should be enabled to capture, aggregate and share relevant information across all functional units within health facility by supplying aggregated data to DHIS2 [21]. Since EMRs produce first-hand information that is recorded on patient – doctor encounters, EMR – DHIS2 integration is critical to ensure that health facilities are reporting health-related data that are reliable, valid, complete, comparable, and timely, to DHIS2 so as to produce analysis of services, diseases and human resources data for health management.

## References

1. Ahanhanzo, Y.G., Ouedraogo, L.T., Kpozèhouen, A., Coppieters, Y., Makoutodé, M., Wilmet-Dramaix, M.: Factors associated with data quality in the routine health information system of Benin. *Arch. Publ. Health* **72**(1), 25 (2014)
2. Nisingizwe, M.P., et al.: Toward utilization of data for program management and evaluation: quality assessment of five years of health management information system data in Rwanda, vol. 9716 (2014)
3. Toohey, D.P., Lee, K., Sabooniha, N., Toohey, D., Lee, K.: An evaluation of hospital information systems integration approaches (2012)
4. MoHSW: Ministry of Health and Social Welfare: Strengthening Health Information System (2010)
5. Deutscher, D., Hart, D.L., Dickstein, R., Horn, S.D., Gutvirtz, M.: Implementing an integrated health record process to create a foundation for clinical practice improvement. *Phys. Therapy* **88**(2), 270–285 (2008)
6. Kariuki, J.M., et al.: Automating indicator data reporting from health facility EMR to a national aggregate data system in Kenya: an Interoperability field-test using OpenMRS and DHIS2. *Online J. Publ. Health Inform.* (2016)

7. Aqil, A., Lippeveld, T., Hozumi, D.: PRISM framework: a paradigm shift for designing, strengthening and evaluating routine health information systems. *Health Policy Plan.* **24**(3), 217–228 (2009)
8. Asiimwe, A.K.: Determinants of effective utilization of routine health information within private health facilities in Kampala, Uganda (a thesis work) (2016)
9. Frye, P.A., Jones, W.A.: Health information technology : integration of clinical workflow into meaningful use of electronic health records. *Perspect. Health Inf. Manag.* (2010)
10. Braa, J., Sahay, S.: *Integrated Health Information Architecture: Power to the Users: Design, Development and Use.* Matrix Publishers, New Delhi (2012)
11. Heywood, A., Rohde, J.: *Using Information for Action: A Manual for Health Workers at Facility Level.* EQUITY Project, South Africa (2002)
12. Karijo, E.K.: Master thesis, Determinants of utilization of routine data for decision making in health facilities in Kitui, School of Public Health of Kenyatta University (2013)
13. Monteiro, E.: Integrating health information systems: a critical appraisal. *Methods Inf. Med.* **42**(4), 428–432 (2003). <https://doi.org/10.1267/METH03040428>
14. Smith, M., Madon, S., Anifalaje, A., Lazarro-Malecela, M., Michael, E.: Integrated health information systems in tanzania: experience and challenges. *Electron. J. Inf. Syst. Dev. Countries* **33**(1), 1–21 (2008)
15. Xiao, H., Qiu, T., Zhou, P.: Integration of heterogeneous agriculture information system based on interoperation of domain ontology. In: 2013 2nd International Conference on Agro-Geoinformatics: Information for Sustainable Agriculture, *Agro-Geoinformatics 2013*, (200903056), pp. 476–480 (2013)
16. Shen, H., Wall, B., Zaremba, M., Chen, Y., Browne, J.: Integration of business modelling methods for enterprise information system analysis and user requirements gathering. *Comput. Ind.* **54**(3), 307–323 (2004)
17. Shaw, V.: Round table health information system reform in South Africa: developing an essential data set. *Bull. World Health Organ.* **83**(4), 632–636 (2005)
18. Shidende, N.H.: Challenges and approaches to the integration of HIS: case studies from Tanzania (2005)
19. Creswell, J.W., et al.: Advanced mixed methods research designs. In: *Handbook of Mixed Methods in Social and Behavioral Research*, vol. 209, p. 240 (2003)
20. Lin, Y., et al.: A sequential exploratory experimental design method: development of appropriate empirical models in design. In: *ASME 2004 International Design Engineering Technical Conferences and Computers and Information in Engineering Conference.* American Society of Mechanical Engineers (2004)
21. Moucheraud, C., et al.: Sustainability of health information systems: a three-country qualitative study in southern Africa. *BMC Health Serv. Res.* **17**, 1–11 (2017)



# Recommendations for M-Government Implementation in Developing Countries: Lessons Learned from the Practitioners

Tupokigwe Isagah<sup>(✉)</sup> and Maria A. Wimmer

University of Koblenz-Landau, Landau, Germany  
{tisagah, wimmer}@uni-koblenz.de

**Abstract.** Researchers argue the potential of mobile technologies to bridge challenges of e-government in developing countries. Despite the demand, research on the design and implementation of m-government is still scarce. The current literature hardly provides comprehensive recommendations for implementing such services in developing countries. This paper aims to bridge the gap by examining the challenges of m-government services from the m-government practitioners of developing countries. Also, it explores the solutions applied by the practitioners to address the challenges. To achieve these goals, online questionnaire and interviews techniques were used to collect data. MAXQDA tool was used to analyze raw data, and we applied the PESTELMO method to categorize the challenges. Results show that designers are facing problems related to requirement engineering, stakeholder management, budget allocation and technology standards. We provide recommendations to improve m-government designs in the future to ensure accessibility and sustainability of services. The recommendations are applicable to government organizations and practitioners of mobile public services.

**Keywords:** M-government · M-government design and implementation · Recommendations of m-government services · M-government challenges

## 1 Introduction

Researchers argue that the dissemination of mobile devices in emerging economies is far greater than desktop and other ICT devices for accessing public services, also known as e-government devices (see statistics of mobile users in Africa<sup>1</sup> and [1]). The massive increase of mobile penetration in such countries strengthens the connectivity of government to people [2]. People can now access public services via mobile devices, also referred to as m-government [3]. M-government tackles existing challenges of e-government such as the digital divide, immobility nature of e-government devices and a high cost of the devices and infrastructure in developing countries [1, 4, 5].

Whilst for a developed nation, where all ‘e’ and ‘m’-government services are assumed to be available everywhere, the same cannot be said of emerging economies

<sup>1</sup> <https://www.gsma.com/mobileeconomy/sub-saharan-africa/>.



[4, 6]. In the latter, e-government infrastructure may exist in urban areas; large areas of potentially barren rural areas are better and more effectively served by m-government. To accomplish this, a guidance to cope with prevailing country context such as political, economic and environmental conditions during design process is imperative.

The literature presents challenges of m-government services; these include challenges reported by end-users (cf. [7]), which are the results of poor designs implemented by designers, developers and architects of m-government services, also referred to as m-government practitioners in this paper. These practitioners are the key players in designing the services. They are expected to understand objectives, examine functional requirements of services thoroughly and derive non-functional requirements that contribute to smooth operation of application and services [8]. Since these practitioners are playing a major role, it is essential to identify and analyze their challenges which leads to poor designs. Such investigation of designers' challenges is scant in the literature at the point of writing this paper.

This paper presents part of the results of ongoing research in the design of m-government services in developing countries. The paper addresses the gap in the literature by conducting an empirical study from m-government practitioners to identify encountered challenges during the design process. The paper also explores solutions used to overcome the challenges. The objectives of this paper are narrowed into two research questions: *What are the challenges faced by the m-government practitioners which results to poor design and poor service usability? What recommendations can be provided to the practitioners to address the identified challenges?*

This paper contributes to the literature by providing empirical findings from m-government practitioners of developing countries. The paper proposes recommendations that can guide m-government practitioners in the design process. The reminder of the paper is as follows: Sect. 2 presents related work of m-government challenges and recommendations. Section 3 outlines research design applied to answer research questions whereas Sect. 4 illustrates results from empirical study. Section 5 introduces set of recommendations to improve m-government services. Subsequently, research implication and conclusions are communicated in Sect. 6.

## 2 Literature Review

According to the UN global e-government surveys, mobile devices are prominent in promoting equal access to service for citizens living in remote areas [1, 9, 10]. The previous survey unveiled the significance of broadband technology for sustaining e-public services in low economy societies [11]. This is because the technology is cheaper than the previous e-government sophisticated connections. Also, Zefferer and Teuf pointed out the significance of a well-established mobile network infrastructure in enhancing communication between governments of developing countries and their people [6]. Mobile devices such as cellphones were already successful used in these countries to transfer money (see in [12]), thus, citizens are familiar with the technology.

Therefore, developing countries should focus on delivering their services via mobile devices to promote Sustainable Development Goals<sup>2</sup> (SDGs) and overcome e-government challenges.

Developing countries responded to the call by introducing mobile public services in their societies. For example, USHAHIDI app is evidenced in Kenya to provide real-time information and quick response to communities during disasters through ping technology<sup>3</sup>. In Tanzania, citizens pay taxes and utility bills such as water and electricity via mobile transactions<sup>4</sup>; this improves the quality of service by saving time unlike cash payments. Likewise, India developed mobile public services ranging from information provision, interaction, transaction and engagement services in order to increase the efficiency and effectiveness of service delivery<sup>5</sup>.

Despite these initiatives in developing countries, several challenges exist on service design and implementation. For instance, research conducted in India on m-government revealed a lack of m-government strategy, poor awareness of services and a high cost of smart phones as challenges which hinder the adoption of the services [13]. These challenges are similar to results from a study conducted in Sub-Saharan countries on m-government design that further determined poor security, a lack of predefined legal standards and poor collaboration and cooperation among public and private sector as bottleneck of m-government implementation [14]. Our previous study categorized existing challenges of m-government design and implementation from literature comprehensively and urged the need to address them [7].

The design and implementation of m-government services require a strategy which includes understanding the stakeholders of the services, particularly users, service provider and practitioners. Isagah and Wimmer pointed out the influence of practitioners to the usage of services since they are responsible in making major design decisions such as determining requirements and design characteristics [8]. Their study also indicated the need for a well-designed back-end infrastructure to support the smooth delivery of government services. Their argument complements the previous study which stressed a need for a good foundation of ICT infrastructure and systems (e-government systems) for successful m-government implementation [15]. Henceforth, m-government practitioners require both front-end (mobile application development) and back-end (information systems) to deliver successful services.

Despite the importance of m-government practitioners in the implementation of services, the current literature lacks research from the designers' perspective [16]. The literature comprises m-government opportunities, drivers, challenges and design approaches such as framework and guidelines reported by end-users and service providers (see in [7, 17]). Also, m-government practitioners lack a comprehensive knowledge of addressing the requirements [8]. Thus, there is a need for identifying the challenges faced by these practitioners and exploring them in order to propose solutions. This paper

---

<sup>2</sup> <http://www.un.org/sustainabledevelopment/>.

<sup>3</sup> <http://www.itwebafrica.com/mobilex/309-kenya/231649-kenya-terror-attack-ushahidi-develops-emergency-app>.

<sup>4</sup> <https://www.tanzaniainvest.com/mobile-money>.

<sup>5</sup> <http://vikaspedia.in/e-governance/mobile-governance/mobile-governance-in-india-1>.

bridges the gap by conducting such a study in the developing country. Accordingly, it proposes recommendations for improving m-government services. The objectives of this paper were achieved by applying methods elaborated in the next section.

### 3 Research Methods

This paper presents insights from the m-government survey which was conducted to study the design and implementation of m-government services. The target group was m-government practitioners from developing countries. We deployed mixed approaches to achieve the objectives: an online questionnaire and a follow-up interview protocol. The former aimed to investigate the crucial requirements, design approaches and challenges of m-government services. The questionnaire consisted of closed and open questions. It explored demographic details, designers experience on m-government services, m-government service design approaches, requirements of m-government services, challenges of m-government services and recommendations for m-government design. The questionnaire was set online using Lime Survey tool, and the link was shared via email to experts spotted online and in conferences, group email lists, and professional forums such as LinkedIn and Twitter. Fifty two (52) m-government practitioners responded to the online survey.

Results from the online questionnaire were used to formulate interview questions. The aim was to deepen the understanding of m-government requirements from respondents and explore stakeholder management. Thus, interview participants were from respondents of online questionnaire. Twenty eight (28) respondents were willing to participate in the interview. We chose eighteen (18) experienced respondents (who have designed more than five services) from the list and reached them via email. The email included interview questions which respondents could respond via email or by scheduling the interview. Twelve (12) participants acknowledged the request and took part in the interview via Skype call and in person. We recorded the interviews and transcribed data for analysis. The transcribed documents were sent to respondents for content approval to ensure data reliability and validity.

With regard to data analysis, MAXQDA<sup>6</sup> software was used to analyze quantitative and qualitative data. The data from the online survey was saved in the excel sheet and later exported to the MAXQDA tool for analysis. As for the interviews, transcribed documents were saved in the tool as documents, and we performed the analysis. The MAXQDA tool allowed us to generate codes that represented a particular context along the analysis. For example, a code challenge was generated to store all constraints of the of m-government services. These challenges were also categorized into other subcodes by using PESTELMO (Political, Economical, Socio-cultural, Technological, Environmental, Legal, Managerial and Organizational) factors [18]. The method is used to structure the recommendations as well.

Since this paper focuses o the challenges and recommendations of m-government, we communicate results related to the objectives in the next section.

---

<sup>6</sup> <https://www.maxqda.com/>.

## 4 Results from the Questionnaire and Interview, and Discussions

A total of fifty two (52) respondents participated in the online survey. These participants answered at least ten (10) out of the fourteen (14) given questions. Among the (14) questions, few of them were optional. The demographic details of the respondents presented in this paper include country of residence and experience in designing m-government services. The former aims to inform the reader the origin country of respondents whereas the latter investigated the experience of the respondents in designing m-government services to support the reliability and validity of data. Respondents country of origin had no effect as the study focus on design processes which is mostly influenced by the experience. The questions were as follows.

- *In which country do you reside?*

Respondents were from the following countries along with the number of respondents: Tanzania (11), India (9), South Africa (5), Turkey (5), Uganda (5), Kenya (4), Brazil (3), Nigeria (2), Malawi (2), Pakistan (2), Afghanistan (1), Albania (1), Lebanon (1) and Uzbekistan (1).

- *How many mobile government services have you designed?*

Forty-two (42) respondents have designed more than one m-government service whereas ten (10) respondents have not yet designed any m-government services. In this paper, we present the challenges of the experienced group.

- *Please mention the utmost five design challenges of m-government services that you have experienced, or you might experience along your work*

The question aimed to understand challenges of m-government design and implementation depicted in Table 1.

Results from the online questionnaire were investigated further in a follow-up interview by identifying challenges that arise in addressing requirements of m-government services identified in [7]. For each requirement, respondents were asked the following question.

- *What are the challenges of addressing (requirement) of m-government services?*

Table 2 depicts results from the respondents regarding challenges faced when addressing requirements. We further asked requested respondents to provide solutions to the challenges identified for each requirement. The question posed was: *What are the proposed solutions to overcome the challenges identified in the previous question?* Their feedback is presented subsequently for each requirement along with the number of respondents.

*Usability:* All respondents (12) indicated the need for stakeholder inclusion and engagement in deriving service objectives, requirements, and performing other important activities in the design process. The respondents also emphasized the significance of a rigorous pilot test to solve most of the challenges. Likewise, there is a need for service awareness (7 respondents) and the use of special code for government services (6 respondents) to promote the adoption of services in the society.

**Table 1.** Challenges of m-government design reported by respondents of the online questionnaire (N = 42)

PESTELMO factors	Challenges along with number of experienced respondents
Political challenge	Lack of support from the government (7)
Economic challenges	Insufficient funds to support the design (8)
Socio-cultural challenges	Lack of user requirement (30)
	Poor user involvement (10)
	Poor user friendly applications (4)
	User illiteracy (20)
Technological challenges	Lack of service accessibility (10)
	Unclear measures of scalability (10)
	Poor user interface design (42)
	Improper measure for ensuring service performance (20)
	Poor security mechanisms (20)
	Incompatibility of applications in different devices (42)
	Unreliable infrastructure which leads to failure of network and low bandwidth (31)
	Poor integration measures (15)
	Lack of standards for sharing information (28)
	Poor content presentation (30)
Lack of predefined standards for designing m-government services (35)	
Managerial challenges	Poor communication among stakeholders (2)
	Government bureaucracy, which leads to failure to meet deadlines (20)
	Lack of understanding Term of Reference (1)
Organizational challenges	Lack of experts in the design and implementation of m-government services (8)

*Interoperability:* Four (4) respondents demanded interoperable layer that will store all the information from subsystems and provide authorized data to connected subsystems. Six (6) respondents revealed the need for data sharing standards that can be commonly used to design m-government services. Along with standards, collaboration and cooperation of stakeholders in the designing process is crucial (2 respondents).

*Integration:* All respondents indicated a need for organizations must plan the process, identify risks and mitigation strategies before integration. Additionally, two (2) respondents urged designers to build *e* and *m*- government as one system to ease integration processes.

*Scalability:* Five (5) respondents highlighted a need for testing the service in a similar number of expected users. Such an approach will help designers to understand scalability constraints at early stages. While observing expected users, four (4) respondents stressed not scaling beyond boundary, i.e., services are provided to the target group. Also, there is a need of infrastructure update to facilitate scalability (3 respondents) and a continuous monitoring of peak times (3 respondents) to provide reliable solutions to scalability.

**Table 2.** Challenges of addressing requirements of m-government services reported by interview respondents (N = 12)

Usability	
Economic challenges	A lack of budget for designing m-government services (6)
	High cost of smart phone, which leads to inaccessibility of data channels (5)
Socio-cultural challenges	Illiterate users who cannot contribute to designing (5)
	A lack of service awareness to citizens (12)
Technological challenges	Unreliable m-government infrastructure (7)
	A lack of usability standards at government level (8)
	A difference in mobile technology capabilities such as screen size variation and different resolutions (10)
	Poor content presentation (3)
Managerial challenge	Service inaccessibility due to poor collaboration among network providers (12)
Interoperability	
Technological challenges	A lack of common standards for sharing data (10)
Managerial challenge	Poor willingness of sharing information among departments (8)
Organizational challenge	A lack of skilled labor who understands the context of interoperability (12)
Integration	
Technological challenge	A lack of integration measures in government departments (10)
Managerial challenge	A lack of coordination and coordination among departments in determining types of standards for integration (6)
Organizational challenge	A lack of experts to address the requirement (5)
Scalability	
Technological challenge	Poor infrastructure such as outdated hardware and software (8)
Organizational challenges	A lack of skilled set within an organization to address the requirement (6)
Security and privacy	
Technological challenge	A lack of guidance to support the section of security measures for m-government services (7)
	Unreliable infrastructure, which threatens the security of services (5)

*Security and Privacy:* All respondents indicated a need for training designers on new security measures and privacy techniques. Training produce informed practitioners regarding the requirements. Three (3) respondents further pointed out the use of cloud technology to secure services for countries which cannot afford security physical infrastructure.

The illustrated challenges in Tables 1 and 2 rationalize the challenges of m-government services pointed out by researchers from developed and developing countries (see summary of challenges in [7]).

In Table 1 respondents have not pointed out environmental and legal challenges. This is because the respondents either do not encounter or not aware of such challenges. Looking back to our previous study, similar respondents called for m-government design approach that considers legal aspects when they were asked to provide recommendations for m-government design framework [19]. Thus, respondents are aware of legal implication to service implementation. Henceforth, this paper argues on the need for having clear regulations and legislation on the design and implementation of m-government services that practitioners must be aware of and abide by them.

From Table 1, the most reported challenge is poor user interface design. This obstacle arises from the lack of predefined standards for designing m-government services which is also advocated by interview respondents, cf. Table 2. Also, the incompatibility of applications in different devices is one of the most reported challenges. This is because m-government practitioners lack a clear approach to design services [8]. There is a need for guiding them in choosing proper technology depending on the type of service and target group.

Furthermore, challenges reported in the empirical study reveal the need for a well-design back-end process (ICT infrastructure) to provide effortless integration of mobile technology to the available services. The challenges unveil further the potential of other environmental factors related to political, managerial and organizational context to support the adoption of technology. Thus, the next section present recommendations which consider multiple views that can improve the design of m-government.

## **5 Recommendations for Successful Design and Implementation of M-Government Services**

From the discussions in a previous section, this paper presents a set of recommendations to improve the design and implementation of m-government services in developing countries. The recommendations are categorized by PESTELMO method as follows.

1. *Political recommendations:* We recommend political leaders and representatives to support the implementation of m-government services (cf. Table 1). The support includes promotion of m-government campaigns in societies; provision of enough budget to complete the project and sustain it; formulation of policies, and promotion of m-government strategy which should be implemented in organizations.

- We recommend m-government practitioners to consider available policies in government or organizations to ensure the support from top leaders and service sustainability.
2. *Economic recommendations:* Based on the findings from Tables 1 and 2 and desk research, we recommend
- Government or organization to have a repository for storing documents and solutions so as to allow reusability of materials for cost saving.
  - Government organizations to deliver their services via affordable mobile channels such as signaling channel (SMS and USSD). These channels are compatible to all mobile devices and do not require internet connectivity to access information.
3. *Socio-cultural recommendations:* The political recommendation highlighted in this paper contributes to solving socio-cultural challenges, i.e. promoting awareness of the service to people. Also, we recommend:
- The government organization to provide training to end-users. Provision of such training at an early stage helps to understand end-users needs and address them.
  - The use common channels that are already accepted by users in the community to ensure the acceptance of the services.
  - End-users to participate in pilot test to ensure a target service meet their needs.
4. *Technological recommendations:* This category provides the recommendations as follows.
- We recommend the adoption of defined standards for delivering public services via mobile technologies. The standards include user interface and content presentation of data channels, user interface and content presentation of signaling channels, and the use of specific codes (for SMS and USSD) for accessing government services.
  - Practitioners are recommended to conduct usability tests to tech-savvy and non-tech-savvy people. This approach helps to draw a mutual conclusion on revising the usability requirement and it increases service acceptance.
  - It is recommended to use a cross-platform framework when designing data channels such as mobile apps to ensure compatibility.
  - We recommend the government to formulate standards that should be commonly used in organizations to establish reliable back-end processes. These include principles, guidelines and formats. Such standards should assist m-government practitioners in organizing data and infrastructure to the ease sharing of resources, easy integration and scalability.
  - Government organizations are recommended to update their infrastructure to keep up with the latest security measures and ensure the performance of services.
  - Designers are recommended not to scale beyond the scope.
  - Designers are recommended to explore the infrastructure of organization and target user to determine type of channels that can be delivered through available infrastructure.



5. *Environmental recommendations:* We recommend

- The use offline techniques to ensure that apps and services work when there is no connectivity. Information to be processed can be uploaded when devices regain the connectivity. Such techniques overcome the environmental nature and geographical restrictions of developing nations.
- Designers to use technologies and other resources that have no effect on the environment when implementing m-government services.

6. *Legal recommendations:* We provide recommendations as follows.

- Government organizations must have a legal framework in place. The framework should provide a common understanding of m-government legislation and regulations, legal implications of m-government services.
- Designers should abide to legal framework entities throughout the design process so as to ensure service acceptance and sustainability.
- End-users must understand the legal implication of a service concerned. The service provider is required to create this awareness to end users before deploying the service in the user environment.

7. *Managerial recommendations:* The recommendations in this level are:

- Government organs and departments, and private sector are recommended to cooperate and coordinate in implementing m-government services. Through their cooperation and coordination, challenges related to addressing the requirements will be reduced. Also, the cooperation and coordination reduce application and service redundancy within an organization.
- M-government practitioners must identify all parties related to the service (public and private) and engage them in the designing process.
- Stakeholders of m-government services must be committed to the design process to ensure completion of project on time.

8. *Organizational recommendations:* We provide the following recommendations.

- Government organizations should provide training and workshop to their employees to update them with new technologies related and associated risks.
- Government organization delivering its services via mobile devices is recommended to have its back-end processes well planned and organized to support a smooth integration of mobile technology for service delivery.
- Government organizations should have clear goals and derive specific objectives related to the service goal, and handle them to the concerned m-government practitioners.

## 6 Conclusions

M-government implementation is potential in developing countries since mobile devices are the most prominent tools for connecting government to its society. The literature presents research on the success factors, challenges faced by users and

general recommendations on the m-government services. However, there is a lack of research on designers' side to explore the practices used to design the services and challenges faced. This paper bridges the gap by examining the challenges of m-government designers, explores their ways of addressing the challenges and proposes recommendations for improving m-government services in developing countries.

The paper contributes to the m-government literature by providing extensive recommendations for improving the services from strategic, design and implementations. Such comprehensive recommendations are lacking at the point of writing. Government organizations from the developing countries that require delivering their services via mobile devices can apply the recommendations. These recommendations will help them to improve the design of m-government services by considering important activities that are crucial in the process to produce proposer and useful designs.

The sample size from online survey and interviewees are not large enough to generalize the findings from the developing countries. Therefore, future studies should focus on increasing the sample size to have strong recommendations to government and m-government practitioners of developing countries. Also, future studies should target evaluating the recommendations in m-government projects to assess their application and validity.




## References

1. United Nations: E-Government for the People. E-Government Survey, New York (2012)
2. United Nations: Leveraging E-Government at a Time of Financial and Economic Crisis. United Nations E-Government Survey (2010)
3. Kushchu, I., Kuscu, H.: From e-government to m-government: facing the inevitable. In: 3rd European Conference on e-Government, MCIL Trinity College Dublin Ireland (2003)
4. OECD: M-Government: Mobile Technologies for Responsive Governments and Connected Societies. OECD Publishing (2011)
5. European Union: eGovernment: Using Technology to Improve Public Services and Democratic Participation. European Parliament Research Service (2015)
6. Zefferer, T., Teuf, P.: Opportunities and forthcoming challenges of smartphone based m-government services. *Eur. J. Epract.* **12**, 56–68 (2011)
7. Isagah, T., Wimmer, M.A.: Mobile government: challenges and needs for a comprehensive design approach. In: Proceedings of the 10th International Conference on Theory and Practice of Electronic Governance (2017)
8. Isagah, T., Wimmer, M.A.: Addressing requirements of m-government services: empirical study from designers' perspectives. In: Proceedings of the 11th International Conference on Theory and Practice of Electronic Governance (2018)
9. United Nations: E-Government and the Future We Want. E-Government Survey (2014)
10. United Nations: Gearing E-Government to Support Transformation Towards Sustainable and Resilient Societies. United Nations (2018)
11. United Nations: E-Government for Sustainable Development. United Nations, New York (2016)
12. Hughes, N., Lonie, S.: M-PESA: mobile money for the "unbanked" turning cellphones into 24-hour tellers in Kenya. *Innovations* **2**(1–2), 63–81 (2007)
13. Sareen, M., Punia, D.K., Chanana, L.: Exploring factors affecting use of mobile government services in India. *Probl. Perspect. Manag.* **11**(4), 86–93 (2013)

14. Munyoka, W., Manzira, M.F.: From e-government to m-government - challenges faced by Sub-Saharan Africa. In: ICCTIM 2014 Proceedings: The International Conference on Computing Technology and Information Management, p. 86 (2014)
15. Kumar, M., Sinha, O.P.: M-government–mobile technology for e-government. In: International Conference on e-Government, India (2007)
16. Lönn, C.M., Uppström, E., Nilsson, A.: Designing an m-government solution: enabling collaboration through citizen sourcing. In: 24th European Conference on Information Systems (ECIS). Association for Information Systems, Istanbul (2016)
17. Bakar, N.S.A., Rahman, A.A.: Research approaches in examining m-government services: an investigation (2014)
18. Mkude, C.G., Wimmer, M.A.: E-government challenges: methods supporting qualitative and quantitative analysis. In: Scholl, H.J., et al. (eds.) EGOVIS 2016. LNCS, vol. 9820, pp. 176–187. Springer, Cham (2016). [https://doi.org/10.1007/978-3-319-44421-5\\_14](https://doi.org/10.1007/978-3-319-44421-5_14)
19. Isagah, T., Wimmer, M.A.: Framework for designing m-government services in developing countries. In: Proceedings of the 19th Annual International Conference on Digital Government Research: Governance in the Data Age (2018)
20. Ghazali, N., Razali, R.: A preliminary review of interface design elements for mobile electronic government systems. In: 2014 Fourth World Congress on Information and Communication Technologies (WICT) (2014)
21. Al-Khalifa, H.S.: Development of mobile government websites: a functional design approach. In: Proceedings of the 13th International Conference on Information Integration and Web-Based Applications and Services (2011)
22. Mtingwi, J.E.: Mobile government in african least developed countries (LCDs): proposed implementing framework. In: IIMC International Information Management Corporation (2015)
23. Hoque, M.R., Mazmum, M., Bao, Y.: e-Health in Bangladesh: current status, challenges, and future direction. *Int. Technol. Manag. Rev.* **4**(2), 87–96 (2014)



# Co-creating an ICT Artefact with Elderly Rural Women in Mafarafara: A Social Structuration Account

Ronel Smith<sup>1</sup> , Marita Turpin<sup>1</sup> , and Marlien Herselman<sup>2</sup> 

<sup>1</sup> Department of Informatics, University of Pretoria, Pretoria 0002, South Africa  
marita.turpin@up.ac.za

<sup>2</sup> CSIR Meraka, Meiring Naude Road, Pretoria 0081, South Africa

**Abstract.** In South Africa, elderly rural women is the most socio-economically disadvantaged population group: their age, gender and rural location all contribute to their disempowerment. For this reason, an ICT4D project was undertaken by the CSIR with the aim of supporting elderly rural women in their livelihood activities. An ICT artefact was established and implemented in a women's Community Centre in Mafarafara, a remote rural village in the Limpopo province of South Africa. The ICT artefact was a rugged information kiosk based on Digital Doorway technology, and was populated with information to assist the women in their farming activities. As part of the women's empowerment, they were involved as co-creators of the ICT artefact and its contents. The study employed a Design Science Research Methodology (DSRM). During the project the strong influence of the local social dynamics on the design of the artefact became apparent. To this end, Giddens' structuration theory was incorporated in the study, to make visible the social dynamics that influenced and in turn were influenced by the design process. In this paper, concepts from structuration theory are applied to qualitative data from the Mafarafara interviews and site visit reports. The value of using structuration theory alongside DSRM to acknowledge the social nature of design is demonstrated. Structuration theory also provides a means to show how the participating women were empowered.

**Keywords:** Elderly rural women · Structuration theory · Digital Doorway · Rural development · Design Science Research

## 1 Introduction

*"Women in South Africa are still the face of poverty, inequality and unemployment. Despite the gains made in women's social and economic standing since 1994 ... these challenges still persist" [1].*

Elderly rural women (ERW) are the most disadvantaged population group in South Africa [1–3]. They are mostly illiterate and poorly educated; isolated and confined to their communities; subject to discriminatory customary laws, persisting patriarchal attitudes and prejudice; have access to severely limited resources and are marginalized

due to the lack of initiatives aimed at their upliftment and empowerment [3, 4]. Socio-cultural norms, values and practices which relegate women to the lowest position in society are still firmly entrenched in rural communities and are adhered to by the elderly and traditional authority structures [5]. The literacy levels amongst elderly black women in particular are significantly lower than their younger counterparts, who received their education after the end of apartheid [3, 6, 7].

Intentionally placing the focus of development projects on the empowerment of women, is important for a number of reasons. Firstly, the economic upliftment of women can contribute to inclusive and sustainable development [8]. Secondly, addressing the disparate development outcomes between men and women, can have a positive influence on food security and household wellbeing [9, 10].

There is wide-spread acceptance that ICT in its various forms can be instrumental in addressing gender inequalities and enabling women to empower themselves socially and economically [11–16]. However, for ICT4D projects to succeed researchers and donors must recognise the agency of women in developing communities; their “experiences, options, choices, dreams, and perspectives” (Nzegwu in [11]).

The Mafarafara ICT4D project was initiated with the aim of supporting ERW from a disadvantaged community by means of an ICT artefact to enable and support their livelihood activities [17]. This paper reports on the study that was conducted to design and develop the ICT artefact, and that involved the women of Mafarafara as co-creators of the ICT artefact. The study was executed using a Design Science Research Methodology (DSRM). While the empirical project was underway, it became clear that the social dynamics within the local community as well as the dynamics between the users and the CSIR researchers had a determining influence on the design of the ICT artefact. To this end, Giddens’ structuration theory [18] was used on the case data to make visible the influence of the social dynamics on the design process. This paper was written to demonstrate how structuration theory was applied in the study.

The paper is structured as follows. In the next section, the empirical and project contexts are presented. Thereafter, the research methodology is presented. This is followed by an analysis of the qualitative data collected during the empirical study, to demonstrate the value of using structuration theory in this context. The paper concludes with a discussion of the findings and implications for future research.

## 2 Project and Empirical Context: The ICT Artefact

This study forms part of the Digital Doorway project that was initiated in 2002 between the CSIR and the Department of Science and Technology (DST). The DD project, as it was coined, formed part of the Government of South Africa’s strategic mandate for ICT development. The project focus was to allow especially the marginalised people in resource deprived areas of South Africa’s deep rural areas, to get access to ICT and to enhance their digital literacy skills [19].

The Hole-in-the-Wall project in India was the inspiration behind the design. The assumption was that if you provided a robust (unbreakable) computer-type device to people they would use it and teach one another to improve their computer literacy skills and they would get access to information that was previously only found in books in

the library [20]. Accordingly, the DD is a kiosk with four screens or terminals, with a client/fileserver PC and two diskless clients designed for a low maintenance solution in order to deploy it outside for public/community access [21]. With the current DD (of which the ICT artefact in this study is a special instance), a user can create a personal account and enter the information (age, gender, home language). This data, as well as specific application usage is hosted on a server. A webcam allows users to create a personalised profile and they receive incentives for logins. This ensures the validation of demographic data [20]. The DD project was seen as a success as it resulted in more than expected evidence of skills gained and use of information in rural areas of South Africa.

This study arose as a result of a decision by the CSIR to propose a project focusing on ICTs, women and agriculture that was informed by the high priority the South African government affords these focus areas. Therefore the DD (selected based to its proven suitability to resource deprived rural environments) was modified with the active participation of the elderly women in Mafarafara to produce an ICT artefact co-created uniquely to suit their requirements.

## 2.1 Rationale for the Co-creation Approach that was Followed

Ramaswamy and Ozcan [22] postulate that the real value of creation does not only apply to co-creating artefacts, but rather lies with the value that the new co-designed artefact within their own contexts can have for participants, based on their involvement in their own networks. This is particularly relevant for this study, as the ERW co-created an ICT artefact based on their needs and gain value out of this co-creation process as it improves the quality of their lives. In South Africa, there is a need for innovation in developing contexts, however the involvement of the government is not very prominent in promoting this [23]. That is why some ICT4D studies do not acknowledge the innovation that takes place at an individual level as they develop products that are rooted in a specific socio-cultural context [24]. The specific co-creation process of Suryana, Mayangsari and Novani [25], was applied here because it indicates that for co-creation to have real value the co-creation process steps should be: *co-experience, co-definition, co-elevation, and co-development*. Ramaswamy and Ozcan [22] concur that the value of design lies in the interactions, where agencies of actors and structuring organisations operate in a networked structure of system–environment interactions. They bridge the theory–practice divide, where interactive artefacts connect new value creation opportunities with resources.

## 2.2 The Project in Mafarafara

The DD was installed at the Setsong Community Centre which was the gathering place for the older women of Mafarafara. The women derived their income from pension, sewing and low scale farming.

Figure 1 shows the ICT artefact being used by the ERW in the Community Centre:



Fig. 1. Women using the ICT artefact in Mafarafara

### 3 Research Methodology

In this section, the study's research philosophy, strategy, data collection and analysis as well as theoretical framework are discussed.

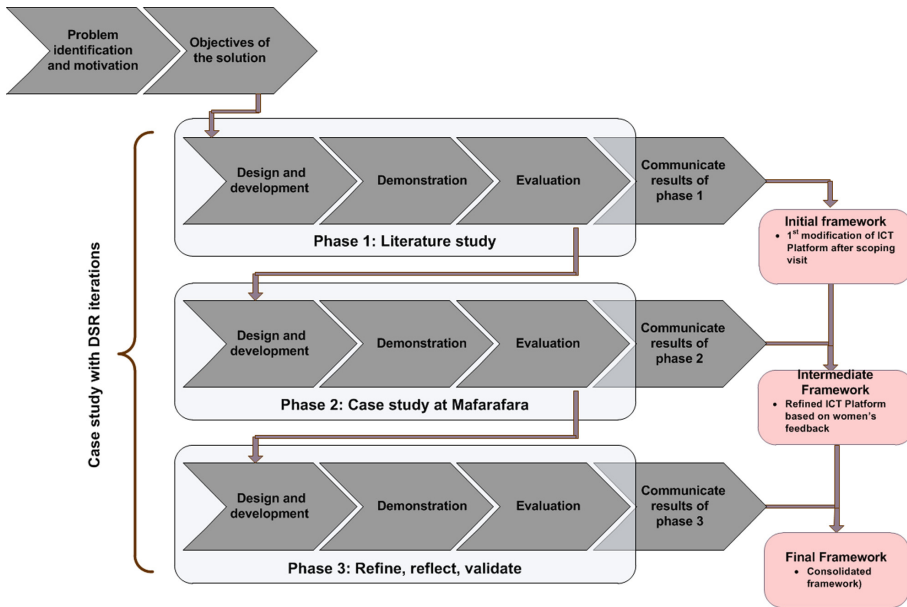
A pragmatist research philosophy was adopted. Pragmatists are concerned with solutions to problems that work, and knowledge is viewed as a way to improve the world [26, 27]. This view aligns well with the Design Science Research (DSR) aim of changing the current situation into a desired one [28]. In fact, it is contended that DSR is essentially pragmatic in nature [29].

DSR was used as the research strategy. DSR is a creative problem solving methodology that focuses on the production of innovative and new knowledge in order to solve a problem. DSR researchers are concerned with relevance and making an impact. DSR is assessed by its pragmatic validity, practical relevance as well as utility [30–32]. DSR's emphasis on making a practical difference makes it suitable to use in an ICT4D context [33]. Of the several Design Science Research Methodologies (DSRM) available, the methodology of Peffers et al. [34] was used to guide and execute this study. Peffers et al. [34] regard DSR as an iterative problem solving process involving the following six steps. For each step, its application to the Mafarafara ICT4D study is indicated:

1. **Problem identification and motivation:** This study aimed to address the disadvantaged position of elderly rural women in the South African context;
2. **Definition of the objectives for a solution:** The objectives of the study were to arrive at an ICT artefact that would enhance the livelihoods of elderly rural women, and secondly to develop a framework for co-creation of such an artefact;
3. **Design and development:** To design and develop improved versions of the artefact over three project phases as shown in Fig. 3, with multiple iterations during phase 2 where a case study was applied. Mafarafara was selected as the case and the ERW

were participants that co-created the ICT Artefact. Structuration theory was applied here as the lens to analyze and comprehend the social dynamics of the community and the value that was gained through the co-creation process;

4. **Demonstration:** The ICT artefact was demonstrated in the Mafarafara case setting;
5. **Evaluation:** The successive iterations of the ICT artefact was evaluated by the rural women of Mafarafara, while a co-creation framework was simultaneously developed and later evaluated by a panel of experts (the description of this framework is outside of the scope of this paper); and
6. **Communication:** The findings of the project were communicated through project reports, academic publications as well as a PhD thesis.



**Fig. 2.** Design Science Research Methodology as applied in this study (Adapted from [34])

For the purpose of this paper, the data collected during Phase 2 (see Fig. 2) will be discussed as it occurred in the form of interviews, focus groups and site visit reports. Interviews and focus groups were conducted in the local language namely Sepedi and translated, transcribed and coded thereafter. The site visit reports were drafted in English. Most of the field work was done by researchers from CSIR who were fluent in both Sepedi and English. Data analysis occurred while the study was ongoing, so that it could inform the improvement of the ICT artefact. Feedback was received during interviews about the way the women experienced the ICT artefact and what further improvements they recommended.



### 3.1 Theoretical Framework

While the CSIR research team was involved with data collection, the authors realized the determining influence of the local social context on the design of the artefact. It was more complex than just understanding the local setting as a passive or static influence; there were community dynamics that had to be continuously understood and taken into account, even though much of it was unstated. In addition, the CSIR research team contributed to these dynamics in planned as well as unanticipated ways. The social dynamics had such a strong influence on the design process (which in turn influenced the social context) that an instrument was required to investigate the influence of the social dynamics on the project. To this end, structuration theory [18] was identified as an appropriate instrument for making visible the social dynamics.

Giddens developed structuration theory as a means to synthesize the mutual influences of social agency and social structure, where social structure refers to the tacit and unstated “social rules” that guide our behavior [18]. According to structuration theory, social structure and agency are mutually constituted:

*“Human agents draw on social structures in their actions, and at the same time these actions serve to produce and reproduce social structure.” [18]:129*

“Agency” refers to our continuous stream of daily actions, rather than discrete events [35]. Action refers to the capability to make a difference, and hence to exercise power.

Social structure consists of rules and resources. Rules can be sense-making or normative in nature (how to do things, or how we are expected to do things). Resources is what gives us social power, and can take the form of authoritative or allocative resources. Authoritative resources refer to the capability of having command over people – whether because of one’s position or because of leadership traits. Allocative resources refer to the capability to draw upon material things in order to have command over our environment and hence social power. The resource is not about the “thing” itself, but about our ability to use it in a certain way [36]. Giddens’ structuration theory can be summarized by the dimensions of the duality of structure shown in Fig. 3 [18, 35]. The dimensions of the duality of structure is the analytical framework that is most often used by researchers as a basis for applying structuration theory [37], and it will accordingly be used in this study.

<b>Structuration process</b>	<b>SIGNIFICATION</b>	<b>DOMINATION</b>	<b>LEGITIMATION</b>
<i>Structure element</i>	Interpretive rules	Resources (authoritative and allocative)	Normative rules
	↓	↓	↓
<i>Modality</i>	Interpretive scheme	Facility	Norm
	↓	↓	↓
<i>Interaction</i>	Communication	Power	Sanction

**Fig. 3.** Dimensions of the duality of structure

## 4 Data Analysis by Means of Structuration Theory

### 4.1 Data Collected During Site Visits

Between April 2013 and October 2016, seven research visits and three technical visits were made to Mafarafara. Research visits lasted 3–5 days each, and consisted of a team of two to four CSIR researchers who collected data while they engaged with the ERW. The first visit was to assess the ERW’s livelihood and information needs. During the second visit, the ICT artefact was installed and training commenced. The subsequent visits were used to provide refresher training and to assess the ERW’s use of the ICT artefact. In addition, the research team tried to find out about further information needs of the ERW and whether any modifications were required to the ICT artefact. The technical visits were done between research visits to make changes or updates to the ICT artefact. The seventh and last research visit took place in October 2016. This visit was to assess the damage that a storm had caused the building housing the ICT artefact. After visit 7 the project was put on hold as the ICT artefact could not be further supported until a new suitable venue was arranged. This remained the status at the time of writing. All seven research visits were accompanied by data collection by means of interviews and/or focus group discussions, as well as site visit reports and these were used for the data analysis.

### 4.2 Social Structuration Account of the Co-creation Process

Below is a demonstration of the social structuration processes that accompanied the co-creation of the ICT artefact, as undertaken by the CSIR research team and the ERW of Mafarafara. To illustrate how the data was presented and analysed, the analysis will be shown that was done for visit 1 (Table 1) and visit 5.

**Table 1.** Data analysis for visit 1

<i>Activity</i>	Signification	Domination	Legitimation
<i>Arrival at Mafarafara</i>			Mma C receives and hosts CSIR group (mutual sanctioning)
	Mma C declares she is not clear on purpose of visit (problem of signification)		
<i>Day 2: Visit to chief</i>			Obtains chief’s blessing on project (normative requirement of traditional culture)
<i>First meeting with ERW</i>	Introductions made between research team and ERW (sense-making ritual)		

(continued)

**Table 1.** (continued)

Activity	Signification	Domination	Legitimation
	ERW struggle to understand what ICT artefact will be like. An attempt is made to answer sense-making questions asked by ERW		CSIR team explains ethical consent process (normative requirement of research community). Informed consent forms signed
<i>Day 3: Visit to crop fields</i>	CSIR team taken to see crop fields for themselves (sense-making by research team)	Crop fields: community's allocative resource. Only partially usable because lack of irrigation	
<i>Second meeting with ERW</i>	Information gathered on women's livelihoods, previous exposure to technology and information needs related to farming		Ethics clearance process with new attendees. ERW conditionally accept the project
<i>Technical site inspection visit</i>	Assessment of physical site to prepare for technology installation (ICT artefact and solar panels)		

The first visit consisted mostly of sense-making activities. Mutual sense-making had to take place to prepare both groups (ERW and research team) for further interaction and the installation that was to follow. In addition, social structures of legitimation were acknowledged and adhered to. These included the recognition of the tribal chief and paying him a visit of respect. From the CSIR's side, their research ethics required them to ensure that all participants understood the informed consent process and forms. Lengthy conversations were required before all participating ERWs were at ease with the consent forms they had to sign (Table 2).

**Table 2.** Data analysis for visit 5

Activity	Signification	Domination	Legitimation
<i>Debriefing: Unhappiness expressed about home interviews during visit 4</i>			The CSIR male researcher broke a social norm by interviewing the women privately at their homes
<i>Further feedback interviews</i>	To most participants, the use of the ICT artefact has become a regular social ritual that gave meaning to their daily existence	ERW more confident using the ICT artefact. Their ability to use it has boosted their self-esteem and gives them social power in the community	
<i>ERW made aware that they will have to take over maintenance of the ICT artefact</i>	While ERW confirm this, they are still not clear how they will do it		

Visit 5 constituted another follow-up visit to find out how the ERW were experiencing and using the ICT artefact, and what further improvements or modifications were required. As the process of co-creation was applied as explained by Suryana, Mayangsari and Novani [25], the ERWs could during the research visits provide inputs to co-create the ICT artefact based on their needs in order to gain value. They *co-experienced, co-defined and co-developed*.

A social surprise awaited the CSIR team. During the previous visit, a male researcher did feedback interviews with the women who used the ICT artefact. Mma C suggested that he spoke to them individually and privately so that they could speak more openly. Times and venues were agreed upon: he agreed with the women to interview them at their homes. None of the interviewees objected to the venues, and 11 interviews were conducted. It appeared that the women's husbands were unhappy when they found out afterwards, and the moral blame was shifted to the researcher. In hindsight, it is easy to say that the researcher should never have conducted the interviews at their homes. However, at the time it seemed the obvious thing to do. For the sake of the social relationship, the male researcher was withdrawn from the project even though he was a valued researcher. The fact that the women were reprimanded for interviews with a male researcher shows their lack of social power in the patriarch community.

Concerning the use of the ICT artefact: it became part of the daily lives of the participants:

*"In the morning we first pray and then the [ICT artefact] is switched on. We then log in... and start playing games or looking at our personal files... Some days, we log in for a while and then go and work in the garden." (Mma MM)*

*"The day starts with having to clean the room and the [ICT artefact]. [We] then log in and participate in the different offerings. When tired, it's time to give others a chance. [We] help each other during the process.... Others [are] sewing clothes.... Others sew reed mats and traditional outfits..." (Mma C)*

*"It's like work, I'm there every day" (Mma FM)*

The women's descriptions of their daily activities show that they visited the community centre on a daily basis, and took turns to work on the ICT artefact and do craft activities like weaving and sewing. The women assisted each other as some of the illiterate older women required help in typing their names. As can be seen, the use of the ICT artefact became a regular social practice at this stage.

#### *Benefits that the ERW Derived from the co-created ICT Artefact.*

The analysis of interview data and site visit reports showed that the women experienced a variety of benefits from using the ICT artefact, such as improving their computer literacy and finding value from the information they could search. It also showed some unexpected benefits. One of these was the immense pride that the illiterate ERW took in being able to type their name (their username to log in was their own name). One woman stated that using the ICT artefact gave her the confidence to use an ATM for the first time – prior to this she needed to take someone along with her to do her ATM banking. These are examples of empowerment within the ERW's particular social context, as it improved their capabilities as well as their self-esteem.

This intervention supports literature [24, 38, 39] that underlines the importance of applying ICT in a specific context to the benefit of a community and taking into account their needs. A natural disaster ended this study and not the fact that the deployed ICT did not support the community to empower them and to improve their lives.

### 4.3 Discussion

With the application of structuration theory, it is shown how the social structures of signification (sense-making or understanding), domination (use of allocative and authoritative resources to exercise social power) and legitimation (application of social values or norms) influence the execution of the project, of which the aim is to improve the design of the ICT artefact for use by the ERW. It is also shown how the use of the ICT artefact by the ERW became a regular social practice, and hence integrated in their daily rituals. The benefits they derived show some evidence of social empowerment.

## 5 Conclusion

The aim of the Mafarafara ICT4D project was to support ERW from a disadvantaged community by means of a co-created ICT artefact that would enable and support their livelihood activities. A DSR methodology was employed to refine an ICT artefact based on Digital Doorway technology. The ERW were continually involved in assessing the usefulness of the ICT artefact and suggesting improvements, to the extent that they were co-creators of the artefact.

In a social setting such as Mafarafara, the understanding of the social dynamics accompanying an ICT4D project is essential to the project's success. To this end, structuration theory was used to make visible the social dynamics accompanying the design and implementation process. It was demonstrated how structuration theory contributed to understand the drivers of project success, as well as areas of potential misunderstanding. It was further shown that the ERW gained social agency through the use of the ICT artefact, which is a form of empowerment.

This study was limited to a single case setting, namely the Mafarafara community in South Africa. However it is part of a larger family of Digital Doorway projects from which mutual learning takes place. A suggestion for future research is to repeat the study with other ERW in a different cultural setting and compare the results, in order to develop a better understanding of ERW as a user and participant group.

## References

1. ANC Women's League: Women and poverty - discussion document, p. 52 (2014)
2. Manuel, T.A.: Speech by Minister of Finance, Trevor Manuel MP, at the 4th World Congress of Rural Women on 24 April 2007 (2007)
3. Statistics South Africa: Social profile of vulnerable groups 2002–2012. Statistics South Africa, Pretoria (2013)

4. Ozoemena, R.: Poverty alleviation strategies in South Africa: creating dignified living for women through social justice and development. Consultancy Africa Intelligence (2010)
5. Diale, N.R.: Community group environment for people participation and empowerment: the socio-cultural perspective. *South Afr. J. Agric. Extension* **41**, 1–9 (2013)
6. Lam, D., Leibbrandt, M., Ranchhod, V.: Labour force withdrawal of the elderly in South Africa. In: Cohen, B., Menken, J. (eds.) *National Research Council Committee on Population: Aging in Sub-Saharan Africa: Recommendation for Furthering Research*, vol. 7. National Academies Press, Washington (DC) (2004)
7. Statistics South Africa: Census 2011: profile of older persons in South Africa. Statistics South Africa (2014)
8. World Bank: Gender in agriculture Source Book. World Bank Press, Washington DC (2009)
9. Etzkowitz, H., Gupta, N., Kemelgor, C.: The gender revolution in science and technology. *J. Int. Aff.* **64**, 83–100 (2010)
10. De Schutter, O.: Gender Equality and Food Security. Women’s Empowerment as a Tool Against Hunger. Asian Development Bank, Mandaluyong (2013)
11. Buskens, I.: Agency and reflexivity in ICT4D research: questioning women’s options, poverty, and human development. *Inf. Technol. Int. Dev.* **6**, 19–24 (2010)
12. Hafkin, N., Taggart, N.: Gender, information technology, and developing countries: an analytic study (2001)
13. Hilbert, M.: Digital gender divide or technologically empowered women in developing countries? A typical case of lies, damned lies, and statistics. *Women’s Stud. Int. Forum* **34**, 479–489 (2011)
14. Terry, A., Gomez, R.: Gender and public access computing: an international perspective. *Electron. J. Inf. Syst. Dev. Countries* **43**, 1–17 (2010)
15. Kuriyan, R., Kitner, K.R.: Constructing class boundaries: gender, aspirations, and shared computing. *Inf. Technol. Int. Dev.* **5**, 17–29 (2009)
16. Fife, E., Pereira, F.: The promise and reality: assessing the gap between theory and practice in ICT4D. *Telecommun. Policy* **40**, 595–601 (2016)
17. Smith, R., Turpin, M.: Design science research and activity theory in ICT4D: developing a socially relevant ICT Platform for elderly women in remote rural South Africa. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) *ICT4D 2017. IAICT*, vol. 504, pp. 345–356. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_29](https://doi.org/10.1007/978-3-319-59111-7_29)
18. Giddens, A.: *The Constitution of Society: Outline of the Theory of Structuration*. University of California Press, Berkeley (1984)
19. Gush, K., Cambridge, G., de Villiers, R., Smith, R.: Digital Doorways. In: Steyn, J., van Belle, J.P., Mansilla, E.V. (eds.) *ICT for Global Development and Sustainability: Practice and Applications*. IGI Global, Hersey (2010)
20. Gush, K.: An open-source tool-set for meaningful monitoring and visualisation of rural ICT projects. In: 2018 IST-Africa Week Conference (IST-Africa). IEEE (2018)
21. Smith, R.: Overview of an ICT platform for remote rural areas: Digital Doorway, 9 years and evolving. In: CIRN Prato Community Informatics Conference, Prato, Italy (2011)
22. Ramaswamy, V., Ozcan, K.: What is co-creation? An interactional creation framework and its implications for value creation. *J. Bus. Res.* **84**, 196–205 (2018)
23. Booyens, I., Hart, T.G., Ramoroka, K.H.: Local innovation networking dynamics: evidence from South Africa. *Eur. J. Dev. Res.* **30**, 749–767 (2018)
24. Jiménez, A., Zheng, Y.: Tech hubs, innovation and development. *Inf. Technol. Dev.* **24**, 95–118 (2018)
25. Suryana, L.A., Mayangsari, L., Novani, S.: A virtual co-creation model of the Hijab fashion industry in Indonesia. *Int. J. Bus. Soc.* **18**, 409–424 (2017)

26. Creswell, J.W.: *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*, Kindle edn. SAGE Publications, New York (2013)
27. Goles, T., Hirschheim, R.: The paradigm is dead, the paradigm is dead...long live the paradigm: the legacy of Burrell and Morgan. *Omega* **28**, 249–268 (2000)
28. Goldkuhl, G.: Pragmatism vs interpretivism in qualitative information systems research. *Eur. J. Inf. Syst.* **21**, 135–146 (2012)
29. Hevner, A.R.: A three cycle view of design science research. *Scand. J. Inf. Syst.* **19**, 87–92 (2007)
30. Simon, H.A.: *The Sciences of the Artificial*. MIT Press, Cambridge (1996)
31. Venable, J.R.: A framework for design science research activities. In: Khosrow-Pour, M. (ed.) *Emerging Trends and Challenges in Information Technology Management*, pp. 21–24. IDEA Group Publishing, Hersey (2006)
32. Vaishnavi, V.K., Kuechler, B.: *Design science research in information systems*. In: *desrist.org: Design Science Research in Information Systems and Technology* (2015)
33. Iivari, J.: A Paradigmatic analysis of information systems as a design science. *Scand. J. Inf. Syst.* **19**, 39–64 (2007)
34. Peffers, K., Tuunanen, T., Rothenberger, M.A., Chatterjee, S.: A design science research methodology for information systems research. *J. Manag. Inf. Syst.* **24**, 45–77 (2007)
35. Mendelsohn, M., Gelderblom, D.: *Revisiting Modernity: Contemporary Sociological Theory*. Only Study Guide for SOC303-8, University of South Africa, Pretoria (2004)
36. Turpin, M.: Autopoiesis and structuration theory: a framework to investigate the contribution of a development project to a rural community. *Syst. Res. Behav. Sci.* **34**, 671–685 (2017)
37. Rose, J., Scheepers, R.: Structuration theory and information system development-frameworks for practice. In: *ECIS 2001 Proceedings*, vol. 80 (2001)
38. Heeks, R., Ospina, A.V.: Conceptualising the link between information systems and resilience: a developing country field study. *Inf. Syst. J.* **29**, 70–96 (2019)
39. Lwoga, E.T., Sangeda, R.Z.: ICTs and development in developing countries: a systematic review of reviews. *Electron. J. Inf. Syst. Dev. Countries* **85**, e12060 (2018)



# A Critical Analysis of the Implementation of Health Information Systems for Public Healthcare Service Delivery in Resource-Constrained Environments: *A South African Study*

Mourine Achieng<sup>(✉)</sup>  and Ephias Ruhode 

Cape Peninsula University of Technology, Cape Town 8001, South Africa  
sachiengm@gmail.com

**Abstract.** The use of technological solutions is argued to offer quality enhancing efficiencies in the delivery process of healthcare services. For this to be realized certain objectives of these technological solutions have to be achieved. The public health system in South Africa faces various challenges such as poor coordination of most technological solutions therefore fragmented; a lack of interoperability between different systems, haphazard procurement processes and poor information management capabilities. The argument in this study establishes that the causes are not purely logistical but also linked to gaps in the adequacy of the health information systems (HISs) and the implementation process of these technological solutions. A case study strategy, whose empirical home is rural South Africa, was employed using qualitative methodology. Activity Analysis and Development (ActAD) framework was used as a theoretical lens within critical realist paradigm. The study was conducted in a public healthcare facility within a resource constrained environment. Semi-structured interviews was used as data collection method and analysis of data was through narrative and explanatory analyses, employing thematic analysis tool. The paper intends to come up with a framework that can be used to inform the implementation process of HIS(s) across board. With a focus on the context of a divergent national service delivery reality that impacts the right to healthcare service in under-served communities.

**Keywords:** Health information systems · Healthcare service delivery · Resource constrained environments · Underserved contexts

## 1 Introduction

Effective healthcare service delivery in the public healthcare sector is built on the back of adequate use of clinical and administration systems implemented in healthcare facilities. Reichertz [1] argues that the most common administrative support functions of these systems include collection, processing, storage and retrieval of data using various innovative Information and communication Technology (ICTs) tools. The healthcare domain incorporates a wide range of technological tools that are rapidly



diversifying in their purposes. These technologies present great opportunities in the transformation of healthcare service delivery process. Readily identifiable opportunities include easy access to integrated real time, relevant administrative and clinical health data and information necessary for adequate service delivery of healthcare and decision making at various government levels [2]. Moreover, improved health outcomes, administrative efficiency, cost effectiveness, or users' experience are also some of the perceived benefits. The significance of these interventions, and their intended beneficial effect on healthcare personnel and health outcomes, it is imperative to ensure that optimal results are achieved, and any unforeseen outcomes identified.

This paper looks at HISs as one of the many technological innovations within the public healthcare domain. HIS is used in this paper to incorporate an all-inclusive range of information and communication technologies interconnected across a health system. Technologies are often viewed as enablers in a healthcare system in improving service provision processes, by aiding institutions to do more with lesser resources, quicker and cost effectively [3, 4]. This point would be ideal for healthcare facilities in resource constrained environments— *this are contexts that are plagued with shortage of human resource, lack of or limited skills and capabilities to formulate policies and strategies for the development or implementation of novel ideas*. However, the perceived benefits of HISs are only possible to achieve when the implementation and infusion of these systems into the work processes of healthcare personnel are done adequately [5]. This study sought to address the question of *why the existing implementation of HISs in public healthcare facilities is not adequately facilitating provision of care services in resource constrained environments*.

In South Africa, an example of HIS existing in the public healthcare domain is the District Health Information system (DHIS) which was established of as a routine system for tracking health service delivery in the public health sector in 1996/97. The system, developed by the Health Information Systems Programme (HISP) was implemented to play a pivotal role in the collection, capturing, storage, analysis and reporting of routine data [6, 7]. Despite the great achievements of the DHIS, increase in the demand for routine information exposed weakness to the system such as poor data quality, dataflow bottlenecks [8] and reporting discrepancies at different levels. A web-based DHIS2 was introduced to mitigate some of the challenges with the earlier version. However, this was only done in one province whilst the rest of the provinces continued with the DHIS.

Many HIS implementations are usually done in a silo ad hoc manner resulting in fragmented systems with limited interoperability and software reuse, and a plethora of small pilots that are often not scalable [9]. This leads to duplication of data and information [10], a high dependency on technical support from external donors and many more challenges. These challenges that are more prevalent at public healthcare facilities in resource constrained environments where data collection is still a significant burden [11]. Resulting to inhibited adequacies as well as analysis and decision making [12, 13].

This paper adopts Damschroder et al. [14] concept of implementation broadly summing it up as encompassing the processes involved in the HISs operating satisfactorily in varied healthcare contexts. This would include analysing healthcare

facilities requirements in varied contexts, installation and configuration, customization, running, testing systems integration, user training and making necessary changes to the system.

## 2 Literature Review

### 2.1 Information Systems in Healthcare

Innovations within the health care sector according to [15] and [16] are directed at improving a healthcare system's efficiency and responding more effectively to patients' care needs thus improving health outcomes. The various types of information systems (IS) in this sector are designed to assist healthcare practitioners with managing daily tasks and patients' information in the delivery of care services to a population [17]. They include the following : (i) *Operational and tactical systems* designed to ease the process of classifying information, (ii) *Clinical and administrative systems* designed for managing patient details on an administrative level, (iii) *Subject and task based systems* such as Electronic Medical Records (EMRs) and (iv) *Financial systems* for tracking revenue and managing billing submissions.

The provision and management of the necessary information is highlighted as an essential ingredient to the system of health care governance [18]. Further arguments are that the delivery of care services is highly dependent on information [19], consequently the management and ultimately adequate use of the technology enablers are of paramount importance [20]. Healthcare institutions rely largely on information about the science of care, individual patients, care provided, result of care, as well as its performance to provide, coordinate, and integrate services [21]. According to [1] and [22], HIS emphasises on optimizing and utilizing information to increase efficiency and effectiveness in healthcare institutions. The systems are also designed to integrate data management and use for the improvement of patient healthcare services provision through better management of patient data at all level of implementation [23]. Most health systems around the world still struggle with implementation, and experience major delays in diffusing innovations [24].

### 2.2 Healthcare Information Systems Implementation

The implementation of HIS has been at the forefront in the field of information systems, with literature revealing an on-going debate between the impact of the technical aspects Vis-a`-Vis human behavioral aspects. Authors like Keen and Morton [25] argue that the IS implementation process is an intuitive skill and that the best way to deal with it is to be technically competent. Contrary to Keen and Morton, [26] and [27] argue that implementation process depends on user involvement, how the prototyping of the system is done, the information analysis done on the nature for the implementation and change agents. The later argument on user involvement seems to carry across literature on IS implementation. Involvement of users in the implementation process is crucial because they can point out where the system could fail. The authors also note other important factors such as top management commitment and training have an effect in

the implementation process (ibid). According to [28] the implementation process of IS includes the following four activities; (i) defining the innovation problem and goal setting; (ii) planning activity; (iii) implementation activity; and (iv) use and development activity. The shaping of the planning and implementation process of information systems in the user organization can be seen to be affected by the development mechanism proceeding in two ways: (i) the strategic goal setting and the definition of planning and implementation practices performed by the management, as well as by the planners; and (ii) the user activity [28–31].

### 3 Methodology

The study was aligned to qualitative research methodology because of the exploratory and explanatory nature of phenomenon under investigation. The research paradigm aligned to this study was the critical realist's perspective. This is because knowledge is considered socially constructed and through retroduction, it provides causal explanations of actual and empirical evidence. The study adopted the critical realist's ontology as it focuses on the generative mechanisms, causal powers, deep structures and reality of entities [32] which have implications on the healthcare service delivery and the implementation of health information systems.

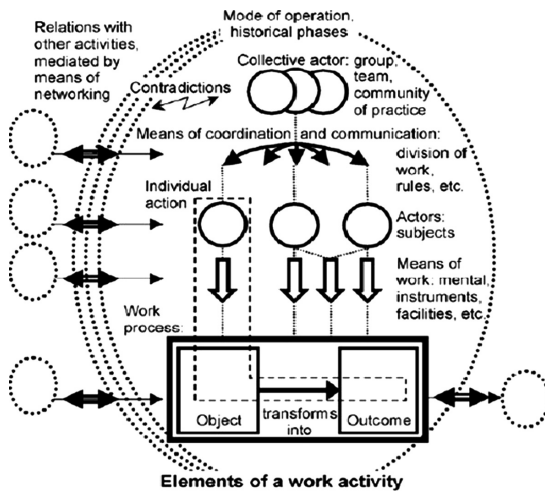
Both positivism and interpretivism paradigms are argued to suffer from the 'epistemic fallacy' i.e. they reduce statements about reality to statements about human knowledge of that reality. Moreover, the two paradigms assume that what exists is only what we observe and experience. It is on the basis of this that critical realism was chosen for this study. Further, the study adopts the use of critical realism paradigm as a means to gain an in-depth understanding of the relation between HIS implementation and its adequate use in the facilitation of care service delivery for an improved health outcome. Arguments are that critical realism simultaneously confronts the central concern of both the natural and social science regimes. It is on the basis of this reasoning that makes critical realism of particular interest in the study of information systems which bears significant relevance to natural science (due to their application in deeply human context such as organizations). The critical realists' assumptions and feature of realism correspondingly matchup with the theoretical lenses upon which this study is hinged: Activity Analysis and Development (ActAD).

#### 3.1 The Use of ActAD Framework in this Paper

ActAD framework was employed in this paper as an analytical lens through which the interplay between HIS and the society within which it is implemented is explored. The framework focuses on a work activity and the key features (object, actions, mediation, subject, actors, tools, transformation, rules, and outcome) of the work system are as illustrated in Fig. 1. The work activity portrays an activity as a collective phenomenon with a shared motive which stems from the organizational objectives or strategic goals. These activities are mediated by mediators such as tools, signs, artefacts, context and conditions. The collective activities involves actions carried out by *actors/subjects* who

collectively or individually are directed by rules and norms established by organizations to achieve a shared *motive or goal*. Context, culture, tools and rules also mediate the relationship between subjects and objects as well as amongst the subjects. The delivery of healthcare services through the use of HIS is seen as the key activity object in the framework. The main activities are therefore the interaction between the actors, tools mediators and the actual healthcare delivery process.

The transformation of the object into an *outcome*, renewal, alteration or abortion of the object have a predetermined timeframe in a work activity. This could be because of the failure of the object to achieve a desired outcome, perhaps as a result of contextual inhibitors or mediator tensions. Therefore, [33] argues that a successful interplay between the object from the mediation process and actions result into outcomes, where the objects undergoes a successful *transformation* into an outcome. In Fig. 1, the object-representing a common purpose held by all actors (Dept. Of health, Medical and clinical personnel, nurses and administrators/clerks) in a public healthcare sector is to provide patients with adequate healthcare services. The object is then broken down into different goals, activities and responsibilities for each actor in the system. The goal and related responsibilities of the main actor, the national Department of Health (D.o.H) in South Africa, is to improve patient care by providing and enabling adequate healthcare services provision in public healthcare facilities. One of the main mediators based on the framework, is enabling factors- public healthcare facilities require enabling tools to be able to provide efficient healthcare services.



**Fig. 1.** The ActAD framework: the structure and relations of a work activity as a systemic entity [35].

The key problem this study sought to address was the perceived gap in the explanation of the failures of the implemented HISs to adequately facilitate healthcare service delivery in public healthcare facilities within a resource constrained environment. The key features of the work system in the conceptualized ActAD framework

which draws on from activity theory, was developed to operationalize and contextualize healthcare activities at public healthcare facilities as shown in Fig. 2. From an activity systems based approach, healthcare service delivery process can be analyzed as a service provision with an objective, mediators, actions, mediator tensions, work activity as a transformation and the activity outcomes.

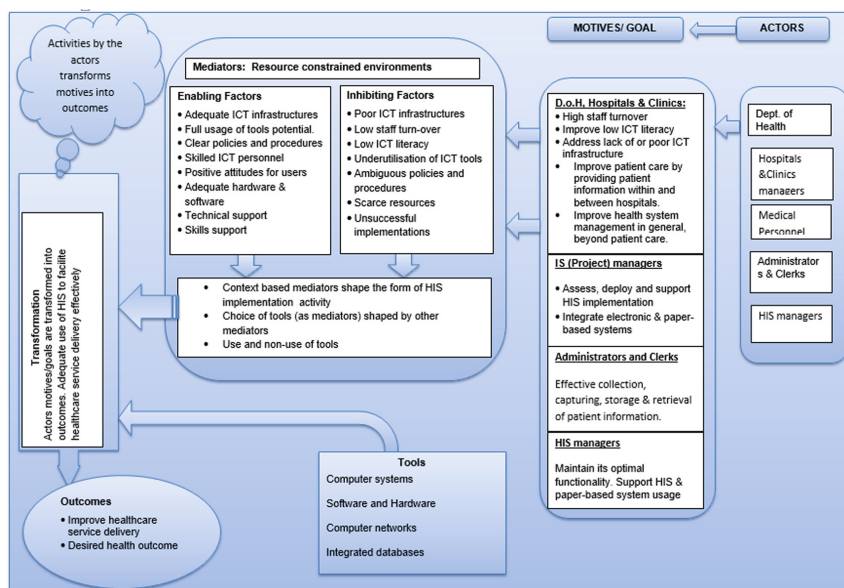


Fig. 2. ActAD analytical framework

### 3.2 Empirical Case

The healthcare facility used in the study is located in the OR Tambo Municipality in the Eastern Cape province of South Africa. Both the municipality and the healthcare facilities bear characteristics of a resource constrained environment. The facilities are government funded and provide tertiary healthcare services to the region. The healthcare facilities are plagued with shortage of clinical staff. The selection criterion of the facilities was based on the availability of health information systems such as the District health information system, patient records management system, laboratory information system and radiological information system.

### 3.3 Data Collection and Sample Size

Data was collected through in-depth open ended semi-structured interviews to gather information about stakeholders' knowledge, experience and, interpretation on the use and implementation of HIS in healthcare facility. Document reviews, observation and review of the software systems in use were also used as data collection

methods. For data analysis, ActAD framework was used as an analytical lens together with thematic and content analysis (for document analysis). A purposive sample was drawn from the provincial Dept. of health, hospital and clinic. The research sample consisted of senior hospital and clinic managers (as they manage the healthcare facilities and are involved in the implementation of various health information systems); clinical and medical staff including nurses (as they are the users of these systems for clinical work to provide services); administrators and clerks (as they use the systems to capture patient details at the entry point); HIS managers and the information systems managers (a representative from the provincial department of health- as they oversee the adoption and implementation of health information systems at healthcare facilities). In Total 21 participants were interviewed over the course of 6 weeks.

### 3.4 Data Analysis and Findings

This section presents the initial data analysis and preliminary findings on the factors of HIS implementation and use in facilitating health care service delivery in public healthcare facilities within resource constrained environments in South Africa's Eastern Cape Province, based on the 21 interviews. The study built the semi-structured interview questions around the ActAD framework, suggesting that healthcare service delivery processes are determined by the interplay between mediators, tools (HIS) and actors. Further questions employed different factors that mediate healthcare service provision in the facilities – dependent variables such as diverse HIS usage or under-utilization and whether the use adequately facilitates the work processes depend on the interplay between the enabling and inhibiting factors. This paper presents the preliminary findings in three themes of investigation: usage of tools, user skills/competencies and functionality (sub-categorised into *system functionality, degree to which the system is used and how the failures affect other functions*). The section draws on Fig. 2 (as an analytical tool) to present the public healthcare service delivery processes as an object activity system.

#### Usage of tools (Health Information Systems)

Based on the initial findings, there is prevalent evidence of usage of tools in the facility for facilitating health care service delivery in the hospital and clinic. Some of the systems have been in use since the foundation of the hospital. The hospital and clinic section are using a combination of electronic systems such as “*Delta9 (an electronic health patient registration system) (PRT1<sup>1</sup>), DHIS, Picture Archiving and Communication System (PACS) and Radiology Information System (RIS) (PRT1, PRT2)*. In the laboratory unit of the hospital “*...we use electronic gate keeping system (in short we call it EGK) the system is used by the all the doctors to request for patients' laboratory test*” (PRT3). The Delta9 system is an electronic system used for patient registration “*...at this unit of the hospital (patient registration), we use the system to only capture and store patient biographical details and record the purpose of the visit*” (PRT1), “*... the patients' record unit also makes use of this system as well... and also the revenue department makes use of this department for billing purposes...*” (PRT1). A major

<sup>1</sup> PRT = Participant.

contradiction is the usage of paper-based system- healthcare facilities still uses the paper folders to store patient clinical data – which limits the sharing of data by multiple users, as paper files can only be in one point and cannot be used in multiple areas at the same time. “... *although we have these systems here we are still required to record the things we do manually*” (PRT3). Although the electronic system is available the paper based system is still mainly used to store “... *the medical information that the doctors and clinicians have written or things like laboratory reports they have requested on the patient*” (PRT4). The clinics make use of the Primary Healthcare information system (PHCIS) for patient data management and reporting.

### **User Skills/Competencies**

The availability and usage of relevant systems in various hospital units reflect a positive development in the findings, however these systems can only add value if their potentials are exploited fully. The analytical framework Fig. 2 suggests that there is a need not only for the presence of the mediating enabling factors such as adequate ICT infrastructure and networks, but also the will of the subjects/actors to put their skills into effective use. User competencies in this paper is used as the understanding, literacy and ability to put a system into effective use [34]. For instance, framework the goal of a medical personnel and clerks/administrators is to provide health care services delivery through effective use of tools, rules and processes. For clerks, information systems such as Delta9 and the EGK systems based on the findings are the main tools (and mediators) - to effectively collect, capture, store, share and maintain the integrity and accuracy of patient data/information in the process of delivering healthcare. This same tools are also utilized by medical personnel to efficiently record, share patient diagnoses and prognoses at the facilities. The framework suggests that for the realization of these operational goals to take place depends on the interplay of the adequacy of ICT skilled personnel, relevant frequent training and readily available technical support for the users. The logic here is that unless the users are competent to effectively use the available tools, they cannot put it into use effective use. For instance PRT 4 indicates that “*sometimes when the clerks enter the doctor’s request into the system you find that they make mistakes that they should not be making like capturing duplicate requests or capturing lab requests that are not made by doctors*”.

### **Functionality**

The analytical framework emphasises the significance of relevant systems with continuous availability and uninterrupted functionality. Findings reveal that a reliable systems improve confidence in the pursuit of user’s operational objectives. Also revealed is that restricted infrastructure capacity, inadequate coordination of networked systems and restricted technical support are the negative mediators (inhibitors) of HIS usage by users in the hospital. Citing resource limitations such as “...*disjointed systems, interruptions of network, technical support for the users...*” PRT5 complains that they have a tendency of interrupting the provision of care.

#### *System Functionality*

Given the significance of systems reliability-continuous availability and functionality, healthcare facilities are expected not only to put appropriate systems in place but also to ensure their undisrupted presence. Continuous updates therefore, are important in

ensuring relevance, so that systems can always react to the current operational needs of the organization. In Fig. 2, the functionality of systems is presented as one of the key enablers (mediating factors) of system usage, without which users cannot effectively achieve their goals. Unfortunately, the findings reveal limitation in the functionality of existing HISs some sections/units of the hospital. For instance, “...*the radiology information system at radiology unit of the hospital had been non-functional for the past six months...*” (PRT6). Similarly, users in other units within the hospital complain of challenges with the systems such going off-line or having technical issues. An administrator admits that the systems “...*are very helpful, however there are many times when the systems go off-line and we have to wait for external people to come and fix the network... so we cannot do our jobs*” Functionality failures are serious with various implications to the work processes of the users within the activity system. These include “*long waiting periods for patients... sometime the patients have to referred to other hospitals or told to come back the next day, and the backlog of work*” (PRT7). What has emerged from these findings is that, in spite of these functionality limitations, the overall user-attitudes towards the system have not been significantly impacted. In fact, it emerged in the findings that users are very fond of the Delta9 and LHis systems. Opinions are that the issues with the systems, “*Delta9 is very helpful in terms of looking up patients’ information in a faster manner than the paper based system where you would be required to go into a store a manually go through stacks of paper work...*” (PRT3). Another respondent said that apart from the network slowness issues, Delta9 “...*makes my work very easy...*” (PRT4).

#### *Degree of Utilization (Tools)*

As discussed earlier, system functionalities, based on the analytical framework, can add full value to the medical personnel and other users’ work processes only if their potential is fully exploited. Having relevant reliable systems in place to support the daily operation of the users is paramount. To this, one participant mentions that “...*especially with the Delta9 system, there are some modules of the system that we are not using that would even make our job better...*” (PRT6). From the medical personnel point of a participant confirms that “...*although we can receive lab result on our mobile phone, some of us rarely utilise that functionality*” (PRT8). There is evidence in a correlation between functionality and usage limitations in the healthcare systems. Systems functionality failures have an inhibiting effect on the adequacy of health care delivery process in the public healthcare facilities. Apart from the system users that are affected by the system usage, other practitioners- because of the networking relationship in the working system, who depend on other system users for relevant information. The head of ICT services at the hospital notes that “...*we do get a lot of frustrated users who log in call for issues they are facing...*” (Participant #7). Consultations with patients can be adversely affected.

In summary, ActAD framework suggests that, whilst usage of HIS to facilitate healthcare service delivery is effected by enabling mediators, inadequate usage is an outcome of a negative interplay between the mediating factors, activities and actors. There are a number of constraints such as limited capacity of the network relative to the ever-increasing traffic and human errors as some of the reasons to the causes which lead to many of the systems functionality failures. There is still evidence of segmentation of



infrastructure connectivity. Also, there seems to be a disconnection between e-health strategies/policies and the actual practice of the implementation and use of HISs in public healthcare facilities. With a focus on the context of a divergent national service delivery reality that impacts the right to healthcare service in under-served communities. This may suggest a need of a regulatory implementation framework guiding the implementation process of the HISs in public healthcare facilities within resource constrained environments.

## References

1. Reichertz, P.L.: Hospital information systems—past, present, future. *Int. J. Med. Inform.* **75** (3–4), 282–299 (2006)
2. Sharmin, S., Faith, B., Prieto Martin, P., Ramalingam, B.: The contribution of digital technologies to service delivery: an evidence review. *IDS Evidence Report 221*, Brighton (2017). *IDS*: <http://opendocs.ids.ac.uk/opendocs/handle/123456789/12862>
3. Smedley, A.: The importance of informatics competencies in nursing: an Australian perspective. *CIN: Comput. Inform. Nurs.* **23**(2), 106–110 (2005)
4. Liu, G.G., Chen, Y., Qin, X.: Transforming rural health care through information technology: an interventional study in China. *Health Policy Plan.* **29**(8), 975–985 (2013)
5. Calligaro, G.L., et al.: Effect of new tuberculosis diagnostic technologies on community-based intensified case finding: a multicentre randomised controlled trial. *Lancet Infect. Dis.* **17**(4), 441–450 (2017)
6. Jacucci, E., Shaw, V., Braa, J.: Standardization of health information systems in South Africa: the challenge of local sustainability. In: Abiodun, O.B. (ed.) *Proceedings of the IFIP 9.4 Working Conference on Enhancing Human Resource Development through ICT*, Abuja, Nigeria, May 2005
7. Venter, S.: Hospital information systems: producing accurate hospital data – a myth or possibility? Presentation at the Health Systems Trust Conference, 11 October 2007
8. Mchunu, N.N.: Adequacy of healthcare information systems to support data quality in the public healthcare sector, in the Western Cape, South Africa (2013)
9. Stansfield, S., Orobato, N., Lubinski, D., Uggowitz, S., Mwanjika, H.: The case for a national health information system architecture; a missing link to guiding national development and implementation. In: *Making the eHealth Connection*, Bellagio (2008)
10. Bakar, A., Sheikh, Y., Sultan, B.: Opportunities and challenges of open source software integration in developing countries: case of Zanzibar health sector. *J. Health Inform. Dev. Countries* **6**(2), 443–453 (2012)
11. Lucas, H.: Information and communications technology for future health systems in developing countries. *Soc. Sci. Med.* **66**(10), 2122–2132 (2008)
12. Shortliffe, E.H., Blois, M.S.: The computer meets medicine and biology: emergence of a discipline. In: Shortliffe, E.H., Cimino, J.J. (eds.) *Biomedical Informatics*, pp. 3–45. Springer, New York (2006). [https://doi.org/10.1007/0-387-36278-9\\_1](https://doi.org/10.1007/0-387-36278-9_1)
13. Katuu, S., Ngoepe, M.: Managing digital records within South Africa’s legislative and regulatory framework. In: *3rd International Conference on Cloud Security and Management ICCSM-2015*, pp. 59–70. University of Washington-Tacoma, Tacoma (2015)
14. Damschroder, L.J., et al.: Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implementation Sci.* **4**(1), 50 (2009)

15. Greenhalgh, T., Robert, G., MacFarlane, F., Bate, P., Kyriakidou, O.: Diffusion of innovations in service organisations: systematic review and recommendations. *Milbank Q.* **82**(4), 581–629 (2004)
16. Omachonu, V.K., Einspruch, N.G.: Innovation in healthcare delivery systems: a conceptual framework. *Innov. J.: Publ. Sect. Innov. J.* **15**(1), 1–20 (2010)
17. Weeks, R.: Health care management: an e-health perspective. Editorial Advisory Committee (2012): 34
18. Mladovsky, P., et al.: Health policy in the financial crisis. *Eurohealth* **18**(1), 3–6 (2012)
19. Bose, R.: Knowledge management-enabled health care management systems: capabilities, infrastructure, and decision-support. *Expert Syst. Appl.* **24**(1), 59–71 (2003)
20. Chassin, M.R., Galvin, R.W.: The urgent need to improve health care quality: institute of Medicine national roundtable on health care quality. *JAMA* **280**(11), 1000–1005 (1998)
21. Rezazadeh, E., Hachesu, P.R., Rezapoor, A., Alireza, K.: Evidence-based medicine: going beyond improving care provider viewpoints, using and challenges upcoming. *J. Evid. Based Med.* **7**(1): 26–31 (2014)
22. Häyrynen, K., Saranto, K., Nykänen, P.: Definition, structure, content, use and impacts of electronic health records: a review of the research literature. *Int. J. Med. Inform.* **77**(5), 291–304 (2008)
23. Paul, R.J., Ezz, I., Kuljis, J.: Healthcare information systems: a patient-user perspective. *Health Syst.* **1**(2), 85–95 (2012)
24. Heeks, R.: *Implementing and Managing eGovernment: An International Text.* Sage, Thousand Oaks (2005)
25. Keen, P.G.W., Scott Morton, M.S.: *Decision Support Systems: An Organizational Perspective* (1978). (04), QA76.6 K44
26. Hirschheim, R.: Information systems epistemology: an historical perspective. *Res. Methods Inf. Syst.* 13–35 (1985)
27. Friedman, A.L., Cornford, D.S.: *Computer Systems Development: History Organization and Implementation.* Wiley, Hoboken (1989)
28. Hyötyläinen, R.: Implementation of technical change as organizational problem-solving process: management and user activities. VTT Technical Research Centre of Finland (1998)
29. Norros, L., Toikka, K., Hyötyläinen, R.: Constructing skill based FMS–lessons for design and implementation. In: *IFAC Proceedings*, vol. 23, no. 7, pp. 151–156 (1990)
30. Hyötyläinen, R., Norros, L., Toikka, K.: Constructing skill based FMS—a new approach to design and implementation. In: *IFAC Proceedings*, vol. 23, no. 8, pp. 53–58 (1990)
31. Kautz, K.: Investigating the design process: participatory design in agile software development. *Inf. Technol. People* **24**(3), 217–235 (2011)
32. Vandenberghe, F.: Avatars of the collective: a realist theory of collective subjectivities. *Sociol. Theory* **25**(4), 295–324 (2007)
33. Mursu, A., Luukkonen, I., Toivanen, M., Korpela, M.: Activity theory in information systems research and practice: theoretical underpinnings for an information systems development model. Computer Science and IT Centre, Koupio University, Kuopio, Finland, Information Research (IR), vol. 12, no. 3, April 2007. <http://informationr.net/ir/123/paper311.html>. Accessed 13 Sept 2018
34. American Library Association: *Information Literacy Competency Standards for Higher Education.* The Association of College and Research Libraries, Chicago (2000)
35. Korpela, M., et al.: Information systems research and development by activity analysis and development: dead horse or the next wave? In: Kaplan, B., Truex, D.P., Wastell, D., Wood-Harper, A.T., DeGross, J.I. (eds.) *Information systems research*, pp. 453–471. Springer, Boston (2004). [https://doi.org/10.1007/1-4020-8095-6\\_25](https://doi.org/10.1007/1-4020-8095-6_25)



# Acceptability and Use of Mobile Health Applications in Health Information Systems: A Case of eIDSR and DHIS2 Touch Mobile Applications in Tanzania

Jimmy T. Mbelwa<sup>(✉)</sup>, Honest C. Kimaro, and Bernard Mussa

Department of Computer Science and Engineering, University of Dar es Salaam,  
Dar es Salaam, Tanzania

jmbelwa@yahoo.co.uk, honestck@gmail.com,  
bernard.mussa@gmail.com

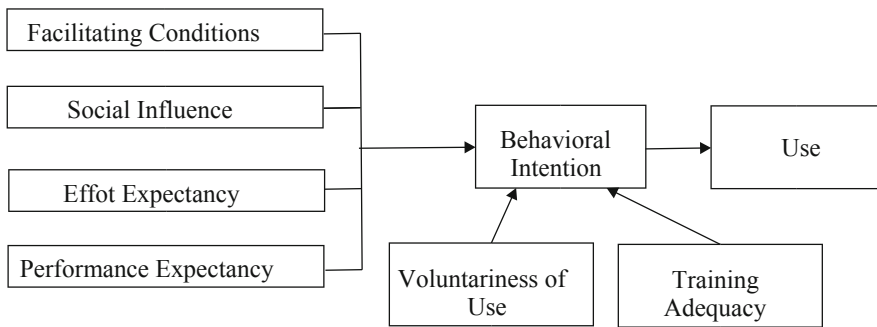
**Abstract.** The use of modern information and communication technology plays a significant role in healthcare services improvement. In the recent years, various mobile application systems have been deployed in the health sectors of different developing countries to facilitate remote data collection and transmission so as to improve its quality and availability. Consequently, understanding the factors contributing to mobile technology acceptance is imperative. The purpose of this study was to adopt a modified UTAUT theoretical model to understand the factors influence acceptance and use of mobile health applications by health workers at health facilities in Tanzania. Questionnaires were used to collect data from health facilities workers. Out of 150 health facilities workers, only 108 return, a 72% return rate whose data was statistically analyzed using SPSS tool. The findings show that effort expectancy and facilitating conditions significantly influence the users located in the urban area on behavioral intention to use mobile health applications. Furthermore, the study shows that the constructs such as social influence, training adequacy, and voluntariness of use do not have a significant influence on the use of mobile health applications.

**Keywords:** Acceptability · Mobile health applications · Health information systems · UTAUT

## 1 Introduction

Public healthcare services can be improved significantly by use of reliable and timely routine health data for making decision. Due to the advancement of the information and communication technologies (ICT), various studies show that ICT can play a significant role in providing a timely, effective and efficient healthcare services improving a routine data reporting [1]. Through ICT technologies, different systems such as health mobile applications and web-based systems have been developed and implemented in different countries [2]. These systems have the potential to provide and promote quality information on routine health data for decision making and planning.

In the recent years, different mobile health applications such as electronic Integrated Diseases Surveillance and Response System (eIDSR) and DHIS2 Touch have been adopted and integrated into DHIS2 (a web-based system) [3] for improving routine data reporting. These applications use mobile phone with the help of the internet to communicate with DHIS2 server. Despite the adoption of these mobile applications, users may jeopardize the efficient and effective interaction of the mobile systems and thus lead to a delay in routine data reporting. Delays on routine reporting of data can endanger the information availability and quality. Various studies have shown that the anticipated goals for developed and implemented a system might not be achieved or not well adopted [4]. Acceptability problems might be among of the main reasons for these deficits and therefore recommended to evaluate the acceptability and use of the systems in order to be able to identify and solve or handle these [5]. Lack of acceptability can lead to delay in routine data and increase the poor quality of information and user’s dissatisfaction [6].



**Fig. 1.** The study model for mobile health applications user acceptance. (Modified from Venkatesh et al. [7])

Due to the importance of eIDSR and DHIS2 Touch as mobile health applications in the health management information system, in this study, we examine the acceptability and use of mobile health applications using key constructs in an extended unified theory of acceptance and use of technology (UTAUT) [7] to describe acceptance of eIDSR and DHIS2 Touch systems in Tanzania setting as a developing country. This study extends the validity and empirical applicability of UTAUT theoretical model by examining it within the context of the national health management information system. This follows to the adoption of the UTAUT model to include voluntariness of use as a predictor as behavioral intention and training adequacy as a direct factor of behavioral intention as depicted in Fig. 1. This study will inform the system developers and

implementers on interventions against the potential problems that can enable them to have successfully design and deployment of health mobile applications in developing countries.

## 2 Related Works

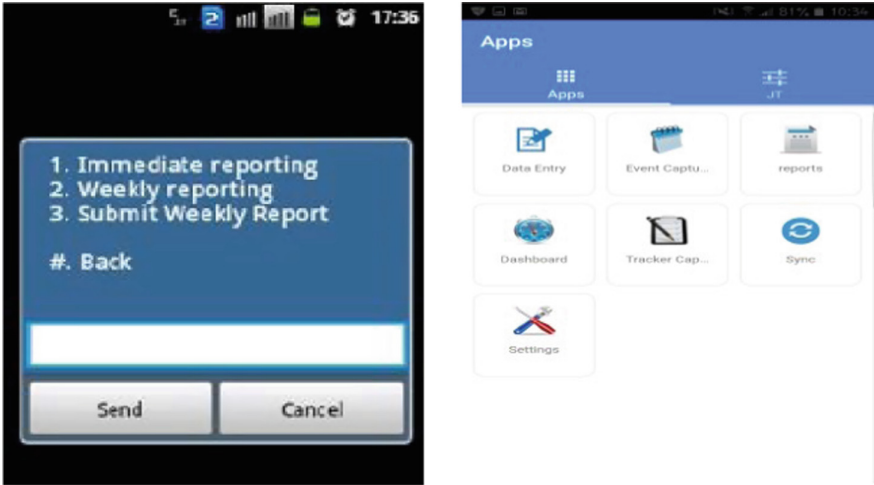
Both researchers have an interest in understanding the factors contributes to the technology acceptance and use. Venkatesh et al. proposed a theoretical model called UTAUT [7] as an acceptance model after comprehensive research. The model defines four constructs which are performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC) as elements of behavior intention and use behavior.

Despite the growing adoption and use of the health mobile systems in the developing countries, there are a few studies that have focused on investigating the acceptance and use of mobile health applications in health care context. Most of the studies are in mobile banking [9], learning and teaching [10], etc. to determine the factors that are influencing the adoption and use of mobile applications in organizations. Miltgen et al. [11] studied the user acceptance on biometric and they focused on the social influences and facilitating factors affecting user acceptance. Oliveira et al. [12] worked on user adoption for mobile banking. This study mainly focused on the effects of UTAUT and regulating factors of gender and age. The intention to use of e-learning systems in the workplace was conducted by Yoo et al. [13] and they used performance expectancy, social influences and facilitating conditions as extrinsic motivation components and effort expectancy as intrinsic component motivation. Moreover, Akter et al. [14] investigated the adopted and acceptance problems of mobile health from the quality of service perspectives.

## 3 Methods

### 3.1 Mobile Health Applications

This study was conducted based on the mobile health applications namely, eIDSR and DHIS2 Touch which are integrated with the DHIS2 software. The eIDSR is a USSD based application used in Temeke district to report immediate and weekly reportable diseases or events of public health importance while DHIS2 Touch is an android application implemented in Wangimombe district which is used to collect and stores routine data. Both mobile applications are used as tools to collect routine health data within respective districts. About 200 users interact with these mobile health applications. The two mobile applications are independent and run separately. The illustration of the user interfaces is shown in Fig. 2.



(a) (b)

Fig. 2. Mobile interfaces of mobile health applications. (a) eIDSR (b) DHIS2 Touch

### 3.2 Studying Setting

The main purpose of this study was to adopt the modified UTAUT model in order to understand the factors that caused the user to accept and use mobile health applications. The key six constructs are performance expectancy, effort expectancy, social influence, facilitating conditions, training adequacy and voluntariness of use as depicted in Fig. 1. This study was carried out on respective districts (Wangingombe located in the rural area and Temeke located in an urban area) and involved health facilities workers as mobile apps users. A structured questionnaire was administered to them. The questionnaire contained the set of questions adapted from [7] to suit the context of this study.

### 3.3 Research Hypothesis

Performance Expectancy (PE) is a degree to which user trust that using ICT application will provide him or her to achieve a performance gain in a job [7]. Previous researches, the performance expectancy is regularly a robust intention predictor [12]. The importance of performance expectancy to health has been shown in various studies [13, 14] and thus we hypothesized that:

H1: Performance expectancy will positively influence the users at health facilities to use mobile health application.

Effort Expectancy (EE) is a degree of ease associated with ICT application use was found that it is an important intention predictor in the UTAUT theoretical model [7]. Previous studies show that the effort expectancy has the influence on behavioral intention when a new technology introduced to users [13, 15]. This research supports

UTAUT and hypothesized that effort expectancy will play a vital role in user acceptance of mobile health application.

H2: Effort expectancy will positively influence the behavior intentions to use mobile health application.

Social influence is the degree to which users perceive that vital others influence them to use a certain technology. Social influence has direct effect on the intention to use a particular technology [7]. Friends, supervisors, and peers of the health facilities workers can influence their behavioral intention to use ICT application provided for health. The author in [16] show that social influence is one of the significant factors influencing adoption of the mobile phone and use in South Africa, and therefore we hypothesized that:

H3: Social influence will positively influence health workers intention to use mobile health application.

Training Adequacy (TA) is an extent to which user believes that the training acquired is enough for her or him to use a mobile health application effectively. In this study, we identified TA as a key factor which influences the intention of targeted users to use mobile health application. Since mobile health application are used at the health facilities level, it is expected that users perceived training received is adequate. This study hypothesized that:

H4: Training adequacy will have a positive influence on health facilities workers intention to use mobile health application.

Voluntariness of Use (VO) is an extent to which user perceives that the user has a choice or not to use health ICT and also it is a significant concept influence intention to use information and communication technology. Voluntariness to use was treated as a compulsory variable in the original UTAUT theoretical model. Voluntariness is a key factor on the acceptance and use of a particular technology. We anticipated that the more voluntariness of use, the more users will have a positive attitude on eIDSR or DHIS2 Touch and thus the more intention to use mobile applications. Therefore, we hypothesized:

H5: Voluntariness of use will have significant influence on behavioral intention to use mobile health application.

According to [11, 13, 14], facilitating conditions have a positive influence on the use of certain technology. Facilitating conditions prediction on behavioral intention is non-important [7]. The influence on intention to use a particular technology will be important if the user believes that support from an organization for technology use is unpredictable. However, when the support is predictable and consistency; we expected that the facilitating conditions will influence behavior intention. Therefore, it is anticipated that use behavior will be predicted by behavioral intention.

H6: Facilitating conditions will positively influence the health workers intention to use mobile health application.

H7: Behavioral intention will have a positive influence on health workers usage behavior of mobile health application.

### 3.4 Data Collection and Analysis

A structured questionnaire was used as a main data collection tool for this study. The questionnaire was printed and self-administered to 108 respondents. The confidentiality was guaranteed to all respondents and filling a name field was considered as an option.

The questionnaire contained the set of questions adapted from [7] which were formulated to capture information for each construct in the modified theoretical model. Formulated indicators for the new constructs which are not included in the UTAUT model was learnt by comprehensive literature review. The 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree) used to measure the constructs. Descriptive analysis of the collected data was analyzed using Statistical Packages for Social Science (SPSS) statistical tool for the goal of getting frequencies, means, standard deviation, skewness and kurtosis.

## 4 Results

### 4.1 Descriptive Statistics

Acceptability and use evaluation of health mobile applications namely eIDSR and DHIS2 Touch was conducted on respective districts, Temeke and Wangingombe. Total of 108 respondents (54 in Temeke district and 54 Wangingombe district) in this study were health facilities workers which represent the daily users of the mobile health applications. Table 1 shows the descriptive statistics of all 26 indicators measured in this study and used to evaluate the acceptability and use of the mobile health applications through the modified UTAUT conceptual model. The majority of statistical analysis procedures are based on assumption that data are normally distributed. The observations for the normalized data is normally equally and symmetrically about the mean. Skewness and kurtosis are statistical measures which are used to establish sample distribution shape. Symmetry is measured by skewness and peakedness of the distribution is measured by kurtosis.

The values for asymmetry (Skewness) lies between  $-2$  and  $+2$ . The values between that range are considered acceptable in order to prove normal univariate distribution. If the value is negative it means that distribution skewed left otherwise skewed right. For zero value, it means that the skewness is perfect normal distribution [8].

Kurtosis values between  $-2$  and  $+2$  are considered acceptable for proving a normal univariate distribution. The value outside mentioned range shows that that the distribution is non-normal. The higher kurtosis value means that the high peak near the mean and the lower kurtosis value means that flat top around the mean [8].



**Table 1.** Measures to determine the reliability and validity of the model

Measurement indicators	Mean		Standard deviation		Skewness standard error		Kurtosis standard error		Definition of construct
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	
PE1: I find mobile health application more useful in my job	4.07	4.11	.843	.462	.325	.325	.639	.639	Performance Expectancy (PE) is a degree to which user trust that using mobile health application will provide him or her to achieve a performance gain in a job
PE2: Using mobile health application helps me to report routine data quickly	4.24	4.09	.823	.597	.325	.327	.639	.644	
PE3: Using mobile health application increases my productivity	3.91	4.00	.917	.752	.325	.325	.639	.639	
EE1: My interaction with mobile health application is understandable and clear	3.94	3.89	.969	.776	.327	.327	.644	.644	Effort Expectancy (EE) is a degree of ease associated with the mobile health application use
EE2: Learning on using mobile health application is easy for me	4.07	3.94	.843	.738	.325	.325	.639	.639	
EE3: it is easy for me to become skillful at using mobile health application	4.06	4.06	.899	.534	.325	.327	.639	.644	
EE4: In general, I find mobile health application easy to use	4.06	3.84	.763	.946	.325	.333	.639	.656	
SI1: People who are important to me think that I should use mobile health application	3.96	3.66	.776	.854	.325	.327	.639	.644	Social Influence (SI) is the extent to which user believe perceives that her or his colleagues and

*(continued)*

**Table 1.** (continued)

Measurement indicators	Mean		Standard deviation		Skewness standard error		Kurtosis standard error		Definition of construct
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	
SI2: My coworkers think that I should use mobile health application	4.07	3.87	.843	.595	.325	.330	.639	.650	supervisors believe she or he should use a mobile health application
SI3: The CHMT has been supportive in the use of mobile health application at my health facility	4.00	4.11	.929	.670	.330	.327	.650	.644	
SI4: Overall, the use of mobile health application has been supportive and encouraged at my health facility	4.11	4.02	.861	.598	.325	.325	.639	.639	
FC1: I have resources. (e.g. mobile phone, computer, reporting forms, internet) to use mobile health application	3.92	3.96	1.089	.706	.327	.327	.644	.644	Facilitating Conditions (FC) is refer to user perceptions of the technical infrastructure or resources available to support the use of mobile health applications
FC2: I have the knowledge necessary to use mobile health application	4.02	3.92	.866	.781	.327	.327	.644	.644	
FC3: Mobile health application experts are available at any time for assistance with mobile health application difficulties	3.83	3.58	.944	.848	.330	.330	.650	.650	

(continued)

**Table 1.** (continued)

Measurement indicators	Mean		Standard deviation		Skewness standard error		Kurtosis standard error		Definition of construct
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	
FC4: I have knowledge sources (e.g. manuals, documents) to support my use of mobile health application	4.07	3.31	.968	1.076	.325	.330	.639	.650	
TA1: The training on using mobile health application is very helpful in my use of the mobile system	4.02	4.13	1.055	.627	.325	.330	.639	.650	Training Adequacy (TA) is an extent to which user believes that the training acquired is enough for her or him to use a mobile health application effectively
TA2: I have a training document as a reference material that I can consult it during the use of mobile health application	3.81	3.17	1.011	1.122	.325	.327	.639	.644	
TA3: I feel training received is adequate for my efficient use of mobile health application	3.55	3.51	1.048	1.012	.327	.327	.644	.644	
TA4: I need another training on mobile health application to enable me use the system efficiently	4.19	4.34	1.065	.706	.325	.327	.639	.644	
TA5: The mobile health application training was well organized and easy to follow	3.91	4.04	.966	.619	.327	.327	.644	.644	

(continued)

**Table 1.** (continued)

Measurement indicators	Mean		Standard deviation		Skewness standard error		Kurtosis standard error		Definition of construct
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	
VO1: Although it might be very helpful, using mobile health application is not obligatory in my work	3.34	3.12	1.018	.968	.327	.365	.644	.717	Voluntariness of Use (VO) is an extent to which user believes that he or she is voluntary using mobile health applications
VO2: My use of mobile health application would be for mandatory routine reporting	4.06	3.87	.811	.625	.325	.354	.639	.695	
VO3: My use of mobile health application would be for voluntary analysis of the health facility data for informed decision making	3.70	3.52	1.093	.969	.325	.365	.639	.717	
BI1: I intend to continue using mobile health application in the future	4.17	4.04	.818	.582	.325	.325	.639	.639	Behavioral Intention (BI): is an extent to which user intends to use mobile health application
BI2: I will continue using mobile health application in my daily work life	4.20	4.00	.833	.679	.325	.327	.639	.644	
BI3: I plan to continue using mobile health application frequently	4.13	4.08	.870	.646	.325	.327	.639	.644	

Mean value shows either majority of respondents agree or disagree with a particular issue and standard deviation shows how respondents differ from a correct issue. Similarities of response in the same issue. Acceptable standard deviation is less than 3.

According to the description of the skewness and kurtosis, it is seeming that the data distribution for variable data is normal. According to the description of the skewness and kurtosis, it is seeming that the data distribution for variable data is normal.

### 4.2 Reliability Measurement

The PLS-SEM used to evaluate the reliability of the instrument’s measurement using SPSS. Table 2 presents the results of the indicator with loadings, composite reliability, Cronbach’s Alpha and average variance extracted (AVE). Since some of the factor loadings exceeded 0.5 and some of the construct reliability values exceeded the recommended level of 0.7, the results show that the internal reliability and convergent validity existed. However, some values are below the recommended values. This might be due to the presence of high variability within questionnaire items.

**Table 2.** Measures to determine the reliability and validity of the model

Construct	Indicator	Factor loadings		CR		Cronbach’s Alpha		AVE	
		eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch
Performance Expectancy (PE)	PE1	-0.084	0.718	0.023	0.407	0.852	0.44	0.028	0.240
	PE2	0.077	0.091						
	PE3	0.269	0.443						
Effort Expectancy (EE)	EE1	0.031	0.458	0.009	0.745	0.908	0.832	0.005	0.441
	EE2	0.075	0.882						
	EE3	-0.021	0.738						
	EE4	0.109	0.48						
Social Influence (SI)	SI1	-0.135	0.75	0.008	0.481	0.913	0.72	0.041	0.238
	SI2	-0.158	0.458						
	SI3	0.308	0.052						
	SI4	0.165	0.422						
Facilitating Conditions (FC)	FC1	-0.034	-0.084	0.001	0.442	0.797	0.564	0.008	0.245
	FC2	0.123	0.365						
	FC3	-0.019	0.773						
	FC4	-0.122	0.493						
Training Adequacy (TA)	TA1	-0.118	0.309	0.229	0.041	0.786	0.571	0.091	0.030
	TA2	0.289	0.033						
	TA3	0.374	-0.026						
	TA4	0.191	0.214						
	TA5	0.427	-0.073						
Voluntariness of Use (VO)	VO1	0.332	0.874	0.312	0.712	0.552	0.639	0.158	0.497
	VO2	0.158	0.242						
	VO3	0.581	0.817						
Behavioral Intention	BI1	0.906	0.924	0.903	0.933	0.966	0.943	0.756	0.822
	BI2	0.872	0.904						
	BI3	0.828	0.892						

### 4.3 Research Model Summary

Six factors were introduced to linear regression to measure the success of the model and predict the causal relationship between the factors and behavioral intention. The factors are facilitating condition, social influence, effort expectancy, performance expectancy, voluntariness of use and training adequacy. Based on the results obtained, the model variance with adjusted R values for eIDSR and DHIS2 Touch are 0.722 and 0.128, indicating that the model explains 72.2% (eIDSR) and 12.8% (DHIS2 Touch) toward the acceptance and use of the mobile health applications in health information systems.

Table 3 present the predictive factors (Beta coefficients) for each hypothesis obtained from the linear regression analysis. The results of DHIS2 Touch show that all six factors did not have a significant influence on behavioral intention to accept and use of mobile health application and the results of eIDSR show that performance expectancy, social influence, training adequacy and voluntariness of use did not have significant influence on behavioral intention to accept and use of mobile health application in health information systems.

The two factors in the eIDSR application, effort expectancy and facilitating conditions have shown positively influence the behavior intentions to accept and use mobile health applications. The beta coefficients are presented in Table 3.

**Table 3.** Unstandardized and standardize coefficients and significance levels of constructs in the model

Construct	B		SE		$\beta$		p	
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch
PE	-.158	0.79	0.098	.188	-.158	.079	.114	.676
EE	.610	-.042	.114	.194	.610	-.042	0.000	.831
SI	.215	.236	.107	.201	.215	.236	.052	.250
FC	0.550	.091	.100	.167	.550	.091	.000	.588
TA	-.233	.296	.126	.204	-.233	.296	.072	.157
VO	.185	.136	.102	.164	.185	.136	.079	0.413

Table 4 present results of the hypothesis testing.

**Table 4.** Summary of hypothesis testing

Hypothesis	Results		Conclusion	
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch
H1	$\beta < -.158, p < .114$	$\beta < .079, p < .676$	Not supported	Not supported
H2	$\beta < .610, p < .000$	$\beta < -.042, p < .831$	Supported	Not supported
H3	$\beta < .215, p < .052$	$\beta < .236, p < .250$	Not supported	Not supported
H4	$\beta < -.233, p < .072$	$\beta < .296, p < .157$	Not supported	Not supported
H5	$\beta < .185, p < .079$	$\beta < .136, p < .413$	Not supported	Not supported
H6	$\beta < .550, p < .000$	$\beta < .091, p < .588$	Supported	Not supported

## 5 Discussions

This study aimed to understand the factors that influence the acceptance and usage of mobile health application in Tanzania using modified UTAUT research model. Previous studies have shown that the acceptance and use of mobile health technologies can improve the quality of health services [16, 17].

Based on the results in Table 1, the study did not find any significant relationship between performance expectancy and behavior intention to accept and use mobile health applications. However, the interviews showed that the users agreed the applications improve their productivity, save time and send a report to the higher level immediately.

The study shows that the effort expectancy of eIDSR has positive influence ( $\beta = .610$ ) compared with DHIS2 Touch. This implies that the users in an urban area feeling comfortable and easy to use mobile health technologies than in rural area.

Furthermore, the study shows that the constructs such as social influence, training adequacy, and voluntariness of use do not have an influence on the acceptance and use of mobile health applications in health information systems. This finding is attributed to the fact that during the time of this study, users may not have complete support, enough training of the mobile health applications and it is not voluntary to use the applications. This finding may appear contrary to the previous studies [7, 16, 17] which confirm that social influence, training adequacy, and voluntariness of use have a significant relationship with behavioral intention in mobile health applications adoption.

Another finding from this study was that the results of eIDSR showed that the facilitating conditions significantly influence ( $\beta = .550$ ) the acceptance and usage of mobile health technologies in an urban area rather than rural area (DHIS Touch). This means that the users in urban area had resources to use mobile applications including necessary knowledge.

## 6 Conclusion

The purpose of this study was to adopt a modified UTAUT theoretical model to understand the factors influence acceptance and use of mobile health applications by health workers at health facilities in Tanzania. The study shows that effort expectancy and facilitating conditions significantly influence the users located in the urban area on behavioral intention to use mobile health applications. These findings of the study inform the implementers to develop strategies for the successfully design and deployment of mobile health applications in developing countries.

Moreover, future studies may involve further analysis using structural equation modelling to determine construct validity and other factors surrounding the acceptance and use of mobile health applications.

These will enable to identify other problems hindering behavioral intention to accept and use mobile applications.

## References

1. Kohn, L.T., Corrigan, J.M., Donaldson, M.S.: Shaping the future for health: to err is human: building a safer health system. Institute of Medicine, Washington (2000)
2. Ali, A.L., et al.: Experience with the Mobile4D disaster reporting and alerting system in lao PDR. In: Choudrie, J., Islam, M.S., Wahid, F., Bass, J.M., Priyatma, J.E. (eds.) ICT4D 2017. IAICT, vol. 504, pp. 525–535. Springer, Cham (2017). [https://doi.org/10.1007/978-3-319-59111-7\\_43](https://doi.org/10.1007/978-3-319-59111-7_43)
3. District Health Information System. <https://www.dhis2.org/>. Accessed Aug 2018
4. Khajouei, R., Jaspers, M.: The impact of CPOE medication systems' design aspects on usability, workflow and medication orders a systematic review. *Methods Inf. Med.* **49**(1), 3–19 (2009)
5. Thyvalikakath, T., Monaco, V., Thambuganipalle, H.B., Schleye, T.K.: A usability evaluation of four commercial dental computer-based patient record systems. *J. Am. Dent. Assoc.* **139**(12), 1632–1642 (2008)
6. Shah, S.G.S., Robinson, I.: Benefits of and barriers to involving users in medical device technology development and evaluation. *Int. J. Technol. Assess. Health Care* **23**(1), 131–137 (2007)
7. Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D.: User acceptance of information technology: toward a unified view. *MIS Q.* **27**(1), 425–478 (2003)
8. George, D., Mallery, P.: SPSS for Windows Step by Step: A Simple Study Guide and Reference, 17.0 Update, 10th edn. Allyn & Bacon Inc., Needham Heights (2009)
9. Zhou, T., Lu, Y., Wang, B.: Integrating TTF and UTAUT to explain mobile banking user adoption. *Comput. Hum. Behav.* **26**(4), 760–767 (2010)
10. Pynoo, B., Devolder, P., Tondeur, J., Van Braak, J., Duyck, W., Duyck, P.: Predicting secondary school teachers' acceptance and use of a digital learning environment: a cross-sectional study. *Comput. Hum. Behav.* **27**(1), 568–575 (2011)
11. Miltgen, C.L., Popovič, A., Oliveira, T.: Determinants of end-user acceptance of biometrics: integrating the “Big 3” of technology acceptance with privacy context. *Decis. Support Syst.* **56**, 103–114 (2013)
12. Oliveira, T., Faria, M., Thomas, M.A., Popovič, A.: Extending the understanding of mobile banking adoption: when UTAUT meets TTF and ITM. *Int. J. Inf. Manag.* **34**(5), 689–703 (2014)
13. Yoo, S.J., Han, S., Huang, W.: The roles of intrinsic motivators and extrinsic motivators in promoting e-Learning in the workplace: a case from South Korea. *Comput. Hum. Behav.* **28**(3), 942–950 (2012)
14. Akter, S., D'Ambra, J., Ray, P.: Service quality of mHealth platforms: development and validation of a hierarchical model using PLS. *Electron. Mark.* **20**(3), 209–227 (2010)
15. Sun, Y., Liu, L., Peng, X., Dong, Y., Barnes, S.J.: Understanding Chinese users' continuance intention toward online social networks: an integrative theoretical model. *Electron. Mark.* **24**(1), 57–66 (2014)
16. Van Biljon, J., Kotzé, P.: Cultural factors in a mobile phone adoption and usage model. *j-jucs* **14**(16), 2650–2679 (2018)
17. Hoque, R., Sorwar, G.: Understanding factors influencing the adoption of mHealth by the elderly: an extension of the UTAUT model. *Int. J. Med. Inform.* **101**, 75–84 (2017)





# The Experience of Chamwino Small-Scale Farmers on the Use of Smartphone in Farming Business, Tanzania

Ezra Misaki<sup>(✉)</sup> 

College of Business Education, Dar es Salaam, Tanzania  
emisaki2000@gmail.com

**Abstract.** The pervasive use of smartphones to acquire diverse information among small-scale farmers has received little attention in studies. This study, therefore, explored the experience of Chamwino's small-scale farmers of the usage of smartphone to address ownership pattern, farming practices, information needs, encountered challenges and training needs for future technological alterations. The study employed qualitative design for data collection and thematic analysis was used. The findings revealed that the longer the distance from Dodoma city centre, the fewer the number of smartphones owners. That, less than half of farmers in Mvumi and Makangwa owned smartphones while, less than a quarter in Itiso, Mpwayungu, and Chilonwa Divisions. That youths owned more smartphones than elders, and mostly second-hand that were inadequately used for farming business. This was because, there was no special farming enabled information system to disseminate agricultural information. Accordingly, the frequently used features were SMS and voice calls. Consequently, farmers need information on inputs, weather, market and finance among others. Alternatively, there was no official training on the use of the device thus the new technology was therefore underutilized. Furthermore, challenges identified were farmers' lack of expertise of utilizing the device, uncomfortable large size and the interface of smartphones. Accordingly, farmers were interested in capacity building as many features were not used adequately. Consequently, the study provides deep understanding of farmers' experience and recommends for technological alteration to increase usability of the device.

**Keywords:** Farmers · Experience · Information

## 1 Introduction

Smartphones with a touch screen interface empowered by Global System of Mobile Communication (GSM) protocol are ubiquitous. The adoption and usage of smartphones are prevalent globally, and the majority 63% of the owners uses it at least every thirty minutes in matters such as making voice call, checking time, and accessing the internet [1]. The internet world statistics report that the number of mobile phone subscribers has reached 6.8 billion, which is closer to the world total population of approximately 7.1 billion [2]. The report shows that more than 3.6 billion people, who are nearly half of the humanity globally, are using messaging application in Latin

America, the Middle East, and Africa. In Africa, 191 million people use social media and messaging apps, and 90% of these use WhatsApp and Facebook applications which are common worldwide [3]. The internet users in Tanzania who access the worldwide web increased approximately from 18 million in 2016 to 19 million in 2017. Internet penetration increased from 40% in 2016 to 45% in 2017 with more than 40.08 million mobile phone subscribers [4]. Thus, the use of mobile phone particularly smartphone is a promising move towards the creation of a superhighway community. Thus, understanding the portion of the subscriber's experience particularly the small-scale farmers who use smartphone is vital for future technological improvement and innovations.

Small-scale farmers are characterized by family labour and own less than ten hectares of land for cultivation [5]. The Small-scale farmers are referred to farmers throughout this article. These farmers use smartphone to acquire knowledge and skills that support farming decision-making [6]. For example, Karetos et al. [7] observe that the USA farmers use smartphone as a supplementary working tool to look for information on weather, news, and market that helps in making decisions on their work schedules. Farmers use smartphone sensors such as camera and GPS to explore agricultural related information. A camera is used to take pictures, send and store them on the server or cloud for future reference or inspection whereby, feedback can be displayed and used by respective farmers. The GPS is used for location-aware application to receive essential environmental information for agriculture such as pests, diseases, weather, soil type, texture, quality, and so on, radiation, location of field and farmers [8]. The smartphone is used to collect and disseminate marketing information (product, price, place and promotion), keep information, and balance the supply and demand for commodities [9]. Smartphone help to estimate harvest and forest fuel [10, 11], provide information as a self-reporting on fish catch rates including common snook, spotted seatrout, and red drum [12]. Therefore, with these multiple functions, a smartphone provides a farmer with a resourceful platform that assists in daily decision-making.

Chamwino farmers have not been left behindhand the advancing smartphone technologies that frequently override other digital technologies in the globe. The Chamwino farmers also use smartphones in various farming related activities to access information that add knowledge and skills. Thus, understanding farmers' experience on the use of smartphone to access or acquire information is important. This information is instrumental in making future alteration of the technology to make it consistent with farmers' expectations. Furthermore, increased popularity of smartphone has therefore inspired researchers into exploring the application of the technology in farming business [6–8]. Several studies on smartphone have been carried out on matters such as awareness [10], assessment of the use of sensor [8], potential evaluation and estimation [10, 11], and on the performance of marketing activities [9]. Thus, smartphone usage has become an integral part of farmers' livelihood for communication.

Unfortunately, few studies have been conducted to understand the experience of farmers who use smartphone to acquire farming information. The study, therefore, sought to investigate the experience of Chamwino farmers that use smartphone to access information to support decision-making. In addition, the study also proposes

areas for further improvements. In future, this would be a milestone of improving future mobile technologies and innovations in agricultural domain, and in helping policy practitioners to deal with the existing gaps. Subsequently, other studies can compare the experience of Chamwino farmers and other areas for technological enhancement.

The study explored the experience of farmers who use the smartphone as a supplementary tool to assist in farming decision-making. The experience focused on ownership level, farming related practices, information needs, challenges, and training needs on the application of smartphone. The idea is to let farmers voice their needs of improving the smartphone quality so that appropriate model can be developed. Thus, farmers who are equipped with diverse knowledge and skills ought to exhibit heuristic character in addressing challenges. To achieve this, the formulated research questions were; (1) *What is the ownership level of smartphones among the Chamwino farming community?* (2) *What have been the farming practices and farmers needs when using the smartphones?* (3) *What challenges do farmers face when using smartphones?* (4) *What type of training do farmers need to help them make better use of smartphone?*

## 2 Conceptual Framework

The conceptual framework focuses on understanding farmers' experiences of utilizing Apps in Smartphone to acquire farming information. Farming information is obtained from farmers themselves, relatives, friends, neighbors and other stakeholders in the farming business. Likewise, farming information is accessed through agricultural enabled information systems such as e-Wallet [23], and the like that disseminates skills and knowledge to assist farmers in decision-making. Thus, stakeholders in the framework include;

- Farmers through Apps communicate with farming stakeholders to acquire information that add skills and knowledge to support farming decisions.
- The relatives, friends, experts, or farmers are a group of stakeholders that are believed to have farming skills and knowledge which are used by farmers to make decisions.
- The agriculture enabled information system is specific software which was developed to disseminate farming information to farmers through Apps. Thereby, it disseminates timely, clear, accessible and transparent farming information to farmers that support decision-making.

The framework is shown (see Fig. 1) as farmers use Apps in smartphone to seek information from stakeholders and from, agricultural enabled information system. Therefore, farmers need to own smartphones to acquire information for farming purposes, and therefore, are expected to reveal farming practice, their needs, encountered challenges, and ultimately to identify the training needs for better utilization of the tool.

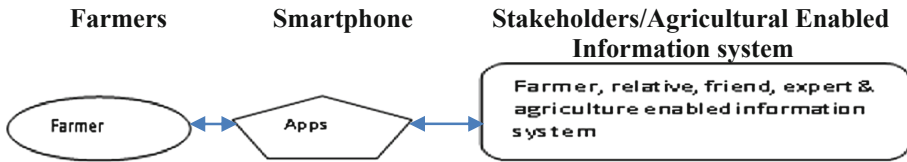


Fig. 1. Framework for understanding farmers experience on smartphone usage

### 3 Methodology

#### 3.1 Research Design

This study employed qualitative approach because of the characteristics of the farmers in Chamwino [13, 14]. Qualitative data collection and analysis aimed at providing in-depth socio-context and detailed description and interpretations [15]. The approach enabled extensive expression from farmers, and which was healthier in collecting relevant information and the freedom of sharing experience. The data collection was preceded by a survey instrument which was developed and distributed to ten academic members of staff at the College of Business Education to check for relevancy of the questions. Thereafter, all the grey areas, which were raised regarding comprehension, clarity, and relevancy, were addressed before administering the questions to the target population.

An interview guide comprised of open-ended questions and focused on themes such as ownership level, farming practices and needs, challenges, and training needs on the smartphone usage in routine activities (see Table 1). The pilot study for further improvement was undertaken at Mgodole-Mkange village Chalinze District, in the Coastal region. Thereafter, the adjustments were made to questions but retaining their original meaning to make them easily understood by farmers.

Table 1. The interview questions on related themes and their relevance to the survey

Theme	Relevancy
What is the <b>ownership</b> level of smartphones among Chamwino farming community?	Understand the ownership pattern of smartphone in rural settings
What have been the <b>farming practices and farmers needs</b> when using the smartphones?	The farmers use of applications in smartphone for farming related business and their current information needs
What <b>challenges</b> do farmers face when using smartphone?	To identify the obstacles which farmers face when using smartphone as a supporting tool to acquire information to support decision-making
What type of <b>training</b> do farmers need to help them make a better use of smartphone?	To understand farmers’ motivation of using smartphone and areas which need training

### 3.2 Study Area

Chamwino is one of the seven districts in Dodoma region with approximately a total population of 340,000. The District is dominated by Gogo followed by other small ethnic groups such as the Barbaigs, the Maasai, the Mbuwi, the Rangì, the Sandawe and the Nguu. Chamwino comprises five divisions namely; *Itiso, Makangwa, Mvumi, Chilonwa and Mpwayungu*. The main economic activities include crop farming, livestock keeping, beekeeping, and seasonal petty businesses [5, 13]. Chamwino was chosen because it is one of the districts affected with food insecurity [5].

### 3.3 Selection of the Participants

A non-probabilistic convenience sampling which involved the population that was enthusiastic in the study was employed. Convenience sampling was chosen because the targeted population met certain practical criteria such as being easily accessible, geographical proximity and availability [16, 17]. The selection was conducted through Village Chairman and Ward Executive Officer. The inclusion criteria involved being a farmer for at least three years, should have participated in any of the community development projects, ability to use mobile phone for communication, and being the head of a household (see Table 2).

**Table 2.** Selected participants by division, village and gender

Division	Village	Participants by gender		Total participants
		Female	Male	
Mvumi	Muungano	2	3	5
	Mvumi Iloilo	1	2	3
Mpwayungu	Chiberela	3	1	4
	Isang'ha	1	1	2
Makangwa	Mlowa barabarani	2	1	3
	Mlowa bwawani	1	2	3
Chilonwa	Nzasa	2	1	3
	Membe	1	2	3
Itiso	Haneti	3	1	4
	Itiso	1	2	3
Total		17	16	33

**Source:** Field report

### 3.4 Data Collection Method

An in-depth interview, which lasted for between 50 and 70 min was administered in Swahili language from 08<sup>th</sup> June to 23<sup>rd</sup> July 2018. Simultaneously, the researcher took notes and audio-recorded the conversations after getting the consent from the respondents. However, the data saturation was reached at 24<sup>th</sup> respondent, after which

additional interviews did not add any new information. The concept of saturation level has been used in previous qualitative studies [18, 19].

### 3.5 Data Analysis

The qualitative thematic analysis was presented systematically in a table format following the pattern reflected in the research questions. Data from audio-recording were transcribed into units that were categorized into themes [20]. Thematic analysis offered a stretchy and useful tool of presenting important detailed information as suggested by Braun and Clarke [21]. Also, as suggested by Creswell [22], thematic analysis involves organizing and preparing the data, doing the initial reading of the information, coding the data, making descriptions from the codes, doing thematic analysis, presenting the finding in tables, and interpreting the findings.

## 4 The Study Findings

The findings are presented based on the analysis performed and the quotes were translated from Swahili to English language.

### 4.1 Ownership of Smartphones

Smartphones were commonly known as “*Touch*” or “*Simu ya kupaata*” (that means a slippery mobile phone). That, less than half of the respondents in Mvumi and Makangwa Divisions owned smartphones. While less than a quarter in Itiso, Mpwayungu, and Chilonwa owned smartphone. Furthermore, the commonly owned smartphones were TECNO, ITEL and Samsung models. However, more than three quarter of the smartphone owned were second-hand, meaning that they had already been extensively used by people other than the current owner. Accordingly, there were limited chances of sharing the smartphones among farmers for use on transactions such as money transfer. Ownership of smartphones was more pronounced among the youth aged between 23 to 45 years than old people of 50 years and above.

### 4.2 Farming Practice and Farmers’ Needs

Participants used smartphones to communicate with relatives, friends, businessmen and women, consultants (public and private) in areas of farming related business, social and political purposes. The farming related information focused on transportation, pesticides, input, finance, market; Social inquiries focused on family matters, while political inquiries were based on vote seeking during the election. Mode of communications was dominated by SMS and voice calls. In addition, a limited number of youths in Mvumi and Makangwa used smartphone for chatting on Facebook, WhatsApp, in-built camera, games and the internet. Few farmers were using smartphones for checking date, checking time and for doing simple arithmetic using in built calculator. Furthermore, farmers needed to get more information on inputs, weather, finance, transport, market, health, and agricultural research reports.

### **4.3 Challenges Encountered When Using Smartphone**

The encountered obstacles include; lack of expertise of operating the device, bulkiness of smartphones, weak networks in Mpwayungu, Itiso and a few areas in Chilonwa as opposed to Mvumi and Makangwa divisions which paired with other studies [23, 24]. Furthermore, the prices of smartphones are too high for many farmers; the existing unfriendly interface disturbs and limits the users. The crowded and the existing unused features in the interface such as; Boomplay, Theme, video player, service, palmstore, micro intelligent, Aha, Asphalt nitro, carlcare, Phone master, assistant, google go cause inconvenience to farmers. Finally, the use of unfamiliar language is a demotivating particularly to the elderly farmers.

### **4.4 The Training Needs on the Use of Smartphone**

Most of the old aged farmers have difficulties of utilizing the smartphone features. Receiving a call was a challenge to old aged farmers and whose fingers were not as agile as those of the younger users. Difficulties in writing and sending messages as the letters are too close to each other on the screen leading to several typographical errors. The participants were able to use voice mail and a clock to check time with ease relative to other features. The respondents had limited use of some of the available features such as SMS, calculator, Bluetooth, camera, and radio. Other features were not used such as; Boomplay, Theme, video player, service, palmstore, micro intelligent, Aha, Asphalt nitro, carlcare, Phone master, assistant and google go. Due to these difficulties, participants expressed interest of attending training on the use of the available applications in smartphones together with those that support crop farming business if available but were reluctant to pay for training charges.

## **5 Limitation**

The study is a qualitative that provides an insight on what is unknown about farmers' experiences in using smartphones to acquire knowledge and skills. Farmers' experience in smartphones usage is wide and therefore, more research in this area is required for future technological alterations.

## **6 Discussion**

### **6.1 What Is the Ownership Level of Smartphones Among the Chamwino Farming Community?**

Ownership of smartphone was diverse across the divisions depending on the proximity to Dodoma central business district. Divisions such as Mvumi and Makangwa closer to city centre had higher ownership of smartphones relative to Itiso, Mpwayungu and Chilonwa because of being located farther away from Dodoma central business. The difference in ownership was attributed by frequency of business transactions between the divisions and the Dodoma city centre. For example, many farmers in Mvumi and

Makangwa owned smartphones because of their engagement in such businesses as hides and skin, cereal crops, grapes, and cattle. In addition, Mvumi had a referral hospital and a daily open-market that attract people from various places.

The respondents believed that ownership of a smartphone was associated with status and prestige. Thus, these perceptions encouraged the farmers to own smartphones and the mostly owned were TECNO, Itel and Samsung models; implying that these devices are in abundant supply. Most of the smartphones owned were second-hand which were often obtained as gifts or presents from relatives or friends. Other farmers buy own smartphones from the shops that sell used items or from friends. However, most of the second-hand smartphones thus acquired had some defects such as a broken touch screen, short battery lifespan, and faulty buttons.

Furthermore, sharing of smartphones was uncommon for fear of damaging the device or lack of skills to operate the devices. The non-sharing was confirmed through experimenting money transfer (M-Pesa, Tigo-pesa and Airtel money) whereby, each participant's name was automatically matched with the names in the researcher's registration list of attendance. The sharing was limited in cases of unanticipated circumstances such as death, injuries, or when someone runs out of airtime while in an emergency. As participants noted *"no one should use another person's smartphones for whatever reason because, if it is destroyed, it costs a lot of money to repair, in addition to transport costs to Dodoma city centre"*. Besides, there were more young people owning smartphones aged between 23 to 45 years than was the case with the elderly people. This is because, the elderly was not as mobile as the young who travel to various places on business transactions and engaging in temporary employment such as security guards. The elderly believed that smartphones are meant for the young, because the phones have slippery interface with several unfamiliar applications.

This finding is in contrast with the results reported in a study by Karetso et al. [7] who revealed that smartphones have penetrated in almost all the environments where people carry out their everyday activities. However, the findings of the current study paired with a study by Sarraf et al. [25], who reveal that not all Americans have equal access to smartphones and that ownership is stratified according to income levels. Thus, smartphone ownership needs an in-depth study to establish a true status of proprietorship.

## **6.2 What Are the Farming Practices and Farmers' Needs When Using the Smartphones?**

The farmers were using the smartphone for farming related business, particularly in seeking for information on transportation, pesticides, inputs, weather, finance, and markets in normal communication system. Transport related information includes availability of trucks, fair charges, mileage charge on transportation of goods, and these are done through contacting a relative or a friend. A smartphone is used to inquire from a relative or a friend to seek for assistance, provide or receive suggestion on any pesticides to use for controlling pests or insects damaging a crop. Furthermore, smartphone is used to inquire various farming inputs (i.e. better seeds, hoe, axe, among others), to seek for clarification on weather forecast from relatives, friends and others whom they are related to, farmers also use smartphones to communicate to other people



who are familiar with financial institutions to seek for clarification on loan or credit acquisition. Financial information which is required includes interest rates on borrowing and timeframe for repaying the loan, and market information includes daily market prices of commodities or the quantities demanded and supplied of specific goods and the ongoing auction market in different places. Thus, communication is carried out between the two related people who are located far apart and is presumed that the other is informed about the issues under the inquiry.

On the other hand, the use of smartphones for social inquiries on family matters was highest and low on political inquiries that happens in a cycle of four- or five-years during the elections. The frequently used features are sending and receiving messages, and voice mails. Few youths use Facebook, camera, WhatsApp and play games. The youths were hardly using the internet for farming activities and were unable to retrieve or store information in a smartphone. Thus, smartphone was underutilized because farmers had low skills and knowledge that limit them from utilising the device.

The Chamwino farmers' lack crop farming enabled information system that supports timely access to the required farming information. Smartphones developed to user's specifications that provide required information is more useful. For example, a smartphone with a sensor is used to detect and diagnose plant disease, calculate fertilizer amounts, study soil texture, estimate the water which is needed by the crops, study water supply and do readiness analysis of the crop [8]. In Bangladesh, farmers use smartphone to obtain latest market prices, negotiate with traders and build trust, access weather data, carry out market research, and coordinate freight transport [9]. Thus, farmers need information about weather, the amount of rainfall, degree of hotness and the like; information on the inputs such as, good seeds, the type of cattle-driven plough, the type of axes and hoe, fertilizer and the like. Differences in the needs make it necessary for the development of smartphone that suit specific groups with few commonly used features such as SMS and voice mail suitable to all the groups across the social and age divide.

### 6.3 What Challenges Do Farmers Face When Using the Smartphones?

Lack of expertise among farmers of operating the device was a more severe with the elderly than was the young farmers, which is supported in [14, 24, 26]. Receiving a call by swiping the receipt-icon in a wrong direction was a common among the respondents. There was no prior training on the use of smartphone making it difficult for farmers to operate the device effectively. Smartphones are perceived by the elderly as designed for youths who have nimble fingers to operate slippery screen. Similar findings are reported in a study by Pongnumkul et al. [8]. As noted by elderly participants "*The white people are canny; they have brought a smartphone, when touched, it displays many complicated items that elderly people cannot appreciate and operate the tool*". However, less than a quarter of the youths could operate ten features implying urgent need of training. Interestingly, the youths who had mastered some functionalities, volunteered to teach others that implied a need for training.

The respondents reported on bulkiness of smartphone as follows, "*Look at how large the size is, we cannot keep it in our trousers pockets when undertaking daily routines. It means if we hold the phone, we should stop doing other economic*

*activities*". Thus, farmers were uncomfortable with the different brands of smartphone due to large sizes that can be solved by supplying different sizes. Furthermore, weak network signals are the results of inadequate and poor infrastructure which are also cited in other studies [23, 24]. The network challenge is a phenomenon that cuts across most of the emerging economies as noted by Nwalieji [24] and needs a joint solution.

The high smartphone price is associated with low income earned by farmers who are heavily dependent on selling farm produce as noted, "*We depend on selling our farm produce at low market price to earn income and buy various needs*". The low-income is also reported by Sarraf et al. [25] in USA and Amadu et al. [27]. A smartphone costs at least Tanzania shillings (Tshs.) 200,000.00 (equivalent to 88 USD) which is equal to foregoing 8.3 bags of maize of one hundred kilograms each. The 8.3 bags are equivalent to approximately an output from two hectares of maize farm. Comparatively, farmers cultivate on average of two hectares, which means, buying smartphone may lead to one-year household starvation. However, a contrastive finding is reported in Pongnumkul et al. [8] who reveal that smartphones are affordable. The probable solution is an intervention that facilitates the transportation of farm produce to distant markets with higher prices, the formation of corporative societies that allow bulk sales from big traders and software developers should manufacture affordable smartphone to farmers.

The unfriendly interface design of smartphone which is so delicate to handle in rural settings particularly to the elderly. The elderly participants noted "*Smartphone do not need rough handling which happens when preparing charcoal furnace for business, chopping big trees, carrying, arranging, and building furnace; these are tedious activities. Sometimes, there are cattle rustling organized by dishonest groups, whereby all people in the village must participate to rescue the stolen cattle. All these are shuddering and rough activities to handle while holding a touch phone*". Similar findings are reported in Wyche and Steinfield [28] that there is a mismatch between management information system design and the handling skills of farmers. The respondents cited faster deterioration of the touch screen as causing inconvenience, which is supported by Pongnumkul et al. [8]. Thus, the developers need to redesign smartphone that endure in shuddering activities, and touch screens that accommodate rough hands and wetness.

The overcrowded and unused applications might be associated with different needs of end users. Different societies have diverse needs that might not always be the same. Thus, there are farmers' needs, health needs (orthodontist, pathologist, psychiatrist etc.), sport's needs (footballers, athletes, table or low tennis, netballers, basketballers etc.), and the needs of economists. The applications that do not support users' needs are likely considered as overcrowded and unused features.

The unfamiliar language to users of the technology is unconceivable as it leads to communication breakdown. The language challenge was more severe among the elderly people who were mostly operating the smartphone by memorizing some few procedures. Unfamiliar language is reported in a study by Anjum [14] who proposed the use of clear language, an argument which is also supported by the current study.

#### 6.4 What Type of Training Do Farmers Need to Help Them Make Better Use of Smartphone?

Farmers need training on receiving voice calls among the elderly groups that swipe receipt-icon on the wrong direction, thus, disconnecting the calls instead of receiving them; farmers need training on the use of smartphones to manage SMS such as typing and forwarding SMS particularly elders. The letters on the screen need enough space to avoid typing errors. The use of Facebook, WhatsApp and internet was limited to farmers due to technical know-how; thus, training is important so that users can be able to exploit the available opportunities in smartphones. The unused features were not familiar to farmers thus training on Boomplay, Theme, video player, service, palm-store, micro intelligent, Aha, among others, may increase the utility. Furthermore, the inclusion of farmers information needs such as weather, inputs and market among others may motivate farmers into adopting the technology.

Thus, willingness to attend training on various applications indicates motivation of using smartphones in farming and in non-farming activities. Capacity building would enable the adoption of the technology which is also recommended by Wyche and Steinfield [28]. Furthermore, inability to pay for training charges might be solved if farmers realize the benefits of using the smartphone for farming business, the relevant authorities should intervene in balancing the local market prices of farm produce and improve infrastructure to fast-track farmers' transportation of the produce to distant market (see Table 3).

**Table 3.** Summary of experience of Chamwino farmers using smartphone

Theme	Main issues found
Ownership of smartphone	There was inadequate ownership of smartphone, second-hand and limited sharing. The youths owning more smartphones than the elder group
Farming practices and farmers information need areas	Smartphones were inefficiently used for farming related business but more on social and less on politics. Farmers need information on input, weather, finance, transport, market, health and agriculture research reports
Challenges	Incompetency, smartphone size, weak network, high prices, unfriendly interface design of the smartphones, crowded features and use of unfamiliar language
Training needs	Respondents need training on SMS, voice call and on unused features in smartphones. Farmers were positive to attend training on the use of features in smartphone but not ready to pay charges

## 7 Conclusion

Farmers' experience on the use of smartphone provides an opportunity to software developers and policy practitioners to undertake future technological alteration. Smartphone ownership level is minimal though increasing, which is contrary to what

the researcher envisaged at the beginning. The ownership of the second-hand smartphone dominates the study area and there is a need for rigorous arrangements to ensure that farmers own and use new smartphones.

However, the use of smartphone for farming business is inadequate and there are no apps for agricultural related activities. Thus, limited utilization is associated with lack of relevant apps; the current apps of smartphone usage were developed without considering farmers' requirements. The study, therefore, recommends for strategies to mitigate the cited limitations and technological alterations to suit farmer's needs. Enhanced technologies and innovations are crucial to support an increased productivity in crop farming value chain. Thus, the provision of training on the application of smartphones is crucial, and there is need for the establishment of mobile-enabled farming information services, which will in the long run, support farmers in improving their knowledge and skills.




## References

1. Zhang, M., Salomon, A.: Always on-a global perspective of mobile consumers experience. In: Interactive Advertising Bureau on Device Research, pp. 1–51. IAB (2017). <https://www.iab.com/wp-content/uploads/2017/06/2017-IAB-Global-Mobile-Experience-Study.pdf>. Accessed 22 May 2018
2. Kambaulaya, G.: Over 40 million Tanzanians now own mobile phones, official TCRA data shows (2017). <https://www.azaniapost.com/economy/over-40-million-tanzaniana-no-own-mobile-phones-official-tcra-data-showsnbsp-h7068.html>. Accessed 23 July 2018
3. Vota, W.: ICT Works. 5Guideline for Using Mobile Messaging Applications in International Development (2018). <https://mail.google.com/mail/u/0/#inbox/165c2bad4acaaf96>. Accessed 13 Aug 2018
4. Ng'wanakilala, F.: Tanzania internet users hit 23 million; 82 percent go online via phones: regulator (2018). <https://www.reuters.com/article/us-tanzania-telecoms/tanzania-internet-users-hit-23-million-82-percent-go-online-via-phones-regulator-idUSKCNIG715F>. Accessed 5 May 2018
5. Misaki, E., Apiola, M., Gaiani, S.: Technology for agriculture: information channels for decision making in Chamwino, Tanzania. In: International Technology Management Conference ICE/IEEE, Belfast, Northern Ireland, pp. 1–8 (2015). <https://doi.org/10.1109/ice.2015.7438675>
6. Socea, A.: Managerial decision-making and financial accounting information. In: 8th International Strategic Management Conference, pp. 47–55. Elsevier Ltd., Iasi (2012). <https://doi.org/10.1016/j.sbspro.2012.09.977>
7. Karetos, S., Costopoulou, C., Sideridis, A.: Developing a smartphone apps for m-government in agriculture. *J. Agric. Inform.* **5**(1), 1–8 (2014)
8. Pongnumkul, S., Chaovalit, P., Surasvadi, N.: Application of smartphone-based sensors in agriculture: a systematic review of research. *J. Sens.* **2015**, 1–19 (2015). <https://doi.org/10.1155/2015/195308>
9. Huq, M., Farahna, K., Rahman, A.: Application of mobile phone in agricultural marketing in Bangladesh. *J. Bus. Manag.* **19**(1), 77–82 (2017). <https://doi.org/10.9790/487x-1901077782>
10. McCormick, J.L.: Evaluation of methods to estimate salmon harvest using angler harvest permits available on a smartphone application. *North Am. J. Fish. Manag.* **37**(1), 1–8 (2016). <https://doi.org/10.1080/02755947.2016.1221005>

11. Ferster, C., Coops, N.C.: Integrating volunteered smartphone data with multispectral remote sensing to estimate forest fuels. *Int. J. Dig. Earth* **9**(2), 171–196 (2016). <https://doi.org/10.1080/17538947.2014.1002865>
12. Jiorle, R.P., Ahrens, R.N., Allen, M.S.: Assessing the utility of smartphone app for recreational fishery catch data. *J. Fish.* **41**(12), 758–766 (2016)
13. Misaki, E., Apiola, M., Gaiani, S.: Technology for small scale farmers in Tanzania: a design science research approach. *Electron. J. Inf. Syst. Dev. Ctries.* **74**(4), 1–15 (2016). <https://doi.org/10.1002/j.1681.4835.2016.tb00538.x>
14. Anjum, R.: Design of mobile phone services to support farmers in developing countries. Unpublished Master Thesis University of Eastern Finland, pp. 1–50 (2015)
15. Vaismoradi, M., Jones, J., Turunen, H., Snelgrove, S.: Thematic development in qualitative content analysis and thematic analysis. *J. Nurs. Educ. Pract.* **6**(5), 100–110 (2016). <https://doi.org/10.5430/jnep.v6n5100>
16. Etikan, I., Musa, S.A., Alkassim, R.S.: Comparison of convenience sampling and purposive sampling. *Am. J. Theoret. Appl. Stat.* **5**(1), 1–4 (2016). <https://doi.org/10.11648/j.ajtas.20160501.11>
17. Farrokhi, F., Mahmoudi-Hamidabad, A.: Rethinking convenience sampling: defining quality criteria. *Theory Pract. Lang. Stud.* **2**(4), 784–792 (2012)
18. Mason, M.: Sample size and saturation in PhD studies using qualitative interviews. *Forum: Qual. Soc. Res.* **11**(3), 1–19 (2010)
19. Fusch, P.I., Ness, L.R.: Are we there yet? Data saturation in qualitative research. *Qual. Rep.* **20**(1), 1408–1416 (2015)
20. Descombe, M.: *The Good Research Guide for Small-Scale Social Research Projects*, 4th edn. McGraw-Hill, Open University Press, Berkshire (2010)
21. Braun, V., Clarke, V.: Using thematic analysis in psychology. *Qual. Res. Psychol.* **3**(2), 77–101 (2006). <https://doi.org/10.1191/1478088706qp063oa>
22. Creswell, J.: *Research Design. Qualitative, Quantitative, and Mixed Methods Approaches*, 4th edn. SAGE Publications, Inc., Thousand Oaks (2014)
23. Nwaobiala, C., Ubor, V.: Effectiveness of electronic wallet system of growth enhancement support scheme distribution among arable crop farmers in Imo state, south eastern Nigeria. *Ser. Manag. Econ. Eng. Agric. Rural Dev.* **16**(1), 355–360 (2016)
24. Nwalieji, H.U.: Assessment of growth enhancement support scheme among rice farmers in Anambra State, Nigeria. *J. Agric. Ext.* **19**(2), 71–81 (2015). <https://doi.org/10.4314/jae.v19i2.6>
25. Sarraf, S., Brooks, J., Cole, J.: Taking a surveys with smartphones: a look at usage among college students. In: *Annual Conference for the America Association for Public Opinion Research*, pp. 1–16. Indiana University, Center for Postsecondary Research, Anaheim, California (2014)
26. Misaki, E., Apiola, M., Gaiani, S., Tedre, M.: Challenges facing sub-saharan small-scale farmers in accessing farming information through mobile phones: a systematic literature review. *Electron. J. Inf. Syst. Dev. Ctries.* **84**(4), 1–12 (2018). <https://doi.org/10.1002/isd2.12034>
27. Amadu, F.O., McNamara, P.E., Davis, K.E., Rodriguez, L.: Community knowledge workers for rural advisory services. Good practice notes for extension and advisory services. In: *Global Forum for Rural Advisory Services Working Paper No. 14*, pp. 1–6. GFRAS, Lindau (2015)
28. Wyche, S., Steinfield, C.: Why don't farmers use cell phones to access market price? Technology affordances and barriers to market information services adoption in rural Kenya. *J. Inf. Technol. Dev.* **22**, 1–27 (2015)



# Exploring the Effect of Mobile Apps on SMEs in Nigeria: A Critical Realist Study

Adedamola Tolani<sup>(✉)</sup> , Adebowale Owoseni ,  
and Hossana Twinomurinzi 

School of Computing, UNISA, Pretoria, South Africa  
damolat@gmail.com, adebowale.owoseni@gmail.com,  
twinoh@unisa.ac.za

**Abstract.** An organisation's dynamic capabilities illustrate how the organisation renews its competencies in response to the evolving environment. This study explored the effect of mobile app usage on the dynamic capabilities (DCs) of SMEs in Nigeria from a critical realist viewpoint. Although literature suggests that mobile apps are used by SMEs, the elusiveness of mobile app usage in developing country contexts requires the investigation of the underlying mechanisms that explain how mobile apps enhance the DCs of SMEs. Using content analysis and retroduction, the study evaluated interview responses from 16 SMEs covering 5 states in Nigeria. The study revealed that mobile apps are used in SMEs in Nigeria (in the real domain) to carry out business processes (in the actual domain) using their DCs (in the empirical domain) for sensing business opportunities. The study suggests that despite the existence of government support for SMEs across Nigeria, these programmes are generally inaccessible and do not include the important ICT or mobile app elements. The study recommends the need for a contextual mobile app suited for SMEs in developing country contexts such as Nigeria.

**Keywords:** Small and medium enterprises · Dynamic capabilities · Mobile apps · Critical realism

## 1 Introduction

Small and medium enterprises (SMEs) play key roles in economic and social development in all countries worldwide. In this era of globalised economies, mobile apps arguably enable SMEs to drive the economic growth of developing countries [1]. Large organisations typically make intentional efforts to make the most of the technological advancements, but there is little research that shows the intentional efforts for SMEs more particularly in developing country contexts. There is nonetheless potential for SMEs to use mobile apps to sense new opportunities in rapidly changing environments.

---

**Electronic supplementary material** The online version of this chapter ([https://doi.org/10.1007/978-3-030-18400-1\\_50](https://doi.org/10.1007/978-3-030-18400-1_50)) contains supplementary material, which is available to authorized users.

This paper draws on the theory of dynamic capabilities (DCs) to explore the effect of mobile app usage on the DCs of SMEs in Nigeria from a critical realist viewpoint. The DC framework is a strategic management paradigm that describes how organisations create, modify and/or recombine internal and external competencies to remain relevant in a rapidly changing environment [2]. The research investigated the role that mobile apps could be playing in enabling SMEs to function optimally within their contexts. Critical realism (CR), as a philosophical paradigm, aids in uncovering the underlying mechanisms that affect the DCs of SMEs in using mobile apps to sense opportunities. Specifically, the research aimed at answering the research question: *How does mobile app usage influence the dynamic capabilities of SMEs in Nigeria from a critical realist viewpoint?*

The remainder of the paper is structured as follows: the literature is reviewed, followed by the research approach. The findings are then presented in the next section. Finally, inferences, areas for further research and limitations are described.

## 2 Literature Review

### 2.1 Small and Medium Enterprises in Nigeria

According to the Central Bank of Nigeria (CBN), 96% of businesses in Nigeria are categorised as small and medium enterprises [3]. SMEs are defined by the National Council of Industries as businesses with 5 to 199 employees and total costs excluding land of not more than 500 million naira (equivalent of US\$1.30 million). A major characteristic of Nigeria's SMEs relates to ownership structure or base, which largely revolves around a key individual or family. The majority of the SMEs are either sole proprietorships or partnerships [4]. They tend to survive financially, provide for families and sustain their businesses due to their dynamism, innovations, efficiency and small size, which allows for faster decision making [5]. SMEs are beneficial to the growth of Nigeria's economy as they provide the breeding ground for the development of entrepreneurial and managerial talent, the critical shortage of which is often a great handicap to economic development. The continuous development of these highly skilled resources and strong information technology adoption are key to the sensing and seizing of new business opportunities. Oyelaran-Oyeyinka [6] states that the enabling factors that drive SMEs in Nigeria include a basic technology knowledge base, entrepreneurship, legal and regulatory structure, basic physical and technological infrastructure, and financial and incentive structures.

### 2.2 Mobile Apps

Mobile apps have been a driving force in the success of some of the world's most valuable organisations, allowing them to operate a unique business model driven by seamless global operations [7]. Mobile apps have enabled organisations to serve their customers and win prospective business by mobilising their desk-based operations to increase business productivity and achieve market advantage [1].

According to Bezerra [7], the adoption of mobile apps can enable fast-growing SMEs to grow their revenue two times faster and add jobs eight times faster than their competitors. Mobile apps enable SMEs to seamlessly take effective decisions and planned and strategic risks while carrying out their business processes [8]. Mobile apps have changed the business landscape for SMEs, creating a new channel for communication, on-the-go customer engagement, promotion of products and services, point-of-purchases for products and customer service, and facilitating multitasking and effective decision making of SMEs. Mobile app usage has changed the way SMEs do business in Nigeria and achieve market advantage over competitors. The research therefore sought to provide answers to the following research sub-question:

SR1: *What mobile apps are predominantly used by SMEs in Nigeria?*

### 2.3 Dynamic Capabilities

DCs are defined as the ability to achieve new forms of competitive advantage by integrating, building and reconfiguring internal and external competencies to address rapidly changing environments [2]. The DCs of SMEs can be harnessed to continuously create, upgrade and keep relevant SMEs' unique asset base by aligning their resources with market needs through the sensing of opportunities [9].

Sensing opportunities involves the ability of SMEs to identify how to interpret new events and developments, which technologies to pursue and which market segments to target [9]. SMEs need to continuously improve on their capabilities to sense new opportunities. They are able to gain competitive advantage in dynamic environments when they consistently develop and renew capabilities over time as new goals appear, in order to respond to opportunities [10].

Owoseni and Twinomurinzi [11] identify the following DCs among SMEs in Lagos: collaboration and product repackaging, repricing of offerings, customer feedback, referrals and usage of social media and the internet as adaptive DCs, imitation and adaptation of product offerings and product packaging and price adjustments of product offerings as innovative DCs. Teece [9] suggests that each of the above DCs dovetails into the micro-foundation of DCs: the ability to sense opportunities, which leads to business transformation. This paper focuses on the ability of SMEs in Nigeria, beyond Lagos, to sense business opportunities using mobile apps.

In the next section, the philosophical lens that guided the research, critical realism, is presented.

### 2.4 Critical Realism

Critical realism (CR) is a realist meta-theoretical social paradigm by Bhaskar [12] to illustrate the significance of well-understood objectivity by distinguishing knowledge from existence. CR defends the critical and emancipatory potential of rational enquiry and was well suited to this research in exploring the DCs of SMEs while using mobile apps. CR can aid in uncovering the mechanisms behind mobile app usage whether these are empirically observable or not. In CR, the researcher is encouraged to use his/her own experience in a rigorous manner to assist in the development of plausible



and defensible explanations [13]. The ideological perspective of CR illustrates that the world exists independently of what we think about it [14] by merging a realist ontology with a relativist epistemology to evaluate the underlying mechanisms and structures behind phenomena, to create theories that are not just concentrates of data [15].

CR served as the philosophical foundation to uncover the underlying mechanisms that enhance the DCs of SMEs in sensing opportunities using mobile apps in Nigeria. According to Bhaskar [12], an objective reality can be identified and described in three hierarchical strata of reality – the real, actual and empirical.

The *real* includes social structures, natural objects and powers that actually exist whether we like it or not, independent of our perception of them. Some are observable and others are not. Causal generative mechanisms emerge from the social structures in the “real” domain of CR [16]. These causal mechanisms produce the events which we wish to uncover in this study [17]. The *actual* domain of CR consists of observable events that occur as a result of the interactions of causal mechanisms (i.e. the real) [17]. The *empirical* is a CR domain where events occur through the observations of ‘experiences’, meaning the noticeable observations of the subjects being examined in this study [18]. This research therefore sought to find answers to the following research sub-questions:

SR2: *What are the causal mechanisms and structures in Nigeria that influence SMEs’ ability to sense opportunities?*

SR3: *What are the observed and unobserved events in Nigeria as a result of the ‘real’ events that influence SMEs’ ability to sense opportunities using mobile apps?*

SR4: *What are the events within SMEs in Nigeria that influence their ability to sense opportunities using mobile apps?*

Figure 1 below illustrates the relationship between the real, actual and empirical domains of CR. It shows how the structures and mechanisms in the real generate the events in the actual, and how the events that are experienced and observed through analytical methods are generated in the empirical domains of CR in SMEs [17].

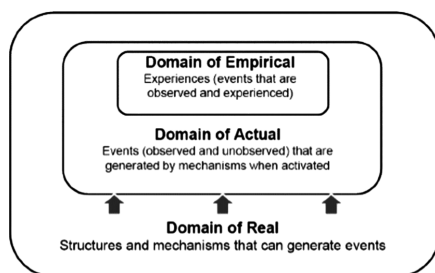


Fig. 1. Domains of CR [17]

## 2.5 Retroduction

Retroduction is the process of working backwards from the *empirical* to the underlying mechanisms in the *real*, critically aligning the structure and agency of SMEs in the

layered ontology, for the purpose of probing, describing or even understanding the effect of mobile apps on the DCs of SMEs [19]. Structure and agency in CR involve the personal and socio-cultural factors in SMEs whose interactions enabled this research to apply retroduction as a mode of inference to investigate the conditions under which each causal mechanism will occur and be observed [20]. Retroduction enabled the critical investigation and discovery of how mobile app usage influences the capabilities of SMEs to sense new opportunities in Nigeria. Retroduction in this instance involved the observation and engagement of experiences of SMEs as decision makers and the real events of SMEs. In retroduction the researcher is encouraged to use his/her own experience in a rigorous manner to assist in the development of plausible and defensible explanations [13].

### **3 Research Approach**

This research adopted the qualitative research approach which focuses on exploring and understanding the meanings attributed to a social or human problem to enable a researcher to generate theories through observation [21]. Qualitative research involves questions and procedures to collect data in the participant's setting. The data is analysed inductively, building from particulars to general themes, and the researcher makes interpretations of the meaning of the research data.

#### **3.1 Background of Researchers**

The primary researchers are practising software developers, with core expertise in operations and service management, process re-engineering and technology advisory services. They have 24 years' experience (combined) in the ICT and financial services sector. They are also managers in the Nigerian financial sector with responsibilities for organisational transformation initiatives, technology advisory management, process improvement and performance management.

#### **3.2 Reliability and Validity**

The reliability and validity of a research study are essential criteria to determine the quality of research using a qualitative research approach based on credibility, neutrality, consistency and trustworthiness [22]. The researchers ensured that the research findings represented the information extracted from the data collected and were a correct interpretation of the participants' views [23]. Credibility of this research contributes to the trustworthiness of the data collected for the research. This was achieved through prolonged engagement of participants, persistent observations, referential adequacy and member checks [24]. The researchers ensured consistency by following the research methodology until the conclusion of the research, and they ensured neutrality by confirming that the research was free from bias.

In this study, the researchers took the following steps:

1. Critical review of existing subjects
2. Design of a research instrument based on dynamic capabilities
3. Approval of ethical clearance received from the host university
4. Adoption of consistent coding and categorisation methods
5. Review of identified codes and categories

### **3.3 Case Study**

A case study is a qualitative research method that investigates an existing phenomenon in its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident [25]. The intrinsic type of case study allows this research to gain a deeper understanding of a particular phenomenon [26]. It enables researchers to collect data using interviews, participant observations, questionnaires, checklists and analysis of recorded data [27].

### **3.4 Population and Sample**

The states of Lagos, Oyo, Abuja, Kano and Kaduna in Nigeria made up the population group of this research. SMEs were the unit of analysis. As such, this study used purposive (judgemental) sampling to identify 16 SMEs in the population group defined by SMEDAN [28] to participate in and provide feedback for interviews.

### **3.5 Data Collection**

The researchers collected data through fieldwork in the form of interviews. Interviews allowed the views, experiences and beliefs of SME participants on the research subject to be explored. The responses from participants were transcribed into text and analysed using applicable coding analysis methods on Atlas.ti. This data collection strategy enabled data to be generated, which was discussed and examined to provide answers to the research sub-questions.

### **3.6 Data Analysis**

Content analysis was used as the analysis method to uncover meaning from the data collected. It offered objective guidelines in the coding of the text and drawing inferences from the data collected [29]. The analysis involved the following steps [30]:

1. Information was extracted on the reasoning of SMEs from feedback received from participants by thoroughly reading through the interview transcripts.
2. Initial codes were generated and categorised by organising the data collected in a meaningful and systematic way. The coding was carried out using the descriptive and in vivo coding methods to assign codes to text and the codes were quantified or counted based on the code frequencies. Coding was carried out by categorising assigned codes based on their relationships to the research question.

3. Abduction reasoning was adopted to understand and analyse the causal mechanisms to generate new theoretical assumptions.
4. Retroduction was carried out to provide explanations on the data gathered and new theoretical assumptions using CR by identifying something significant about the research questions.
5. The theoretical assumptions were connected to generate specific contexts to explain the subjects of study.

## 4 Discussion of Findings

### 4.1 Demography

The SMEs in this study included 16 business types that cut across 7 industries. The size of the SMEs ranged from 2 to 50 employees with an average business age of 7.5 years.

### 4.2 Content Analysis: Critical Realist Constructs of SMEs in Nigeria

The analysis was structured using the constructs of critical realism: real (causal mechanisms), empirical and actual. 414 unique codes in total were identified. The categorisation of the codes using their anchor codes and frequencies was used to group the codes into 112 real, 41 actual and 261 empirical (supplementary material) constructs.

#### **Real (Causal Mechanism) Constructs of SMEs in Nigeria**

The *real* is described as the social structures, real objects and powers that exist independent of our perception of them, whether observed or not.

112 unique codes were identified as real. The unique codes were categorised into 3 groups based on the relationships of the unique codes, namely ICTs (mobile apps) (65), market limitations (5) and organisational constraints (42).

The frequency of codes suggests that mobile app objects exist as causal mechanisms within SMEs. The 16 SMEs that participated in this study used a total of 27 mobile apps with a total usage frequency of 65 and an average of 2 mobile apps per SME. The mobile apps were categorised into 5 categories: payment apps (4), e-commerce apps (3), social media apps (42), productivity apps (15) and custom apps (1). The code categorisation suggests that SMEs use social media apps primarily to sense business opportunities. The top 3 mobile apps used by SMEs were Facebook at 18.4% adoption, Instagram at 15.4% adoption and WhatsApp at 15.4% adoption. Some SMEs used custom-built mobile apps for sales and marketing, and productivity apps for accounting, communications and documentation purposes, while others used e-commerce apps for online sales.

This provides answers to the research sub-question: *What mobile apps are predominantly used by SMEs in Nigeria?*

Feedback received from participants on their usage of mobile apps includes the following:

*“yes, we do that through our Facebook and Instagram page and few sponsored ads online through Facebook and Instagram sponsored ad, it is relatively okay in terms of price and it is readily available at any time.”*

*“diamond bank app, I use them for transferring funds to my suppliers”*

*“I use the WhatsApp for the WhatsApp status for posting my work and I use it for to interact with my clients my customer”*

*“Yes, I use LinkedIn mainly to get industry trends, hmmm to get information from other people in the business”*

The code categorisations confirm that SMEs use mobile apps to run business operations but encounter unskilled human resource issues, lack of financial access, regulatory issues and taxation issues that affect their capabilities to sense business opportunities.

### **Actual (Observed/Unobserved Events) Constructs of SMEs in Nigeria**

The *actual* is described as events that occur whether observed or not as a result of the causal mechanisms identified above. 41 unique codes were identified as actual. The unique codes were administrative operations (9), expenditure monitoring (10), financial management (3), business reporting (2), create organisational policies (1), outsourcing services (1), project management (2), sales and marketing (5) and knowledge development (8). The frequency of the codes illustrates that various business processes exist as observed and unobserved events in SMEs. This research suggests that these business processes are influenced by the mobile apps used by SMEs to sense business opportunities.

Feedback from the SMEs was as follows:

*“The finance being the backbone of the business is managed meticulously with respect to forecast and budget by increasing revenue (price and quality sold) and by judicious spending of expenses where necessary.”*

*“The human/personnel resources department are mainly the ones with the responsibility of knowledge development”*

The events identified above provide answers to the research sub-question: *What are the observed or unobserved events in Nigeria that influence SMEs’ ability to sense opportunities using mobile apps?*

### **Empirical (Observed) Constructs of SMEs in Nigeria**

These are described as events that are observed through formal, analytical and theoretical approaches [31]. 261 unique codes were identified and categorised into 10 groups. The frequency of the code categorisation illustrates that SMEs have various DCs: training and capacity development (52), sales and marketing (26), carry out market research (16), interaction and participation (63), product marketing and research (45), review operations (13), create new product ideas (11), carry out marketing strategy (17), access government SME programmes (7) and product branding (11). This study suggests that SMEs have the capabilities to run their business operations using mobile apps.

Feedback from the SMEs is as follows:

*“yes, we do that through our Facebook and Instagram page and few sponsored ads online through Facebook and Instagram sponsored ad, it is relatively okay in terms of price and it is readily available at any time.”*

*“[www.jakesbooksmed.com](http://www.jakesbooksmed.com) you can also go on konga and jumia and still have us there as part of our online, you click on jakes books medical equipment on konga, if you google it, it will bring out our shop. The same thing with jumia.”*

*“and social media of recent which we delve into. So, ICT has helped to showcase our new offering and to reach out to people who we think will need our services”*

Other SME participants said:

*“No, because I have not heard of such programme organized by government agencies”*

*“they are not fully up to task and it is a challenge to them even finding most of us and I will actually say they are not up and doing with their responsibility in terms of identifying the right SMEs and providing certain solutions to that problem. So they are not helping boost ability to grab new opportunity”*

This study reveals that events generated through observation in the empirical domain of CR in SMEs in Nigeria are their capabilities to manage product sales and marketing, create new product ideas, manage product branding, attend training and access government programmes. This identifies their existing competencies to gain competitive advantage. The events identified above provide answers to the research sub-question: *What are the events within SMEs in Nigeria that influence their ability to sense opportunities using mobile apps?*

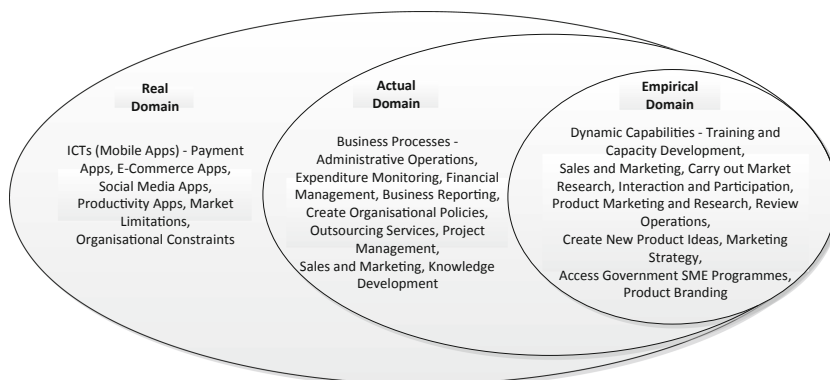
### 4.3 Retroductive Reflection

Retroduction is the process of working backwards from the empirical to the real, attempting to describe the relationships that result in the observable events.

The findings in this study showed that SMEs have the dynamic capabilities despite having to satisfice in using freely available ICT (mobile apps). The mobile apps enable SMEs to carry out their business processes to sense new business opportunities. These business processes are, however, hampered by market limitations and organisational constraints such as unskilled human resource issues, lack of financial access, regulatory issues and taxation issues. SMEs are therefore forced to learn to use ICT in ways which work for them.

Further, this study reveals that SMEs use ICT to access general market information that is not localised for their environment using the internet. This is not effective for sensing new business opportunities. This leads to SMEs' inability to have adequate information on SME programmes to receive the necessary capacity development and funding support.

The capabilities of SMEs are a result of the usage of different ICTs (mobile apps) as shown in Fig. 2 below.



**Fig. 2.** CR domains of SMEs in Nigeria

They use different types of ICT tools – this indicates the opportunity to create an SME ICT artefact, i.e. mobile app, that improves the DCs of SMEs to overcome the market limitations and organisational constraints in Nigeria. Also, the artefact should integrate with SME government agencies to enable SMEs to easily access localised information on market trends, developments and SME programmes. The artefact should allow SMEs to enhance their capabilities to carry out business processes effectively in sensing new business opportunities.

## 5 Implication of Research Findings

This research positioned itself within the CR perspective to understand how mobile apps influence the capabilities of SMEs to better sense opportunities in changing market dynamics through retrodution. In this study, the real constructs of CR in SMEs suggest that causal mechanisms and structures that affect SME capabilities to sense business opportunities in Nigeria are ICTs (i.e. mobile apps), market limitations and organisational constraints. The actual constructs of CR in SMEs suggest that the observed or unobserved events in Nigeria that influence SMEs' ability to sense business opportunities are their business processes. The generative mechanisms identified in this research are the ICTs (mobile apps) used in SMEs in Nigeria, namely payment, e-commerce, social media and productivity apps.

In Nigeria, the unstable policy environment and the ineffective policy implementations by critical government agencies have impacted on economic growth and development [32]. This has raised the need for SMEs to constantly look for alternative ways of exploring new business opportunities [33].

Conclusions were drawn about how the use of mobile apps can influence the capacity of SMEs to sense business opportunities in Nigeria. Based on the findings stated above, there is a need for SMEs to use mobile apps to easily access government programmes, attend training, manage projects, carry out research on markets and products, access market reports and provide customer support.

## 6 Contribution of Study

This research presents a critical realist investigation of the real, actual and empirical domains of CR in SMEs in Nigeria. The result of this research serves as a methodological and practical contribution to knowledge which can be adopted by SMEs to use mobile apps effectively to sense new business opportunities. This study also provides details for solution requirements to develop an SME contextual mobile app to enable access information on government programmes, renewal of organisational processes, allocation of resources, knowledge development and transfer, and effective decision making.

## 7 Conclusion

This study examined the effect of mobile apps in SMEs to sense new business opportunities in Nigeria. The research was conducted using a qualitative research approach from a critical realist viewpoint. The study suggests that despite the existence of government support for SMEs across Nigeria, these programmes are generally inaccessible and do not include the important ICTs or mobile apps.

This study confirms that ICTs (mobile apps) (real domain) are used by SMEs to carry out business processes (in the actual domain). These are influenced by their DCs such as (empirical domain) sensing new business opportunities in Nigeria. SMEs in Nigeria satisfice with free apps for banking, e-commerce, social media, productivity for their sales and marketing, collaboration and payment operations.

There is an opportunity to develop an ICT artefact (preferably a mobile app) that is better suited for SMEs to enhance their capabilities to carry out business processes effectively.

## 8 Limitations of the Study

This research focus was limited to DCs in Nigerian SMEs. Further research should be considered to identify the adaptive, absorptive and innovative DC manifestations of SMEs in Nigeria and how mobile apps influence the DCs.

## References

1. O'Halloran, J.: SMEs Get Productivity from Mobile Applications. <http://www.computerweekly.com/news/2240088236/SMEs-get-productivity-from-mobile-applications>
2. Teece, D., Shuen, A., Pisano, G.: Dynamic capabilities and strategic management. *Strateg. Manag. J.* **18**, 509–533 (1997)
3. Abdullahi, M.S., et al.: The nature of small and medium scale enterprises (SMEs): government and financial institutions support in Nigeria. *Int. J. Acad. Res. Bus. Soc. Sci.* **5**, 527 (2015)
4. Ogbo, A.: The role of entrepreneurship in economic development: the Nigerian perspective. *Eur. J. Bus. Manag.* **4**(8), 95–105 (2012)





5. Bello, O.: SMEs in Nigeria. <http://olusola2bello.blogspot.com/>
6. Oyelaran-Oyeyinka, B.: FSS 2020 International Conference SME: Issues, Challenges and Prospects. [http://www.cenbank.org/fss/wed/SME\\_Issues,ChallengesandProspects\\_OyeyinkaBanji.pdf](http://www.cenbank.org/fss/wed/SME_Issues,ChallengesandProspects_OyeyinkaBanji.pdf) (2007)
7. Bezerra, J., et al.: The Mobile Revolution: How Mobile Technologies Drive a Trillion Dollar Impact (2015)
8. Bula, H.: Evolution and theories of entrepreneurship: a critical review on the Kenyan perspective. *Int. J. Bus. Commer.* **1**, 81–96 (2012)
9. Teece, D.: Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strateg. Manag. J.* **28**, 1319–1350 (2007)
10. Mohamad, F., Ahmad, Z., Siti, N.: The concept of dynamic capability for managing technology and change. *Strateg. Manag. Q.* **2**, 93–108 (2014)
11. Owoseni, A., Twinomurinzi, H.: The use of mobile apps to enhance SMEs in conditions of uncertainty: a case study from Lagos, Nigeria. In: Proceedings of the 10th Annual Pre-ICIS SIG GlobDev Workshop, Seoul, South Korea (2017)
12. Bhaskar, R.: A Realist Theory of Science SE - Radical Thinkers. Verso (1975)
13. Hobáin, L.: A Critical Realist study of Dynamic Capabilities in SMEs (2012)
14. Zachariadis, M., Scott, S., Barrett, M.: Exploring critical realism as the theoretical foundation of mixed-method research: evidence from the economics of IS innovations. Working Paper Series. Cambridge Judge Business School (2010)
15. Mats, A., Kaj, S.: Reflexive Methodology: New Vistas for Qualitative Research. Sage Publications Ltd., Thousand Oaks (2009)
16. Elder-Vass, D.: Re-examining Bhaskar's three ontological domains: the lessons from emergence. In: Lawson, C., Spiro Latsis, J., Martins, N. (eds.) Contributions to Social Ontology, p. 160. Routledge Taylor & Francis Group (2007)
17. Mingers, J.: Realizing information systems: critical realism as an underpinning philosophy for information systems. *Inf. Organ.* **14**, 87–103 (2004)
18. Jeppesen, S.: Critical realism as an approach to unfolding empirical findings: thoughts on fieldwork in South Africa on SMEs and environment. *J. Transdiscipl. Environ. Stud.* **4**, 1–9 (2005)
19. Eybers, O.: Critical realism and retrodution. <https://oscareybers.wordpress.com/2011/12/05/critical-realism-and-retrodution/>
20. Fletcher, A.: Applying critical realism in qualitative research: methodology meets method (2016)
21. Morgan, D.: Integrating Qualitative and Quantitative Methods. Presented at the (2014)
22. Bashir, M., Muhammad Tanveer, A., Azeem, M.: Reliability and validity of qualitative and operational research paradigm (2008)
23. Guba, E.G., Lincoln, Y.S.: Competing paradigms in qualitative research (1994)
24. Myburgh, C., Poggenpoel, M.: Qualitative methods: a research approach worth considering. *S. Afr. Psychiatry Rev.* **10**, 65–67 (2007)
25. Soy, S.: The case study as a research method. <https://www.ischool.utexas.edu/~ssoy/usesusers/l391d1b.htm>
26. Hasa: Difference Between Case Study and Ethnography. <http://pediaa.com/difference-between-case-study-and-ethnography/>
27. Balaraju, B.: Case study and Ethnography (2014). <https://www.slideshare.net/balarajbl/case-study-ethnography>
28. SMEDAN: Smedan and National Bureau of Statistics Collaborative Survey: Selected Findings (2013). [http://nigerianstat.gov.ng/pdfuploads/SMEDAN2013\\_SelectedTables.pdf](http://nigerianstat.gov.ng/pdfuploads/SMEDAN2013_SelectedTables.pdf)

29. Prasad, D.: Content analysis: a method of social science research. In: Lal Das, D.K. (ed) *Research Methods for Social Work*, pp. 174–193. Rawat Publications, New Delhi (2008)
30. Björn, B., Morén, S.: Analysis of generative mechanisms. *J. Crit. Realis.* **10**, 60–79 (2011)
31. Basden, A.: Bhaskar's Critical Realism (2013). <http://www.dooy.salford.ac.uk/ext/bhaskar.html>
32. Etuk, R., Etuk, G., Baghebo, M.: Small and medium scale enterprises (SMEs) and Nigeria's economic development. *Mediterr. J. Soc. Sci.* **5**, 656 (2014)
33. Okello-Obura, C., Matovu, J.: SMEs and business information provision strategies: analytical perspective (2011). <http://www.webpages.uidaho.edu/~mbolin/okello-obura-matova.htm>



# Evaluating mHealth Apps Using Affordances: Case of CommCare Versus DHIS2 Tracker

Amrit Chhetri<sup>1</sup>, Mari Iversen<sup>1</sup>, Jens Kaasbøll<sup>1</sup> ,  
and Chipo Kanjo<sup>2</sup> 

<sup>1</sup> University of Oslo, Oslo, Norway

amritchhetri@gmail.com, {mariive, jensj}@ifi.uio.no

<sup>2</sup> University of Malawi, Zomba, Malawi

chipo.kanjo@gmail.com

**Abstract.** CommCare and DHIS2 Tracker are two software packages which were configured for community health workers (CHW) in Malawi and evaluated and compared. To capture a wide scope of aspects including possible developmental ones, the Affordance concept was applied as an analytic frame. Being configurable software packages, concept of Platform Affordance was considered but abandoned, since its domain could be covered by the configurator's affordance. To operationalize the concept, usability concepts from HCI were applied for the evaluation and comparison of end-user and configure affordances. Organisational Affordance, based on structuration theory modalities, was used to characterize affordances not attributed to specific people.

The study revealed that much as CommCare is more specific to CHWs, hence having more weight on the configuration (where configuration was quicker) and end-user affordances (with an ability to display images which could be used for health promotion) compared to DHIS2, it had weak organisational affordance mostly due to license fees. Further, DHIS2 had the ability to produce reports summarizing health indicators and comparing the data generated with data collected outside the DHIS2 App.

In addition to usability issues, the CHWs perceived that any of the systems would relieve them from bulky registers to carry and time-consuming reporting, hence affording more time for other tasks. Observations of their slow typing speed point in the opposite direction. While the Affordance concept emphasizes the relationship between users and technology, the case points to the need for not making users' first impression the only basis for judging affordances.

**Keywords:** Affordances · Usability · mHealth app · CommCare · DHIS2 tracker

## 1 Introduction

The two mHealth Apps namely: CommCare and DHIS2 tracker are used by Community Health Workers (CHWs) in Malawi. Since we could not find any comparisons of the two systems, our practical research question was: what are the pros and cons of the two?

While CHWs were the end users, the softwares had to be configured by others, hence the comparison should also include their perspective. Third, the Ministry of Health would be the manager of the information systems, so the software needed to be considered also in that respect. Since the Affordance concept has been used when studying development [1], we chose this theoretical frame. It captures technology seen from individual users' point of view, hence it enables assessing the technology as experience by CHW and the configurers. To address the organizational perspective, we adopt an extension of the concept into organizational affordance as presented in [2]. Pushing the theory beyond its previous usage, we ask the research question; how we operationalize the affordance concept cater for such a mixed evaluation?

### 1.1 CommCare and DHIS2Tracker Applications

The CHWs in Malawi work under the Environmental Health Department. They play an important role in connecting the communities and the national health sector. CHWs make 30% of the health workforce in Malawi with the responsibility of providing curative, promotive and preventative care. Their job activities range from provision of primary health care, to household visits, disease surveillance, and health promotive talks. The CHWs are overburdened and as a way of easing their work load, there is a new global interest focusing on the CHWs, providing mobile health (mHealth) applications as a solution for data capturing, including CommCare and DHIS 2.

CommCare is an open source mobile health platform used in more than 50 countries and consist of two components; CommCare mobile and CommCare HQ [3]. The CommCare platform offers as set of modules including data reporting, worker monitoring, analytics dashboards, decision-making support and tracking of individual data records and is configurable through the CommCare HQ web-interface without any programming. The data collected using CommCare Application is stored in their HIPAA compliant [4] server. CommCare offers multimedia options such as pictures, audio records and videos and also supports offline data storage. However, CommCare is not free to use and you have to pay for extra features. CommCare Application is tailor made for CHWs.

DHIS2 is also a free and open source software with several modules used for validation, collection, analysis, and presentation of aggregated and patient-based statistical data. It is currently in use in more than 80 countries. The DHIS2 allows configurers to customize information systems through an open meta-data model without coding. The data is stored in a database set up by the owners of the data on a server of their choice. In this research the DHIS2 Tracker capture module for Android was used. Tracker capture is a configurable multiple event program that allows to capturing client data. Tracker capture does not support multimedia options. DHIS2 is not developed for any particular user group, it was developed as a general application for statistical reporting in hierarchical organisations and is also used in other domains like education and agriculture. DHIS2 Android can also operate offline, thus fitting places where there is no internet connection; hence, useful for CHWs.

We chose CommCare [3] as a representative for systems designed for CHWs and DHIS2 as a general application and set up an experiment to compare their usability and examine if there are design aspects that the two systems could learn from each other.

The comparison is based on user preferences and usability; aiming to understand why one application is possibly more preferable than the other.

## 1.2 mHealth Experiences

Mobile health (mHealth) refers to the usage of mobile technology to promote and support healthcare activities such as data collection, health promotions, etc. By using mHealth services we can potentially increase and improve on affordability of interventions for health promotion. There have been several studies on mHealth in an African context. Example of this is a study done in Uganda where Chang, Njie-Carr [5] looked at perceptions and acceptability of an mHealth application at a community-based HIV/AIDS clinic. However, this research did not look at usability but it discussed other important aspects such as mHealth features, benefits and potential challenges such as security concerns and patients confidentiality. Overall, there was great enthusiasm amongst the CHWs in the study for using the mHealth tool as part of their interventions [5]. Thondoo [6] also explored potential benefits of using mHealth tools with the CHWs cadre with a focus on functionality of the mHealth tools. Further, a systematic review of 44 mHealth projects in Africa identified several factors that contributes to having successful implementations [7]. The factors include accessibility, acceptance and low-cost of the technology introduced, effective adaption to local contexts, strong stakeholder collaboration, and government involvement. They also identified challenges that could affect the implementation as follows: dependent on funding, unclear healthcare system responsibilities, unreliable infrastructure and lack of evidence on cost-effectiveness.

## 2 Theoretical Approach

Affordance concept was coined by Gibson [8] and has been used in information systems literature for characterizing the functions of the IT system which enables (or restricts) the user to carry out their actions. Later, Norman [9] introduced the affordance concept to the HCI community. This led to two perspectives on affordances; one stemming from Norman's view of properties in the IT systems enabling and guiding the user [1, 10]; the other viewing affordances as emerging in users' practice [11]. However, the Norman's perspective of affordance has been contested, arguing that it has ambiguity [12]. Aiming at evaluating the IT support for CHWs, we opted for the alternative used in ICT4D literature [1] and which considers properties of the technology. A good number of researchers have used Affordance Theory to assess the uses and consequences of such IT artefacts [12].

Using a methodology that combines qualitative methods of document analysis, interviews and observation with an experiment; this paper evaluates the *configuration*, *end-user* and *organisational* affordances of two mHealth Apps (CommCare and DHIS2 tracker) used by Community Health Workers (CHWs) in Malawi. The two applications were designed for home visits. In this study, CHWs were used to test the two systems and give feedback.

## 2.1 Individual Affordance

When designing a system, the designer makes sure that the client's needs are well represented and the relevant functionality is perceivable for one to be able to continue with development. When a developer sees a system design, they are able to perceive it and translate it into programs; similarly, it should be the case that when a user sees the program interface, they should have a hint on how to use it. When you first see something you have never seen before, how do you know what to do? Norman [10] argue that the appearance could provide the critical clues required for its proper operation. A good number of researchers have used Affordance Theory to assess the uses and consequences of such IT artefacts [12].

Affordances are relational properties between user and technology, thus the technologies can only be evaluated related to users. Given that two users who share roles nevertheless may differ in their relationship to the IT, an ethnographic study of all users should have been carried out. For practical reasons, two distinct user groups were identified and their experiences formed the basis for the evaluation.

For a systematic approach to individual affordance, we borrowed the usability concept from the HCI literature, where one definition of usability [13] “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use” reflects the affordance view. Once a product is useable, it has three main outcomes: first, it is easy for the users to become familiar and competent with the system. For example, a useable application in a health facility should allow a health worker to easily understand how to enter data and register a client. Second, the system should make it easy for its user to achieve their objectives. The system should guide the user throughout the process. Lastly, it should be easy to recall the user interface. Ideally the users should learn from the first usage of the application and recall how it was done subsequently. To identify usability, usability testing is done; this is based usability goals which include: effectiveness, efficiency, safety, utility, learnability and memorability [14]. For the sake of this research we have extracted three usability goals that we found more relevant. These goals are effectiveness, efficiency and learnability. Effectiveness concerns the accuracy with which the user can achieve specified goals. For instance, a health worker's ability to effectively register a client. Learnability concerns the ease in which users develop competence. For instance, health worker ability to effectively learn to use the system. Efficiency refers to the way a product or system can support users in carrying out their tasks.

Configurers use the software platform to tailor the system to local needs. Hence, we could, in line with Koskinen and Bonina [15], who considers innovation platforms for ICT4D, use the expression *platform affordance* to characterize the affordance for configuration. An important aspect of platform affordance is that the platform should enable designs not foreseen by the platform developers, however, we did not evaluate this aspect of the systems. Since configurers are also individual users of the software, usability was also chosen as the basis for evaluating the softwares for both for them and for end-users of the systems.

## 2.2 Organisational Affordance

Information systems have non-functional qualities like cost, support, security and more, which the whole organization or unknown stakeholders may have to relate to. These qualities may fall completely outside of usability concept. An approach to organizational affordances has been built [2] through adding the three modalities from structuration theory [16]; norms, power and meaning; to the technological dimension. This is in line with calls made in literature to broaden the focus of affordances to organisational level in order to study IT-Associated organisational change.

The system cost will be one of the qualities that has to be considered, and this falls under the power mode of the organizational affordances. Security is another aspect of patient information system for which there can be norms, and for which resources (power) and meaning are also relevant.

## 3 Methodology

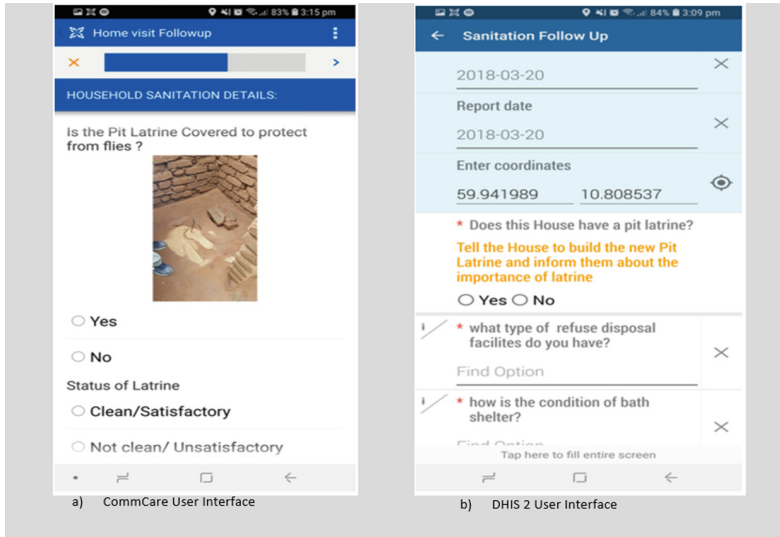
This study uses a methodology that combines qualitative methods of document analysis, interviews and observation with an experiment to evaluate the *end-user*, *configurer* and *organisational* affordances of two mHealth Apps (CommCare and DHIS2 tracker) used by Community Health Workers (CHWs) in Malawi. Initially, document analysis, interviews and observation were carried out to gain an understanding of the CHWs roles to help us configure the apps. The outcomes of the initial investigations showed that the CHWs spend majority of their time on household visits. In between, they also conduct outreach clinics for specific health services like immunization. Another semi-structured interview was conducted to map the background of the CHWs, their experience with technology, their work role and their educational background. Following which the apps were introduced (this will be explained in the next section) and finally the researcher observed the participants using the apps and take notes. Where participants were stuck or taking too long to complete capturing data for a particular case, the researcher would intervene and assist them.

To address the core of their work, we chose to set up the two softwares to capture the data that the CHWs collect on household visits. This include demographics of the household and status of latrines, water source and other facilities the household may have. The two health programs contained the exact same data elements in the same sequence. The difference between the two being the interface as well as the multimedia option in CommCare. Pictures for guiding how to build latrines and hand-washing facilities were added to CommCare to assist the CHW. Figure 1 illustrates the user interfaces of CommCare and the DHIS 2 Android App. The CommCare system has been set up with some illustrations.

### 3.1 Setting Up the Experiment

The experiment mostly involved configuring the two systems for use. In total, 12 CHWs drawn from three clinics in Zomba district in Malawi participated in the experiments. All of the CHWs tested both apps, however half of the participants tested

the DHIS2 app first before testing the CommCare, while the other half tested the CommCare app first before testing the DHIS2 app. A set of guiding questions regarding user preferences was developed to guide the CHWs.



**Fig. 1.** User Interfaces of the two mHealth Apps

### 3.2 Cases

Cases used in the testing of the health app were created in advance to allow participants use similar case for each of the two health apps. The participants were expected to tick off data elements if they were present in the case or type in some text into the health app based on situation. An example of a case used: *“household is not using two-cup system”*. The participant should then indicate in the health app that two-cup system is not being used. This is done by clicking on the “no” radio-button belonging to that data element.

Three groups of participants took part in the experiment. The first batch comprised three CHWs and they all had previous experience in using CommCare. The second batch had four participants, all had no prior mHealth experience; and the last two batches had a total of 5 participants.

## 4 Results

We explain the results based on the participants previous experience with the system (considering that some of the participants had already had a chance of using one of the systems) and configuration variations of the two systems i.e. with CommCare, it is possible to set it up with one data field per page or with multiple fields per page;



whereas with DHIS2, you can only have multiple fields per page. Secondly, CommCare App allow for images whereas DHIS2 does not. It was also found that CommCare App requires licensing, whereas DHIS2 does not require any form of license.

#### 4.1 Application Preference (CommCare vs. DHIS2)

Preference of the two applications varied for different reasons. For example, the first group comprising three CHWs preferred CommCare since they had previous experience using it. The second group which had four participants, without any prior experience with mHealth applications were given the two systems as shown in Fig. 2 where CommCare App was set up with one data field per page and DHIS2 with multiple fields. The CHWs reacted to this comparison by saying that they preferred DHIS2 because having several data entry fields/questions on a single page makes it easier to track and recheck them. CommCare also supports multiple questions per page, but the default setting is one question per page as shown in Fig. 2(a).

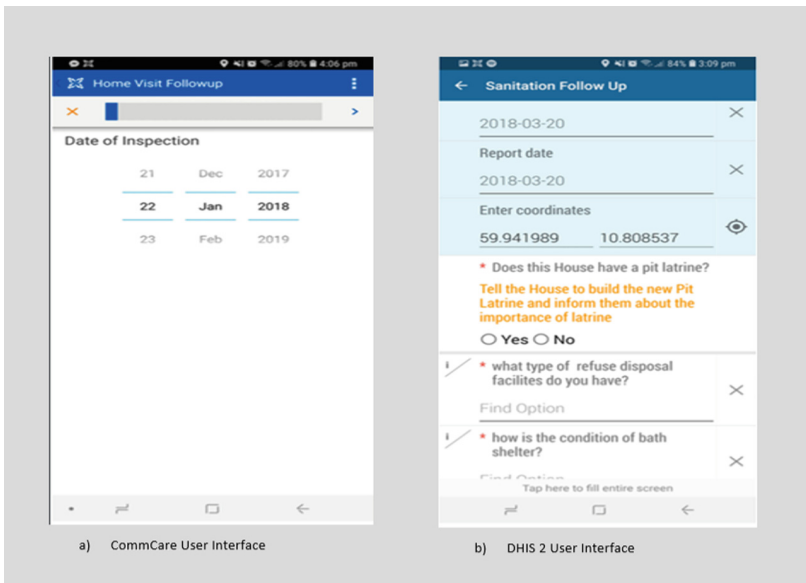
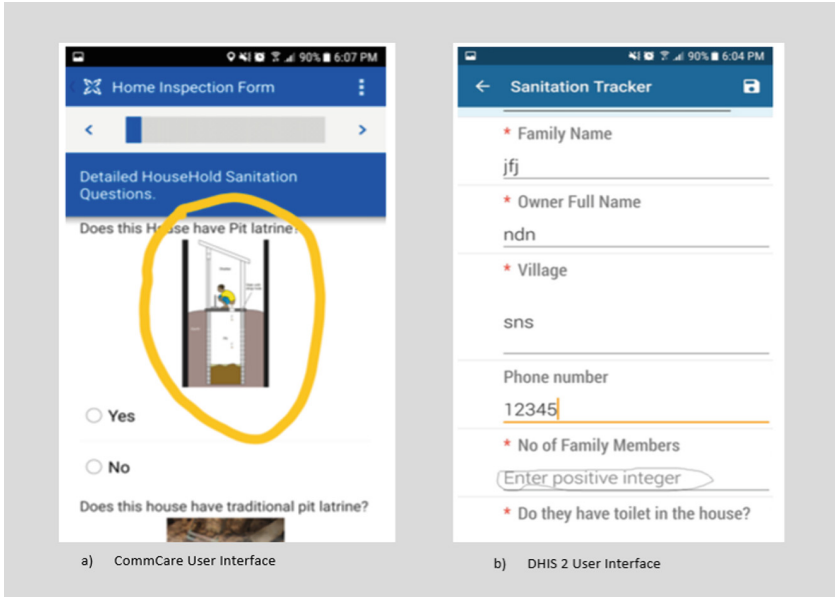


Fig. 2. CommCare with one data field per page, DHIS2 with several fields

Another finding was that much as participants were happy with the possibility of having images in the CommCare App, the nature of image used mattered to them. For example, participants were not happy with the image for latrine that was initially set in the CommCare App in the first experiment as illustrated in Fig. 3(a). The impression was that this was too abstract for health promotion in the villages. In the second round, the image was changed to one which the community could relate with as shown in Fig. 1(a).



**Fig. 3.** Drawing of latrine in CommCare (a). Placeholder text in DHIS2 (b).

It was also found that the participants were not happy with some text which they thought was unnecessary. For example, they did not make any sense of the text in the DHIS2 App “Enter positive integer” see Fig. 3(b).

In the last two evaluations, with a total of five CHWs, both applications were set up with the same data fields on each page. CommCare’s ability to display images was exploited, and images like that of latrine shown in Fig. 1 were included. The CHWs were given the applications to test in opposite order (i.e., if previously participants started with CommCare, while in this round participants would start with DHIS2 and vice versa).

All participants in the experiments agreed that the image functionality in the CommCare App added value. For the DHIS2 App, participants preferred the function of tagging mandatory fields with an asterisk and explained that it was value adding. Otherwise, they observed that there were no major differences between the two Apps. The CHWs were of the opinion that the two applications did nearly the same thing and were very similar so much so that choosing one over the other seemed rather strange.

Overall, all CHWs who participated preferred using an app to using a paper-based system. Reasons given were that it will ease carrying bulky books around as they move from one household to the other. Another reason was that time spent (a day or more) to compile reports at the end of the month will be reduced.

The researchers observed, that the CHWs spent twice the time filling the electronic forms compared to the paper registers. This was due to their slow typing speed, which reflected their unfamiliarity with computers (or typewriters).

## 4.2 Applications Use

CHWs found the two applications to be very similar, and equally easy to use. They indicated that both applications were effective. The CHWs considered effectiveness as key. The fact that we were able to change the abstract latrine image in CommCare application to a more realistic latrine picture based on their context was considered as a good example of changing ineffectiveness of the images included to an effective image. Since the two health applications had the same data elements the CHWs were rather confused on why they should choose one over the other. The fact that CHWs preferred using the applications over the use of paper registers also attested that the applications were effective. Four of the CHWs used the DHIS2 Tracker application for two weeks after the experiment. While the researchers noticed that these CHWs spent around twice as much time on registering data in the application versus the paper registers, this time consumption was never mentioned by the CHWs. It may be that they will gain speed over a period, with more practice.

During observation, a trend emerged where most participants would most of the times forget which button to press to start registering a new client. This was considered to be a result of lack of sufficient IT competence as they were unable to explain what the different icons meant and what they were used for.

## 4.3 Application Configuration

Both DHIS2 and CommCare are configurable without coding, and configuration is carried out in another module than the end-user application. This allows for change in configuration to suit end-user needs if the set-up is not optimal or preferred. The only drawback is that, the configuration is not done by end-users. One of the researchers (the first author), a computer scientist, was the configurator. It was actually the first time he did this and he reported on the configuration processes as follows: In the version of DHIS2 used, the meta-data and other configurations of the health programs are done in different parts of the system. For instance, there is one module to create the data-elements, another module to create programs rules and a third module to put the data-elements in the right order. In CommCare, everything is done in the same module of the system. Further, CommCare also support drag and drop of data elements, allowing one to change the order of data elements simply by clicking on one of the elements and drag it to the right position so as to have data elements in the order one wants them to appear on the screen. In DHIS2 changing the order of the data elements is done by selecting the data element to be moved and then use on-screen arrows to move the data-elements up or down. However, when having a long list of data-elements one scrolls up and down through a small view, as only seven data elements are visible at a time.

The experience of the configuration show that CommCare configuration was quicker and easier to learn and use. Despite the fact that the default configuration only allowed for one data field per page, the end result of the configuration of the two applications were very similar as confirmed by the CHWs.

#### 4.4 Data Storage and Reports

One more functional issue became apparent. DHIS2 patient data is stored in the national DHIS2 database at the Ministry of Health in Malawi. There, the data is aggregated to obtain indicators of different programs such as: immunization coverage, counts of pregnant women, etc. With paper reporting, the CHWs summarize the data on a monthly basis. With the introduction of the application, the calculations are done by the software. In addition, the CHWs can get reports from the national database in a Dashboard app on their phone/tablet on health for their catchment area and they will be able to compare their data with data from other catchment areas and also be able to see time trends. Figure 4 illustrates the different DHIS2 components and how they relate to each other.

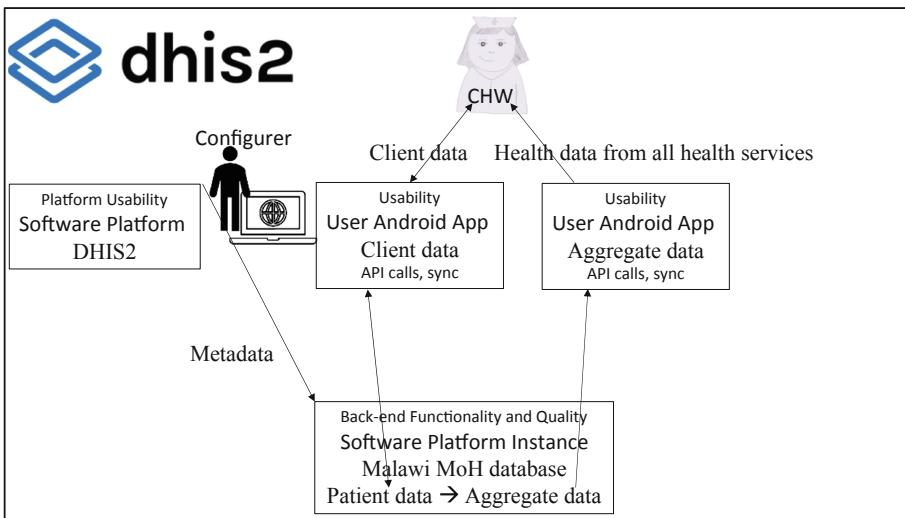


Fig. 4. DHIS2 environment

CommCare data on the other hand is stored at a server outside the country. This data does not feed into the national aggregates, hence the data captured through CommCare application does not have any data repositories at national level. No record of this data is available locally. To obtain an aggregate report, a request has to be sent to CommCare’s software vendor, and the report is delivered in pdf format. This report will go to the District Health Office and not directly to the CHWs, see Fig. 5 for an overview.

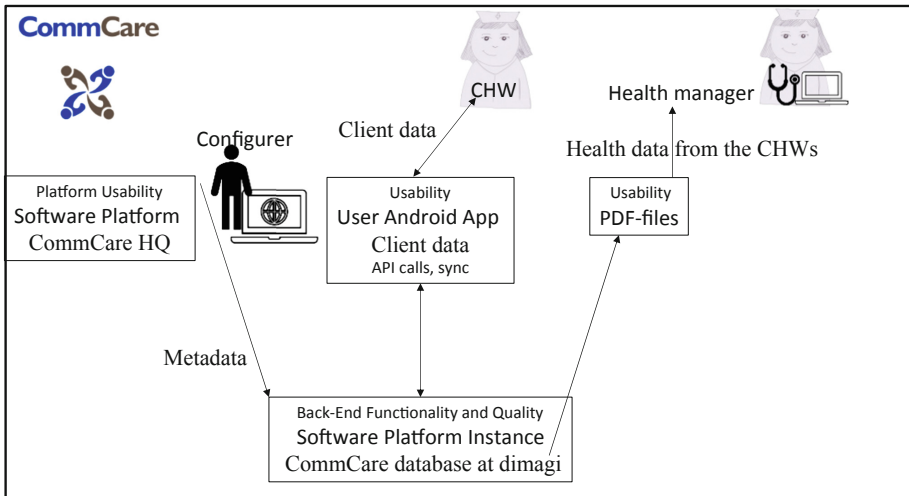


Fig. 5. CommCare modules

#### 4.5 Non-functional Qualities

The list of non-functional requirements for an information system is long; and ISO 25010 [17] lists 31 sub-categories from *accountability* to *user error protection*. One quality which is not covered by ISO, but nevertheless found to be relevant in our case was cost, both initial and life-cycle. However, cost is included as one of the 58 categories in the Wikipedia list of non-functional qualities [18]. The systems utilize the same hardware. Differences in internet usage are unknown. The cost of setting up DHIS2 is probably higher than CommCare, as noticed by the configurer. However, while DHIS2 is free, CommCare requires licenses per user, and reports require additional payments. The three-month license for the experiment with a small number of users was USD1500.

## 5 Discussion and Conclusion

As mentioned earlier, of interest in this paper are *platform (configuration)*, *end-user* and *organisational* affordances. For these affordances, the following characteristics were examined: *affordance existence*, *perception* and *effect* for each of the two systems. Implications of these affordances are also included in the discussions below.

CommCare and DHIS2 have end-users and configurers, hence the systems were evaluated and compared relative to these groups. Being individual users, their experience can be expressed through the affordance concept.

Software license cost was identified as a distinctive factor at the organizational level. Cost belongs to the resources/power mode of the structuration theory and will therefore be characterized as such in the comparison, see Table 1. This research did not address other organizational factors like security and capacity for hosting servers.

**Table 1.** Affordances of CommCare and DHIS2

	CommCare	DHIS2
End-user affordance	Good for client data Good for health promotion due to illustrations Poor for Health data	Good for client data Poor for health promotion due to lack of illustrations Good for Health data
Configurer affordance	Good for effectiveness and efficiency	Good for effectiveness Poorer for efficiency
Organisational Affordance – Power	High license cost	No license cost

This study was aimed at evaluation of two software packages. To operationalize individual affordances, the usability approach from HCI was adopted. On the organizational side, other functional and non-functional requirements were considered. The comparison between the systems could have been done without using affordance concept.

Affordance has been used in ICT4D literature since it goes beyond usability to include people’s innovations and applications of the technology outside its intended design. Such innovative use would be a strong indicator of *development* taking place. The results that CHWs preferred any mHealth app to the paper-based system lies outside of the usability and non-functional requirement comparison carried out. We could say that the mHealth systems would relieve the CHWs from other tasks. In this case, the CHWs are not afforded with new opportunities through the ICT, but being relieved from other duties by the technology may afford them time for other tasks.

Affordance-by-relief was based on the utterances of the CHWs, while the researchers observed that the apps actually occupied more of their time, at least before their typing speed increased. This contradiction points to the risk of basing conclusion on affordance increase only on the informants’ statements. The novelty of the technology and its association with modernity may create initial enthusiasm which may fade after some experience with time consuming typing and the inevitable troubleshooting of software and hardware that will take place. According to [19], the CHWs may have perceived a false affordance, but [20] argues that this is rather a misinterpretation. Only a longer term study would reveal whether the mHealth apps save CHW time.

Instead of applying the concept of Platform Affordance [15], this was covered through analyzing the affordance of those doing the software configuration. Since Affordance is relational between user and technology, we found it more appropriate to talk about Affordance from the configurer’s point of view.

While Affordance has been regarded as something which the actor can perceive directly, [20] also introduces Hidden Affordances. These are properties of the technology which users do not perceive. The configurer did not perceive the option of having more data fields in one screen immediately, thus this affordance was initially hidden. Thus, an actor may need to learn to discriminate the information in order to

perceive directly. In this way learning can be seen as a process of discriminating patterns in the world, rather than one of supplementing sensory information with past experience [20]. But this does not resolve the situation. This distinction contradicts Gibson's assertion that perception is 'direct' and yet still runs into the problem of what the 'relationship' between actor and environment consists of. It also renders affordances unknowable.

Norman [10] argues that the appearance should provide the critical clues required for its proper operation. The design community adopted the concept of affordance arguing that the designer focuses on what actions the user perceives to be possible. Even if this guideline might have made the configure avoiding the initial problem, it would not address possible misconceptions about the efficiency of the apps for the CHWs' tasks.

The Affordance concept was not operational for comparing two softwares to be used for the same tasks. However, it allowed for characterizing the users' comprehension of IT versus paper-based information systems. While previous literature points to Affordance as the relationship between users and technology as perceived by the users, the CHWs' belief in efficiency and the configurator's initial misconception point to the unanswered question of who will decide which affordances that exist.

## References

1. Thapa, D., Sein, M.K.: Trajectory of affordances: insights from a case of telemedicine in Nepal. *Inf. Syst. J.* **28**(5), 796–817 (2018)
2. Vyas, D., Chisalita, C.M., Dix, A.: Organizational affordances: a structuration theory approach to affordances. *Interact. Comput.* **29**(2), 117–131 (2017)
3. dimagi (2018). [www.dimagi.com](http://www.dimagi.com). Accessed 2018
4. Health Information Privacy (2018). [www.hhs.gov/hipaa/index.html](http://www.hhs.gov/hipaa/index.html). Accessed 2018
5. Chang, L.W., et al.: Perceptions and acceptability of mHealth interventions for improving patient care at a community-based HIV/AIDS clinic in Uganda: a mixed methods study. *AIDS Care* **25**(7), 874–880 (2013)
6. Thondoo, M., et al.: Potential roles of mHealth for community health workers: formative research with end users in Uganda and Mozambique. *JMIR mHealth uHealth* **3**(3), e76 (2015)
7. Aranda-Jan, C.B., Mohutsiwa-Dibe, N., Loukanova, S.: Systematic review on what works, what does not work and why of implementation of mobile health (mHealth) projects in Africa. *BMC Public Health* **14**(1), 188 (2014)
8. Gibson, J.J.: *The Ecological Approach to Visual Perception*. Houghton Mifflin, Boston (1979)
9. Norman, D.A.: *The Psychology of Everyday Things. (The Design of Everyday Things)*. Basic Books, New York (1988)
10. Norman, D.A.: Affordance, Conventions, and Design. *Interactions* **6**(3), 38–43 (1999)
11. Leonardi, P.M.: When does technology use enable network change in organizations? A comparative study of feature use and shared affordances (2012)
12. Pozzi, G., Pigni, F., Vitari, C.: Affordance theory in the IS discipline: a review and synthesis of the literature. In: *AMCIS 2014 Proceedings* (2013)
13. International Organization for Standardization: ISO 9241: ergonomics of human-system interaction. In: *Usability: Definitions and Concepts* (2018)

14. Rogers, Y., Sharp, H., Preece, J.: *Interaction Design: Beyond Human-Computer Interaction*. Wiley, Hoboken (2002)
15. Koskinen, K., Bonina, C., Eaton, B.: Digital platforms in the global south: foundations and research agenda. In: *Development Implications of Digital Economies*. Centre for Development Informatics, University of Manchester (2018)
16. Giddens, A.: Agency, structure. In: Giddens, A. (ed.) *Central Problems in Social Theory. Contemporary Social Theory*, pp. 49–95. Palgrave, London (1979)
17. ISO: *ISO/IEC 25010 Software Product Quality* (2018)
18. Non-functional requirement. In: *Wikipedia* (2018)
19. Gaver, W.W.: Technology affordances. In: *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. ACM (1991)
20. McGrenere, J., Ho, W.: Affordances: clarifying and evolving a concept. In: *Graphics Interface* (2000)





# Investigating the Efficiency of ICT Infrastructure Utilization: A Data Envelopment Analysis Approach

Yinka Oyerinde<sup>(✉)</sup>  and Felix Bankole 

University of South Africa, UNISA Science Campus,  
Florida, Johannesburg, South Africa  
57645752@mylife.unisa.ac.za, bankofo@unisa.ac.za

**Abstract.** A lot of research has been done in the field of Information and Communication Technology for Development (ICT4D) investigating and measuring the impact of Information and Communication Technology (ICT) investments on Human Development. Education is a major component of the Human Development Index (HDI) which affects the core of Human Development. This research investigates the relative efficiency of ICT infrastructure utilization with respect to the educational component of the Human Development Index (HDI). A Novel conceptual model is proposed, and the Data Envelopment Analysis (DEA) methodology used to measure the relative efficiency of the components of ICT infrastructure (Inputs) and the components of education (Outputs). Results show a strong impact of ICT infrastructure on educational attainment and adult literacy rates, a strong correlation between this infrastructure and literacy rates as well as provide a theoretical support for the argument of increasing ICT infrastructure to provide an increase in human development especially within the educational context.

**Keywords:** ICT4D · Data Envelopment Analysis · ICT infrastructure · Educational attainment/adult literacy rates · Human Development Index · Learning Analytics

## 1 Introduction

The field of Data Analytics in Education, otherwise known as Learning Analytics (LA) and Educational Data Mining (EDM) is fast gaining grounds in term of research interests and advancement in technology [39]. The ever-demanding need for knowledge and knowledge management drives the thirst for technological advancements in the aid of learning delivery [42]. With the overwhelming successes gained in Data Analytics in the Business Industry, it is little wonder that Data Analytics has found its way into the Education Sector especially in ICT4D research. Considering that the amount of data produced inside and outside higher education institutions is growing exponentially, more and more educational institutions, seem to be exploring the potentials of Data Analytics [32]. As new findings and outcomes of research crop up daily, it is evident that successes in Data Analytics in Education can have overwhelmingly positive impacts on learning management and delivery. With Educational

Attainment being one of the core indices for measuring Development with respect to the Human Development Index [8, 11, 51], there is no doubting the viability of any Data Analytics in Education research.

Recently, researchers and developers in the education community began to explore the potentials in adopting analogous techniques for gaining insight into learning management and delivery. Two major areas currently under development and which are oriented towards the inclusion and exploration of big data capabilities in the educational environment are Educational Data Mining (EDM) and Learning Analytics (LA) [40]. Romero and Ventura [42], postulated that although prior researches have focused more on the implementation of data mining techniques and models to discover educational data, EDM is however an emerging discipline for developing methods to explore unique types of data from within the educational context. In fact, according to Zorrilla et al. [53], EDM is an application of data mining techniques implemented in education for better comprehension on students' learning processes and acknowledging the ways they participate in it with the sole aim of improving the quality of the educational system.

With regards to ICT4D, national development encapsulates the notion of human development as the means of enlarging people's choices to acquire knowledge, amongst others, in order to have access to the resources needed for a decent standard of living [11, 51]. Over the last three decades, the lexicon of national development has been expanded to certain intervening variables and social factors such as education and some other aspects of human welfare [5, 11, 17]. In line with this, countries have defined policies that show an emphasis on creating support mechanisms for the use of ICT, including for example, technical and pedagogical support, and putting special attention on the use of ICT in teaching and learning [27]. However, in providing and defining these policies, a crucial question all policy makers must answer is if increased investments in ICT infrastructure provides any improvement in human development especially for Africa [9].

In this paper, we aim to investigate the efficiency of ICT Infrastructure utilization on Education as a component of National Development vis a vis adult literacy rates and educational attainment for post-secondary and tertiary education levels. We also employ the same education index employed by Bankole et al. [9] introduced by Orbicom [37] and ITU to emphasize the impact of higher education on ICT development. With most of the research in Learning Analytics focusing on the teaching and learning activities, this research aims to show how LA can be implemented for policy and decision making within the general context of ICT4D research and thus show it is not limited to enhancing class room interactions. The rest of the article is organized as follows: Section two provides the overview of literature, section three discusses the theoretical framework, section four provides the research methodology, section five provides the DEA analysis, section six provides discussion of findings, section seven limitations and section eight conclusion and future work.

## 2 Overview of Literature

The need to understand the relevance of education in Human Development cannot be over-emphasized. A lot of research postulates that increase in ICT investments and penetration on the continent will bring about a corresponding increase in Human Development [4, 33]. Ganju et al. [19] believe that the use of ICT enables the transfer of information to communities that may not have access to education. However, in Africa, three quarters of the population is illiterate and live in rural areas that lack basic facilities [34] and lack of these facilities, which include infrastructure, on which ICT development requires to run, limit the effectiveness of ICT interventions and penetrations especially in education [38]. Even though the last decade has seen an explosion in the use of ICTs in developing countries [52], it is important to consider the unequal distribution of access to the affordances of ICT in Africa [41].

Bankole et al. [9] showed that any empirical investigation with regards to education for ICT4D research, needs to consider higher education as one of the main parameters. The empirical study carried out by Kiiski [29] found that tertiary education has a positive and statistically significant impact on ICT development. Briede [12] believes this is so because those who have attained levels of higher education usually are the leading persons and have an important impact on public events and its development. Many Higher Education institutions in the Developing Economies have invested heavily in the use of ICT for teaching and learning i.e. use of mobile and/or home-based ICT infrastructure as tools to extend teaching and learning possibilities [27] however, its impact has been minimal [36], despite the differences in the level of ICT development across countries [27].

Recent studies also believe that Higher Education quality and attainment are necessary to bridge the “digital divide” defined by [20, 31, 35]. An example of such is India’s National Mission on Education through Information and Communication Technology (NMEICT) which seeks to bridge the digital divide by formulating an educational policy which, amongst others, aims at enhancing the use of computing devices for the purpose of teaching and learning among urban and rural teachers/learners in the Higher Education domain [43]. Also, the Plan Ceibal initiative in Uruguay [25], seeks to bridge this digital divide by being both a social and an educational policy that, amongst others, has the purpose of establishing the conditions for equal access to ICT; facilitate the construction of new learning environments adequate to demands of the information and knowledge-based society; and making available to students and teachers new tools that can widen their learning, increase their knowledge, and develop their awareness of lifelong learning [27]. ICT facilitates and improves students’ knowledge and promotes positive attitude to learning. Therefore, if students in developing economies are to compete with their counterparts in the developed world, effort must be made to develop their ICT abilities [36].

Moving to ICT and its effects on educational technologies, a New Media Consortium (NMC) Horizon report in 2013 identified, amongst other things, emerging technologies that would have significant impacts on education within a 5-year window. One of such technologies identified was Learning Analytics which would impact education by customizing the learning experience and/or measuring performance

through analysis of massive amounts of student learning data [28]. In the context of higher education, Big Data and Learning Analytics promises increased efficiency and cost-effectiveness [23, 40, 45–47]. With the potential of educational technologies to positively improve educational quality and attainment, there is great optimism that ICT in education can greatly increase both average literacy rates and educational attainment levels in developing economies. However, despite these promises being included in education policies that are related towards achieving a positive impact of ICTs on students' achievements, there is no conclusive evidence to support this, especially in developing countries [26]. This situation has posed new questions to the research community and policy makers, who are now looking for much more precise definitions of the role of ICT in teaching and learning [27]. It is in search for these precise definitions that we carry out this study to investigate the efficiency of ICT infrastructure utilization on education with respect to human development.

### 3 Theoretical Framework

This research falls within the progressive perspective of ICT-enabled development as postulated and defined by Avgerou [7]. The theory behind this perspective is that it considers ICT as an enabler of transformations in multiple domains of human activities. ICT-enabled developmental transformations are assumed to be achieved within the existing international and local social order [7]. Central in this theoretical perspective is the view that investment in ICT and effective use do matter for the economic development of a country [30]. It is however acknowledged that ICT needs to be accompanied by organizational or national restructuring to deliver productivity gains [16, 18].

This research proposes a novel conceptual model for measuring efficiency of ICT Infrastructure on Education and is derived from Bankole et al. [9] model for measuring Impact on Human development. From this study Human Development is expressed as:

$$HDI = f[\textit{Standard of living (GDP per capita), Education (Literacy rates/ Enrolments) and Health (life expectancy)}]$$

For this research we focus solely on the Education component of Human Development and propose a model which takes on a linear equation derived from Bankole et al. [9] model for measuring impact on education within the Human Development Index. In this model, we make use of ICT infrastructure available for utilization from 2010–2016 and obtained from ITU and not ICT investments as was done by Bankole et al. [9]. We also focused on educational attainment and not enrolment as we are measuring impact of a utilized infrastructure within the educational context and not its potential utilization which will be valid for enrolment. Finally, this research does not consider the interaction of the facets of ICT investments as was done by Bankole et al. [9] because it is not considering investments anymore but the infrastructure available for utilization.

The model for this study is:

$$\text{The impact on Education (Adult Literacy rates/Attainments)} = f[\text{Internet Infrastructure (II)} + \text{Computer Infrastructure (CI)} + \text{Mobile Phone Infrastructure (MPI)}].$$

### 4 Research Methodology

The research methodology employed in this study is the Data Envelopment Analysis (DEA) model. DEA is a well-known non-parametric linear programming method for measuring the relative efficiency [10, 49] and has also been used for understanding the impacts of IT investments on performance and productivity [24]. DEA is a data-oriented method for evaluating the performance (efficiency) of entities known as Decision Making Units (DMUs) [10] which uses input-output data to compute an efficient production frontier produced by the most efficient DMU’s. DEA, unlike a parametric method, is context specific with respect to the interpretations of the results of the analysis, which are restricted to the sample and should not be generalized beyond the sample [44].

DEA, therefore, can then be viewed as a multiple-criteria evaluation methodology where DMUs are alternatives, and DEA inputs and outputs are two sets of performance criteria where one set (inputs) is to be minimized and the other (outputs) is to be maximized [15]. In DEA, these multiple criteria are generally modelled as in a ratio form, e.g., the CCR ratio model [13, 15] which is expressed as:

Maximise:

$$h_0 = \frac{\sum_{r=1}^s u_r y_{r0}}{\sum_{i=1}^m v_i x_{i0}}$$

Subject to:

$$\frac{\sum_{r=1}^s u_r y_{rj}}{\sum_{i=1}^m v_i x_{ij}} \leq 1$$

Where:

$$j = 1, \dots, n, v_r v_i \geq 0; r = 1, \dots, s; i = 1, \dots, m.$$

where  $x_{ij}$  and  $y_{rj}$  represents DEA inputs and outputs of the  $j$ th DMU, and  $u_r, v_i \geq 0$  are unknown variable weights to be determined by the solution of the problem [13]. Although  $x_{ij}$  and  $y_{rj}$  can be referred to in different terms, rather than “inputs” and “outputs”, for this research, ICT infrastructure serve as the Inputs and Educational Attainment/Adult Literacy Rates serve as the Outputs.

There have been some studies that have used DEA to measure efficiency in education. Gupta and Verhoeven [22] measured the efficiency of education in Africa and Clements [14] measured efficiency of education in Europe. St. Aubyn [48] and Afonso and St. Aubyn [1–3] measured with respect to OECD countries. However, only Tondeur et al. [50] and Gülbahar [21] have examined the efficiency of countries in utilising their ICT resources for educational outputs and the Impact of ICT on education. Recently, Aristovnik [6] did a study on the impact of ICT on educational performance and its efficiency in select EU and OECD countries using DEA.

Based on Bankole et al. [9] investigation of the impact of ICT investment on human development, this research goes a step further to measure ICT infrastructure available for utilization and no longer investments in ICT which are available for potential utilization. Hence the variables used will be individuals with access to computers, internet and mobile phones. Since the focus of this paper is to investigate with respect to education only as an aspect of human development, the education component will include educational attainment from post-secondary level through to bachelors' level and adult literacy rates. An Input-Oriented Basic Radial Model (BRM) with Constant Returns to Scale (CRS) DEA approach is used for this research. This is based on the theoretical assumption that the ICT infrastructure (Input) are controllable and increase or decrease in the levels of these inputs is expected to bring about a corresponding increase or decrease in the levels of Educational Attainments and Literacy Rates (Output) respectively.

For this study, time series data from UNESCO; educational attainments; World bank; literacy rates and ITU; individuals with computers, internet and mobile phones were obtained. Available data was collected for all countries in Sub-Saharan Africa, Northern Africa, and select countries in Europe and Northern America. These were compared with world values to measure relative efficiency. Data for the past 7 years, 2010–2016 was collected and the average was calculated and used for the values representing each DMU.

## 5 DEA Analysis

The analysis was done using the Data Envelopment Analysis Online Software (D.E.A. O.S.) available online at <https://deaos.com>. An Input oriented BRM model using the Constant Returns to Scale method was used for calculating the relative efficiency of the DMU's. Table 1 shows the data collected computed as ratios to population as well as the indices and their respective parameters. Tables 2 and 3 show the outcomes of the analysis carried out while Table 4 gives an overview of the data statistics.

**Table 1.** Average Regional Values for 2010–2016

Regions	Individuals using computers	Individuals using internet	Individuals using mobile phones	Educational attainment (Post-secondary)	Educational attainment (Short cycle tertiary)	Educational attainment (Bachelors)	Adult literacy rate
	INPUT	INPUT	INPUT	OUTPUT	OUTPUT	OUTPUT	OUTPUT
Sub-Saharan Africa	0.24	0.1399	0.7495	0.1086	0.056	0.0288	0.6287
Northern Africa	0.4257	0.3004	0.8827	0.1235	0.1327	N/A	0.7236
Europe & North America	0.7631	0.7074	0.9134	0.2962	0.2539	0.2168	0.9915
World	0.61	0.4343	0.8772	0.2695	0.2167	0.1507	0.8559

**Table 2.** Basic radial models (envelopment forms) weights

Regions	Individuals with computers	Individuals with internet	Individuals with mobile phones	Educational attainment (Post-secondary)	Educational attainment (Short cycle tertiary)	Educational attainment (Bachelors)	Adult literacy rates
Sub-Saharan Africa	3.984	0	0.058	9.208	0	0	0
Northern Africa	2.349	0	0	0	4.737	0	0.475
Europe & North America	1.31	0	0	1.073	0	2.159	0.216
World	1.605	0	0.024	3.711	0	0	0

**Table 3.** DEA analysis summary for the regions

DMU	DEA parameters	Individuals with computers	Individuals with internet	Individuals with mobile phones	Educational attainment (Post-secondary)	Educational attainment (Short cycle tertiary)	Educational attainment (Bachelors)	Adult literacy rates
Sub-Saharan Africa	Slacks	0	0	0	0	0	0	0
	Weights	3.984	0	0.058	9.208	0	0	0
	Values	0.24	0.14	0.75	0.109	0.056	0.029	0.629
	Targets	0.24	0.14	0.75	0.109	0.056	0.029	0.629
Northern Africa	Slacks	0	0.013	0.065	0.061	0	0.087	0
	Weights	2.349	0	0	0	4.737	0	0.475
	Values	0.426	0.3	0.883	0.124	0.133	0	0.724
	Targets	0.414	0.279	0.793	0.184	0.133	0.087	0.724
Europe & North America	Slacks	0	0	0	0	0	0	0
	Weights	1.31	0	0	1.073	0	2.159	0.216
	Values	0.763	0.707	0.913	0.296	0.254	0.217	0.992
	Targets	0.763	0.707	0.913	0.296	0.254	0.217	0.992
World	Slacks	0	0	0	0	0	0	0
	Weights	1.605	0	0.024	3.711	0	0	0
	Values	0.61	0.434	0.877	0.27	0.217	0.151	0.856
	Targets	0.61	0.434	0.877	0.27	0.217	0.151	0.856

**Table 4.** Data statistics

Index	Maximum	Minimum	Mean	Standard deviation
Individuals with computers	0.24	0.7631	0.51	0.1963
Individuals with internet	0.1399	0.7074	0.396	0.2081
Individuals with mobile phones	0.7495	0.9134	0.856	0.0628
Educational attainment post-secondary	0.1086	0.2962	0.2	0.0841
Educational attainment short-cycle tertiary	0.056	0.2539	0.165	0.0766
Educational attainment bachelors	0	0.2168	0.099	0.0884
Adult literacy rates	0.6287	0.9915	0.8	0.1369

## 6 Discussion of Findings

From the analysis, we can see from Table 5 that Northern Africa is 97.2% relatively efficient in its utilization of ICT Infrastructure for the educational component of National Development while Sub-Saharan Africa, Europe and North America and the World are optimally relatively efficient. Interesting to note, however is that even though Sub-Saharan Africa has the average lowest percentage of ICT infrastructure utilization, educational attainments and adult literacy rates, it is optimally using its current ICT infrastructure with respect to Education in the Human Development Index. This may be as an outcome of a well-known bias of Data Envelopment Analysis where the DMU with the lowest input is more likely to have a high efficiency rating, however, this supports the notion that should there be an increase in ICT Infrastructure, there will be a somewhat corresponding increase in educational attainment and Adult Literacy rates which will inevitably bring about an increase in the Human Development Index.

**Table 5.** Efficiency summary

DMU	Efficiency
Sub-Saharan Africa	100%
Northern Africa	97.20%
Europe and North America	100%
World	100%

As expected, Europe and North America have the highest average values for ICT Infrastructure utilization, educational attainments and literacy rates and are optimally relatively efficient in this regard. Although Northern Africa have higher average values than Sub-Saharan Africa across most of the indices, the fact that there was no data available for Educational Attainment (Bachelors) may be a mitigating factor against their relative efficiency frontier thus reducing the efficiency value. This is not to say however that Northern Africa is not efficient, but rather has the lowest relative efficiency in this grouping and within the context of the model used.



Another interesting finding from the analysis of the data, as presented in Table 6, is the correlation between the input indices and the output indices. Individuals with computers has the strongest correlation with educational attainment and adult literacy rates while individuals with mobile phones has the weakest correlation. This may also be a strong indication of the outcome of pedagogical changes in teaching and learning which now include higher usage of computers. This could be a result of the introduction of online learning and blended learning environments into education. It would be interesting to see, as m-learning initiatives pick up, whether the correlation between mobile phones and educational attainments and literacy rates will become stronger.

**Table 6.** Correlation between input and output indices

Index	Individuals with computers	Individuals with internet	Individuals with mobile phones
Educational attainment (Post-secondary)	0.9456	0.905	0.6947
Educational attainment (Short cycle tertiary)	0.9942	0.951	0.8794
Educational attainment (Bachelors)	0.8972	0.8982	0.5709
Adult literacy rates	0.9932	0.9913	0.8246
Average	0.9576	0.9364	0.7424

## 7 Limitations

The main limitation of this study is the availability of the data for the dataset. The data was collected from the United Nations Educational, Scientific and Cultural Organization (UNESCO) - educational attainments; World bank - literacy rates and the International Telecommunication Union (ITU) - individuals with computers, internet and mobile phones. Considering that the years being investigated are the most recent and the sources of the data are credible and well cited sources for scientific data collection, some countries within each region did not have data available for one or more years being investigated. This may have positive or negative effects on the regional averages calculated as the data collected is represented as a percentage of the population of the countries. Also, the limitation in availability of data make it difficult to carry out intra-regional comparative analysis in order to see how individual countries within each region fare amongst themselves.

## 8 Conclusion and Future Work

This research has been able to show that ICT infrastructure available is currently making an impact on human development with respect to educational attainment and adult literacy rates. This is evidenced by the fact that the data collected was data of ICT infrastructure currently available for utilization by the regions within the specified time

and not investments made during this time. This is a direct response to Bankole et al. [10] which asked the question if increased investments in ICT infrastructure provide any improvement in human development in Africa. The research further shows that regions with significantly lower educational attainment and literacy rates are relatively efficiently utilizing their significantly lower ICT infrastructure and therefore provides an albeit assumptive basis for justifying increased spending in ICT infrastructure. Using the CRS model for the DEA analysis, the research has been able to show that while controlling the inputs (ICT Infrastructure) an increase in the input has a tendency to result in a corresponding increase in the output (Educational Attainment/Adult Literacy Rates) and vice-versa, therefore impacting positively the educational component of the Human Development Index.

The research has also been able to show that there is a strong correlation between ICT Infrastructure and Educational Attainment/Adult Literacy rates. The correlation is strongest on the individuals with computers index of the ICT Infrastructure as shown in Figs. 1 and 2. This shows that increased spending in computer hardware and availability of these resources to individuals may have a strong impact on education. The correlation not only justifies the spending on ICT infrastructure for education, but also justifies the notion that its increased utilization brings about increase in educational attainment and not just enrolment thereby increasing literacy rates. It is important to note that the strongest correlation occurs between the individuals with computers and educational attainment post-secondary indices which is shown in Fig. 2. This also justifies the increased investments being made in ICT in secondary education and not just tertiary education.

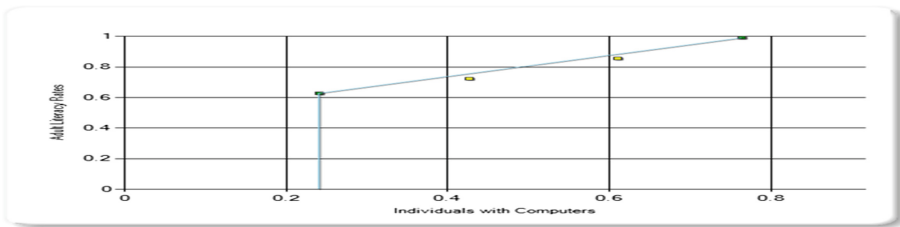


Fig. 1. Correlation between individuals with computers and adult literacy rates

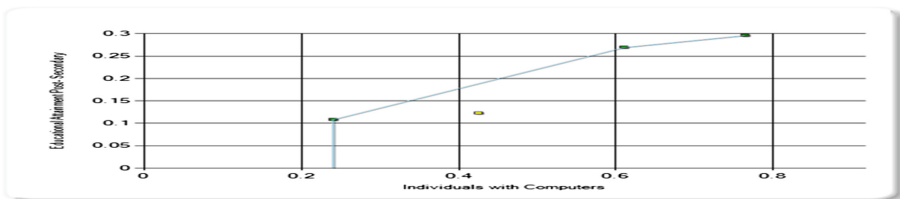


Fig. 2. Correlation between individuals with computers and educational attainment post-secondary

While acknowledging that DEA as a methodology in itself is context specific and by its very nature of being non-parametric does not allow for generalization beyond the context [44], the research has been able to prove that within the sample itself and within the context of educational attainment/adult literacy rates, there is a strong impact of ICT on Human Development albeit within the Educational index. The research has also been able to show how Learning Analytics can be applied for decision making outside the teaching and learning environment and for policy directions. An area of future research would be to expand this context by showing how ICT impacts on each of the components of the Human Development Index within the specified DMU's and determine the correlations, if any between them. Another area of future research also would be to explore the other DEA models available and determine if there are any other significant correlations or findings, which can have strong impacts on ICT infrastructure investments, on the individual Human Development Indices, as well as measure the productivity over time of the ICT infrastructure utilization. Future research can also be carried out to investigate further the impact, if any, of the strong correlations between ICT infrastructure and educational attainment/adult literacy rates and what this may mean in the broader ICT4D context.

## References

1. Afonso, A., St. Aubyn, M.: Non-parametric approaches to education and health efficiency in OECD countries. *J. Appl. Econ.* **8**(2), 227–246 (2005)
2. Afonso, A., St. Aubyn, M.: Cross-country efficiency of secondary education provision: a semiparametric analysis with non-discretionary inputs. *Econ. Model.* **23**(3), 476–491 (2006)
3. Afonso, A., St. Aubyn, M.: Relative efficiency of health provision: a DEA approach with nondiscretionary inputs. ISEG-UTL, Department of Economics Working Paper n° 33/2006/DE/UECE (2006)
4. Akpan, P.: Africa and the new ICTs: implications for development. In: Proceedings of the International Federation for Processing Conference (IFIP TC9), South Africa (2000)
5. Anand, S., Ravallion, M.: Human development in poor countries: on the role of private incomes and public services. *J. Econ. Perspect.* **7**(1), 133–150 (1993)
6. Aristovnik, A.: The impact of ICT on educational performance and its efficiency in selected EU and OECD countries: a non-parametric analysis (2012). <http://dx.doi.org/10.2139/ssrn.2187482>
7. Aygerou, C.: Discourses on ICT and development. *Inf. Technol. Int. Dev.* **6**(3), 1 (2010)
8. Bankole, F.O., Shirazi, F., Brown, I.: Investigating the impact of ICT investments on human development. *Electron. J. Inf. Syst. Dev. Ctries.* **48**(1), 1–19 (2011)
9. Bankole, F.O., Brown, I., Osei-Bryson, K.M.: The impact of ICT infrastructure on human development: an analysis of ICT-Use in SADC countries. In: Proceedings of the 11th International Conference on Social Implications of Computers in Developing Countries, Kathmandu, Nepal, May 2011 (2011)
10. Bankole, F.O., Osei-Bryson, K.M., Brown, I.: ICT infrastructure utilization in Africa: data envelopment analysis based exploration. In: Proceeding of Special Interest Group on ICT and Global Development at Americas Conference on Information System (AMCIS) Workshop, Detroit, USA (2011)
11. Bankole, F., Mimbi, L.: ICT infrastructure and it's impact on national development: a research direction for Africa. *Afr. J. Inf. Syst.* **9**(2), 1 (2017)

12. Briede, B.: Usage of the goals for sustainable development in formation of learning outcomes in higher education. In: Rural Environment. Education. Personality. (REEP). Proceedings of the International Scientific Conference (Latvia). Latvia University of Agriculture
13. Charnes, A., Cooper, W.W., Rhodes, E.: Measuring the efficiency of decision-making units. *Eur. J. Oper. Res.* **2**(6), 429–444 (1978)
14. Clements, B.: How efficient is education spending in Europe? *Eur. Rev. Econ. Finan.* **1**, 3–26 (2002)
15. Cook, W.D., Tone, K., Zhu, J.: Data envelopment analysis: prior to choosing a model. *Omega* **44**, 1–4 (2014)
16. Dedrick, J., Gurbaxani, V., Kraemer, K.L.: Information technology and economic performance: a critical review of the empirical evidence. *ACM Comput. Surv.* **35**(1), 1–28 (2003)
17. Desai, M.: Human development. *Eur. Econ. Rev.* **35**(2–3), 350–357 (1991). [https://doi.org/10.1016/0014-2921\(91\)90136-7](https://doi.org/10.1016/0014-2921(91)90136-7)
18. Draca, M., Sadun, R., Van Reenen, J.: Productivity and ICTs: a review of the evidence. In: Mansell, R., Avgerou, C., Quah, D., Silverstone, R. (eds.) *The Oxford Handbook of Information and Communication Technologies*, pp. 100–147. Oxford University Press, Oxford (2007)
19. Ganju, K.K., Pavlou, P.A., Banker, R.D.: Does information and communication technology lead to the well-being of nations? A country-level empirical investigation (2015)
20. Gilhooly, D., Ocampo, J.: *Creating an Enabling Environment: Toward the Millennium Development Goals*. The United Nations Information and Communication Technologies Task Force, New York (2005)
21. Gülbahar, Y.: ICT usage in higher education: a case study on preservice teachers and instructors. *Turk. Online J. Educ. Technol.* **7**(1), 32–37 (2008)
22. Gupta, S., Verhoeven, M.: The efficiency of government expenditure: experiences from Africa. *J. Policy Model.* **23**(4), 433–467 (2001)
23. Hargreaves, A., Braun, H.: *Data-driven improvement and accountability*. National Education Policy Centre, Boulder, CO. (2013). <http://co.chalkbeat.org/wp-content/uploads/sites/2/2013/10/PB-LB-DDIA-POLICY-FINAL-EMBARGOED.pdf>
24. Hatami-Marbini, A., Saati, S., Tavana, M.: An ideal-seeking fuzzy data envelopment analysis framework. *Appl. Soft Comput.* **10**(4), 1062–1070 (2010)
25. Hinojosa, J.E., Jara, I., Brun, M.: Case study: Uruguay. In: Kozma, R.B. (ed.) *Transforming Education: The Power of ICT Policies*, pp. 125–164. UNESCO, Paris (2011)
26. Hinojosa, J.E., Isaacs, S., Bougroum, M.: Information and communications technologies for improving learning opportunities and outcomes in developing countries. In: Wagner, D. A. (ed.) *Learning and Education in Developing Countries: Research and Policy for the Post-2015 UN Development Goals*, pp. 42–57. Palgrave Macmillan US, New York (2014). [https://doi.org/10.1057/9781137455970\\_3](https://doi.org/10.1057/9781137455970_3)
27. Enrique Hinojosa, J.: New challenges for ICT in education policies in developing countries: the need to account for the widespread use of ICT for teaching and learning outside the school. In: Lubin, I.A. (ed.) *ICT-Supported Innovations in Small Countries and Developing Regions*. ECTII, pp. 99–119. Springer, Cham (2018). [https://doi.org/10.1007/978-3-319-67657-9\\_5](https://doi.org/10.1007/978-3-319-67657-9_5)
28. Kadam, U.: *Impact of Technology in Higher Education* (n.d)
29. Kiiski, S.K.: Cross country diffusion of the Internet. UNU/WIDER Discussion Paper WDP 2011 (2001)
30. Mann, C.L.: Information technologies and international development: conceptual clarity in the search for commonality and diversity. *Inf. Technol. Int. Dev.* **1**(2), 67–79 (2004)





31. Molina, A.: The digital divide: the need for a global e-inclusion movement. *Technol. Anal. Strateg. Manag.* **15**(1), 137–152 (2003)
32. Moreira, F., Gonçalves, R., Martins, J., Branco, F., Au-Yong-Oliveira, M.: Learning analytics as a core component for higher education disruption: governance stakeholder. In: *Proceedings of the 5th International Conference on Technological Ecosystems for Enhancing Multiculturality*, p. 37. ACM (2017)
33. Neumayer, E.: The human development index and sustainability—a constructive proposal. *Ecol. Econ.* **39**(1), 101–114 (2001)
34. Ngwenyama, O., Andoh-Baidoo, F.K., Bolou, F., Morawczynski, O.: Is there a relationship between ICT, health, education and development? An empirical analysis of five West African countries from 1997–2003. *Electron. J. Inf. Syst. Dev. Ctries.* **23**(5), 1–11 (2006)
35. Norris, P.: The worldwide digital divide. In: *Paper for the Annual Meeting of the Political Studies Association of the UK, London School of Economics and Political Science* (2000)
36. Olaniyi, T.K., Ademola, E.O.: Deployment of information and communication technology in higher education learning environment of emerging Nigerian economy. *Afr. J. Comput. ICTs* **7**(1), 121–126 (2014)
37. Orbicom: *From the Digital Divide to Digital Opportunities: Measuring Infostates for Development*. Claude-Yves Charron, Montreal (2005)
38. Oyerinde, O.D.: A review of challenges militating against successful e-learning and m-learning implementations in developing countries. *Int. J. Sci. Adv. Technol.* **4**(6), 1–5 (2014)
39. Oyerinde, O.D., Chia, P.A.: Predicting students’ academic performances—a learning analytics approach using multiple linear regression. *Int. J. Comput. Appl.* **157**(4), 37–44 (2017)
40. Papamitsiou, Z., Economides, A.: Learning analytics and educational data mining in practice: a systematic literature review of empirical evidence. *Educ. Technol. Soc.* **17**(4), 49–64 (2014)
41. Prinsloo, P.: Context Matters: An African Perspective on Institutionalizing Learning Analytics. *Include us All! Directions for Adoption of Learning Analytics in the Global South*, p. 24 (2018)
42. Romero, C., Ventura, S.: Educational data mining: a survey from 1995 to 2005. *Expert Syst. Appl.* **33**(1), 135–146 (2007)
43. Sahu, S.: *Role of ICT in Enhancement of Quality Learning and Teaching in Higher Education* (2017)
44. Samoilenko, S.V., Osei-Bryson, K.M.: *Creating Theoretical Research Frameworks Using Multiple Methods: Insight from ICT4D Investigations*. Auerbach Publications, Boston (2017)
45. Siemens, G.: Learning analytics: a foundation for informed change in higher education (2011). <http://www.educause.edu/library/resources/learning-analytics-foundation-informed-change-higher-education>
46. Siemens, G., Long, P.: Penetrating the fog: analytics in learning and education. *EDUCAUSE Rev.* **46**(5), 30 (2011)
47. Siemens, G.: Learning analytics: envisioning a research discipline and a domain of practice. In: *Proceedings of the 2nd International Conference on Learning Analytics and Knowledge*, pp. 4–8. ACM (2012)
48. St. Aubyn, M.: Evaluating efficiency in the Portuguese health and education sectors. *Economia*, **26** (2002). SSRN: <https://ssrn.com/abstract=504942>
49. Thanassoulis, E., Kortelainen, M., Johnes, G., Johnes, J.: Costs and efficiency of higher education institutions in England: a DEA analysis. *J. Oper. Res. Soc.* **62**(7), 1282–1297 (2011)

50. Tondeur, J., van Braak, J., Valcke, M.: Towards a typology of computer use in primary education. *J. Comput. Assist. Learn.* **23**, 197–206 (2007)
51. UNDP: United Nations Development Programme. *The Millennium Development Goals*, UNDP (2006)
52. Walsham, G.: ICT4D research: reflections on history and future agenda. *Inf. Technol. Dev.* **23**(1), 18–41 (2017). <https://doi.org/10.1080/02681102.2016.1246406>
53. Zorrilla, M., García, D., Álvarez, E.: A decision support system to improve e-learning environments. In: *Proceedings of the 2010 EDBT/ICDT Workshops 2011*. ACM (2010)

# **ICT for Displaced Population and Refugees: How It Helps, How It Hurts**



# Mobile Technology for Record Keeping by Women Entrepreneurs in Tanzania: User Requirement Assessment

William Clifford Gomera<sup>1,2</sup> , Jarkko Suhonen<sup>2</sup> ,  
Solomon Sunday Oyelere<sup>2</sup> , and Alsen Florian Kapinga<sup>1,2</sup> 

<sup>1</sup> College of Business Education (CBE),  
P.O. BOX 1968, Dar es Salaam, Tanzania  
w. gomera@cbe.ac.tz

<sup>2</sup> School of Computing, University of Eastern Finland, Joensuu, Finland

**Abstract.** Mobile phone technology is increasingly being used as a tool for communication among women entrepreneurs in Sub-Saharan Africa. However, little has been done in identifying user requirements for record keeping by the mobile applications among women business in Tanzania. The present study applied the design thinking approach in explored women entrepreneurs' user requirements for a mobile application for keeping record. Data were collected through focus group discussion and interview. The data were qualitatively coded into themes and were analyzed through descriptive statistics. The study established that women entrepreneurs need to keep records for purchases, sales, loan balance, amount due for payment, cost of goods sold, goods purchased, purchase cost, available stock, selling price, day sells information, customers, records, and market network. Similarly, they wanted an application that is easy to operate, using Swahili, a familiar language, outputting symbols and figures and producing specific records and reports. The findings underscore that design thinking can reliably be applied in user requirement definition stage of design science research to anticipate qualities for record-keeping using the mobile technology.

**Keywords:** Mobile technology · Women entrepreneurs · Record keeping · Design thinking · User requirement · Design science research

## 1 Introduction

The number of women entrepreneurs' accessing capital, training, productive re-sources and technologies that can alleviate work burden is very low worldwide, and Tanzania in particular [1, 2]. Study made in Tanzania [3] attribute the observed low number of women benefitting from these opportunities to social-cultural challenges and patriarchy. In Tanzania [4], observed that women are hindered from accessing resources and financial services, compared to men, irrespective of the fact that the ratio of females to males in a population is higher.

In realization of these problems, Tanzanian Savings and Credit Cooperative Societies (SACCOs) have shown great commitment to support women entrepreneurs



(WEs) through services such as savings, loan services, training and other business opportunities [5, 6]. Consequently, several studies have investigated the role of SACCOs in supporting women entrepreneurs financially and socially [7]; challenges facing SACCOs microcredit programs, characteristics of SACCOs, and the importance of SACCOs on the economies of developing countries [8, 9].

Of all the studies on the role of SACCOs and other stakeholders in supporting women entrepreneurs' business development, the extent to which the mobile technology helps women entrepreneurs to keep records of their businesses has not been comprehensively studied. Mobile technology, among other things, can help women entrepreneurs to increase market efficiency, keep records of sales and purchases, promptly communicate business information, establish business networks, and improve productivity through a better supply chain management it offers [10, 11]. It can also help them to monitor profits, losses, expenses, and in determining a minimum selling price [12, 13].

Furthermore, the mobile technology can help institutions involved with women entrepreneurs, such as SACCOs to address socio-cultural constraints that bar women from attaining entrepreneurial excellence; in particular, in addressing the lack of or inadequate knowledge of record keeping among women entrepreneurs, which has quite often lead to failure in their businesses [3, 14].

In this backdrop, the present study felt the need to assess user requirement for a mobile record-keeping application for women in Tanzania. The main question that the study pursued was: *“What are the function and design requirements for a mobile application for record keeping by women entrepreneurs?”*

This study contributes to the creation of novel and true body of knowledge on how to apply the design thinking and DSR process in developing an application for record keeping. In addition, this study contributes to a new context for integrating an interdisciplinary approach in undertaking societal problems, such as the use of mobile technology in addressing business challenges. Furthermore, the study adds to the existing body of knowledge about mobile technology application in the domain of entrepreneurship and towards solving a real societal problem in the business arena, for instance, recordkeeping, and producing various reports for financial control.

## **2 Background Information**

### **2.1 The Increased Mobile Phone Usage in Tanzania**

Mobile phone ownership in Tanzania has remarkable grow in terms of the number of operators and subscribers over the past few years. There is over 40 million fixed land-line and mobile cellular subscribers in Tanzania, as of December 2017 [15]. The significant growth is attributed to the widespread of cellular towers all over the country, positive perception of the society of the importance of the mobile phone, and the affordable price of purchasing mobile handsets [15]. The increased ownership of mobile phones implies an opportunity to improve business development of women entrepreneurs through enhancing record keeping.

## 2.2 Record-Keeping and Its Importance in Business

Record keeping is an art of keeping records of all business undertakings in a regular and orderly manner for providing means by which an enterprise can be conducted in an orderly manner [14]. This is different from bookkeeping that only involves the recording of business transactions. Record keeping is very important for sustainability and growth of any enterprise, especially to WEs. This is because it increases chances of businesses survival, serves as a basis for planning, and keeping a business in a sound and healthy state in a competitive economy [16]. Further, record keeping gives background information, which can help women entrepreneurs to change or improve their business prosperity: i.e. business progress, obstacles, trend and so forth. The records help entrepreneurs to make informed decisions, and in so doing, avoid business failures.

Olukton et al. [14], summarize the objectives of record keeping as; (1) provision of an accurate or thorough picture of operating results, (2) allowing comparison of current information with prior years' operating results, (3) helping in seeking funds from financial institutions, (4) allowing fast, accurate, and reliable access to records, and (5) ensuring timely disposal of redundant information. Against this backdrop, women entrepreneurs have to keep proper and adequate records so that they can ensure the orderly conduct of business and the making of informed decisions about critical issues for the survival of their businesses. Similarly, they should abide by the principles of accuracy, authenticity, accessibility, completion, comprehensive, effectiveness and safety of the records.

## 2.3 The Contribution of SACCOs Service to the Development of Women's Enterprises

According to the National Census of 2012, Tanzania estimated to have a total population of 60,151,311 people, out of which, 30,857,623 (51.3%) are women. Moreover, women constitute 53.3% of the whole Tanzanian work age of 23,466,616 people [17]. This implies that the socio-economic development of this country significantly depends on women.

Nonetheless, patriarchal cultural practices often bar these women to access information, opportunities, business networking, and finance potentials. As a result, they are less exposed and are underrepresented in many sectors [4, 18, 19]. This underscores the importance of all initiatives towards empowering this important group of the population. Financial empowerment of women, whether through lending, saving, remittances or other services – inevitably increases women success in their engagements [6, 16, 20].

Micro-credit institutions are thus strongly encouraged to provide Tanzania's women with loans and other services that can help them to grow their enterprises. Afrin et al. [21], write that “for the development of women entrepreneurship, stimulatory supports are essential as the women are unaware of their capabilities. They concluded in their study that Microcredit programme provides many stimulatory services along with loans for women entrepreneurship development.

In Tanzania, SACCOs are the microfinance institutions controlled by members with the aim of promoting savings, providing microcredits at competitive rates and assisting

them in marketing their products and services. These financial and non-financial services are designed to help poor people who are excluded from formal banking services, in most developing countries to maximise benefits in their enterprises [7, 8, 22]. SACCOs offers credit to women for generating income for themselves and their families, creating jobs and making significant contributions to the country's economy [22].

### 3 Research Design

#### 3.1 Design Science Research and Design Thinking

The focus of this study was to identify user requirement for a mobile application that can help women entrepreneurs to keep records of their business activities. User requirement definition is one of the stages for designing artifacts for solving practical problems according to DSR framework [23, 24]. DSR framework encompasses stages such as problem explication, requirements definitions, design and development, demonstration, and evaluation [24, 25]. Moreover, DSR can be focused on three research cycles: (i) the relevancy cycle, (ii) the design cycle, and (iii) rigor cycle. The relevancy cycle contributes to the identification of requirements and contributes to the design science activities. The rigor cycle connects the design science activities with the knowledge, whereas, the design cycle iterates between design and development of an artefact and process of the research [25].

The design thinking concept has been specifically applied in the stage of user requirement definition due to its richness in focusing on human and their working environment. It also ensures full participatory of expected end users in identifying the quality of anticipated output of the ongoing project [28]. The design thinking supplemented DSR at this stage due to the best interest of humankind and its unique way of approaching issues, problems and opportunities. Hence, it reduced the gap between the theory, local environment, and humankind, while maintaining the amount of rigor necessary for the reliable results [27].

In the context of our work, both design thinking and DSR approaches informed activities for transforming WEs' businesses through the mobile technological solution [23]. Additionally, the study employed a qualitative research design to establish inspiration space for technological innovation solution for record keeping by women entrepreneurs. The approach was chosen because of its effectiveness in soliciting in-depth user requirements [28, 29] using the limited available resources.

#### 3.2 Study Area

This study was conducted in Dar es Salaam, which is one of the regions in the Eastern part of Tanzania. Dar es Salaam Region was chosen because there is high level of interactions between WEs and SACCOs compared many regions of Tanzania; exactly, 405,907 urban MSEs, out of 1,220,464 urban MSEs in Tanzania [4]. This suggests that conscientization of SACCOS business is higher in Dar es Salaam than in other regions of Tanzania.

### 3.3 Sampling Strategy

The sample of the study was drawn from women entrepreneurs in Dar es Salaam Region who are the members of SACCOs. Women entrepreneurs were targeted in this study because their main source of capital is SACCOs. Purposive sampling strategy was adopted in this study in order to increase validity, reliability, and wide range of responses. Purposive sampling enabled the researchers to choose relevant respondents to address the research questions of this study [30].

### 3.4 Data Collection Methods

This study employed eclectic approach in collecting data for this study due to the fact that one approach would compensate for the weaknesses of another approach. One approach would also capture information that would not be captured by another approach.

**Face-to-Face Interview.** The researchers conducted face-to-face interviews with 20 (twenty) women entrepreneurs and 5 (five) managers from different SACCOs. The interviews were recorded with the consent of the participants. Face-to-face interviews enable the researchers to obtain in-depth information and offered a great flexibility in data collection process [31]. Interview tends to bring higher responses as it establishes a rapport that motivates a respondent in question to answer questions [32]. The interviews employed unstructured and general open-ended questions to elicit views and opinion from the participants [33]. The use of interview inspired women entrepreneurs to provide trustful and precise answers [32].

**Exploratory Focus Group Discussion.** Researchers conducted three exploratory focus group discussions with three groups of women entrepreneurs to define the problem precisely and to identify user requirements for record keeping by the women entrepreneurs.

### 3.5 Analysis

The primary data were coded according to themes and were analyzed qualitatively. Additionally, descriptive statistics was applied in establishing the quantitative results concerning user requirement of the mobile application. Analyses focused on identifying an appropriate service in empowering women entrepreneurs offered by SACCOs and a potential of using a technological tool to strengthen such service.

### 3.6 Ethical Consideration

During the data collection, consent was sought and obtained from all participants. The agreement was to strictly use the information obtained for academic and research purposes only. Besides, it was agreed that participants' information and any material or pictures that could identify them would not be disclosed. Lastly, participants were free to withdraw from the study or were not forced to talk during the interviews and focus group discussions.

## 4 Results

The study set out to identify user requirements that should be incorporated in the design of a mobile application for record-keeping by women entrepreneurs. The data were derived from face-to-face interview and exploratory focus group discussion. The majority of participants were 35–44 years old (21 out of the 25 participants), had completed secondary education (19 out of the 25 participants), and had six or more years of experience in business (22 out of the 25 participants). This part presents the attitude of participants towards record-keeping and the design requirements in a mobile application for helping WEs and SACCOs to keep business records.

### 4.1 Attitudes Toward Record-Keeping by Women Entrepreneurs

Most of the participants in this study exposed that they were keeping records of different activities of their businesses. However, they observed that their records were incomplete, inaccurate, in bad format and ephemeral. They attributed the poor record-keeping to lack of knowledge of record keeping, intensive time demand for record keeping exercise, lack of record keeping tools, and an assumption that SACCOs were liable to keep business records of its customers. A few of the respondents demonstrated through their answers that they did not see the importance of keeping records as long as they were the sole owners of the businesses they ran.

All the same, many respondents considered record keeping as an important service for their businesses, irrespective that they did not keep them properly. Most of them recognized the importance of retrieving the amount of loan balance, savings they have in SACCOs, the sells per day, cost of sales and the amount of remaining stock any time they want it.

### 4.2 Function Requirements for the Mobile Application for the Women Entrepreneurs

Women entrepreneurs considered record-keeping as an important service in their business undertakings. Respondents identified functions involved in their businesses as recording, purchasing, selling and marketing products. For each of these functions, they identified their preferred requirement in the proposed mobile application as follows.

Under recording function, users required that the application be able to record information regarding their contribution balances to SACCOs, loan balances, amount due for the installment pay, amount invested for their business and payment for transport, rent, water bills, electricity bills and other business expenses. As regarding purchasing function WEs would like the application to record number of units purchased, purchases cost, raw materials bought, available stock and cost of goods sold.

Moreover, for selling function, they required the application to records units of products sold, selling prices, and total sells per day. Moreover, for marketing function, they proposed that the application be able to record customers served, kind of products they bought, date of purchases, estimated time for serving a customer, and the debts

that the customer owes the seller. Further, they wanted the application to offer market-networking services to its users. Table 1 summarizes key functions in women’s enterprises and their attendant requirements in the proposed mobile application for record keeping among WEs in Tanzania.

**Table 1.** Functions in women’s entrepreneurship and their attendant requirements in the mobile application for record-keeping.

S/N	Function	Ability required in the record keeping mobile application for WEs
1	Recording	Ability to record contribution balance, loan balance, amount due for payment, amount invested for their business, payment for transport, rent, water bills electricity bills and other business expenses
2	Purchasing	Ability to record amount of goods purchased, purchases cost, available stock, cost of goods sold and raw materials bought
3	Selling	Ability to record units, selling prices, total sales per day
4	Marketing	Ability to record contact of customers served, kind of product bought, date of purchases, estimated time for another order, debts and market networks information

### 4.3 Design Requirements for the Mobile Application for the Women Entrepreneurs

The study participants noticed that the mobile phone has a high potential to improve their record keeping procedures if tailored to their needs. They required a mobile application, which output symbols and figures the Swahili language, the familiar language to Tanzanians. Similarly, they asserted that “the application should have a direct connection with SACCOs for financial information and should produce specific business reports”. They added that such reports should be realized in audio or word document formats for easy reference by different users. They also recommended that the application files be lightweight to ensure transferability.

**Table 2.** Recommended user requirement for the record Keeping App for WEs

User requirements	Interviewees		FGD groups		Comment
	Mention	Not mention	Mention	Not mention	
Ease of use	20/25 80%	5/25 20%	2/3 75%	1/3 25%	Preferred
Operation in Kiswahili language	19/25 76%	6/25 24%	3/3 100%	0/3 0%	Preferred
Symbol and figures output	18/25 72%	7/25 28%	3/3 100%	0/3 0%	Preferred
Specific record services and reports output	12/25 48%	13/25 52%	3/3 100%	0/3 0%	Preferred
Operation in non-smartphones	3/25 12%	22/25 88%	0/3 0%	3/3 100%	Not preferred

As demonstrated in Table 2, the majority of the interviewees 80%, participants in FGDs (in 2 out of 3) required the application to be ease of use. This confirms that WEs prefer artifact that is simple to use. The analysis also indicates that the usage of Swahili, the native language, was highly recommended by participants, i.e. 78% of total WEs interviewed and the participants of all the 3 FGDs conducted. Further, the use of symbol and figures in the application was highly recommended by the users to accommodate users who cannot read and write – 72% of the interviewees and all participants in the 3 FGDs.

The contradictory results were on the output requirement of the proposed application. Whereas, only 12/25 (48%) of the interviewees needed the application to produce specific record services and reports, participants in all the FGDs (3out of 3–100%) wanted that the application be able to produce specific record services and reports. However, only 3 out of 25 interviewees (18%) proposed that the application be accessible in non-smartphones, likewise, none of the FGD i.e. 0/3 (0%) mentioned it as one of their requirement. This indicates that people with low education level can use any technology it is simplified and suited to different contexts.

## 5 Discussion

This study focused on the initial stages of DSR project development i.e. problem explication, and user requirements definition of technological intervention [24]. The design thinking approach in problem explication and user requirement stage of DSR is the best thought to supplement in developing an artefact because it overlapping spaces like inspiration, ideation and implementation than only a sequence of orderly steps [28]. DSR framework was integrated with design thinking for the sake of end-user involvement in the solution-making process, which could result in a more sustainable sense of ownership and acceptance of the artefact. The design thinking approach is a very important aspect to incorporate when researchers apply both DSR framework according to [24], and rigor design as stipulated by [26], especially at problem explication and user requirement definition stage. This is because it tends to yield unexpected benefits in establishing user requirements using small resources in DSR process [24, 36]. The main research question in this study was: What are the function and design requirements for a mobile application for record-keeping by women entrepreneurs? Consonantly, respondents aired their ideas, which were discussed and consensus reached.

The analysis shows that the respondents preferred an application, which is capable of recording their transactions, purchases, sells and marketing. They wanted the application to be able to record account balance of savings in SACCOs, loan balance, and amount due for payment, goods purchased, purchases cost, available stock, selling price, day sells information, units sold, selling prices, and total sells per day. Moreover, they required the application to save customers' contacts, products bought, date of purchases, estimated time for another order, debts and market networks information.

These records and information requirement were determined by the activities performed by WEs in their business undertakings. This implies that the design of an artefact should reflect the activities performed by its expected end users. Studies such

as MBs training [34], bookkeeping for informal workers [12], and technological innovation for market application by WEs in Iringa Region [13] have confirmed this assertion in different contexts.

Moreover, we confirmed that WEs and SACCOs managers preferred an application that is easy to operate, using Swahili, the native language, outputting symbols and figures, and outputting specific record services and reports. Ease of use and native language medium were the most preferred attributes in the proposed application. The recommendation of Swahili as the main communication language of the application concurs with [35], whom in 2016, equally found that potential users of applications in informal sector preferred Swahili as the language of the applications. Moreover, the requirement that the application output symbols and figures concurred with the findings of [12, 13].

The results thus clearly show the need for an application that contextualizes business undertakings by WEs. The defined user requirements for mobile recordkeeping, reliably established a base for anticipated functional and non-functional qualities for artefact to be used by WE in record keeping centred on participant themselves. Moreover, due to small resources available, the participant came up with the viable solution on record keeping by using the existing mobile phone. This brings up the fundamental base of frugal innovation aim at producing good enough, affordable and relevant solution to existing solution mainly for the societies faced with extremely scarce resources. Usage of existence infrastructure in design and development is a fundamental base of the frugal innovation [36].

In this sense, the study contributes to research and practitioners that the design thinking can supplement the DSR framework, to accurately and economically establish the user requirements for an artefact that reliably solves their practical challenges.

## 6 Conclusions

This study came about in the backdrop that factors such as low income, social-cultural responsibilities and stereotypes barred women entrepreneurs from undertaking records of their business as required. It was based on the realization that women entrepreneurs needed to efficiently keep records of their financial transactions, sells, purchases, stock information and marketing, just to mention a few, to derive substantial benefits of their enterprises. The realization, underscores the need for a special, low technology application to help WEs with the keeping of records of their businesses efficiently.

The mobile application appeared ideal for the purpose because of their availability and efficiency in data management. However, contextualization of their functions was found necessary to ensure that they best serve the intended objectives among WEs in Tanzania.

This study analysed the general user requirement for WEs in mobile record keeping. However, user requirement done in a small group of people that only interact with SACCOs, hence, it limited with comparison to other group of people like men entrepreneurs. In addition, the study show very general user requirement of record keeping for many services and activities of the group analysed. Researchers encouraging that a user requirement study in a specific services and activity for a detailed analysis.



Moreover, the design thinking supplemented DSR framework to establish user requirement for a mobile application in record keeping by WEs. The user requirements defined are in terms of functions and the characteristics of the application. The next phase of the study will be to design and develop an artifact for record keeping by women entrepreneurs in Tanzania. In line with the DSR framework, the activity will involve the WEs, researchers and software engineers. The future studies will demonstrate, evaluate, and re-design the intervention according to the evaluation results.

## References

1. Zukang, S.: Women's Control over Economic Resources and Access to Financial Resources, Including Microfinance. United Nation - Department of Economic and Social Affairs - Division for the Advancement of Women, New York (2009)
2. Vossenbergh, S.: Women entrepreneurship promotion in developing countries: what explain the gender gap in entrepreneurship and how to close it? Maastricht School of Management, Maastricht, The Netherlands (2013)
3. Kapinga, A.F., Suero, C.M.: Exploring the socio-cultural challenges of food processing women entrepreneurs in Iringa, Tanzania and strategies used to tackle them. *J. Glob. Entrep. Res.* **7**, 17 (2017)
4. Maleko, G.N., Liheta, B.S., Aikaruwa, D., Lukas, A., Sumari, G.A.: Women participation in microfinance institutions of Tanzania: the case of savings and credit co-operative societies (SACCOS). *J. Bus. Adm. Educ.* **4**(2), 139–175 (2013)
5. Bwana, K.M., Mwakujonga, J.: Issues in SACCOs development in Kenya and Tanzania: the history and development perspectives. *Dev. Ctry. Stud.* **3**(5), (2013)
6. Moturi, C., Mbiwa, P.: An evaluation of the quality of management information systems used by SACCOs in Kenya. *TQM J.* **27**(6), 798–813 (2015)
7. Marwa, N., Aziakpono, M.: Financial stability of Tanzanian saving and credit cooperatives. *Int. J. Soc. Econ.* **42**(10), 870–887 (2015)
8. Frank, T., Mbabazize, M., Shukla, J.: Savings and credit cooperatives (SACCO's) services' terms and members' economic development in Rwanda. *Int. J. Commun. Coop. Stud.* **3**(2), 1–56 (2015)
9. Masele, J., Fengju, X., Masele, J.Z.: The role of government microfinance credit scheme in Tanzania a case of NEDF–SIDO. *IOSR J. Bus. Manag. (IOSR-JBM)* **17**(7), 8–22 (2015)
10. Aker, J.C., Mbiti, I.M.: Mobile phones and economic development. *J. Econ. Perspect.* **24**(3), 207–232 (2010)
11. Sife, A.S., Kiondo, E., Macha, J.G.: Contribution of mobile phones to rural livelihoods and poverty reduction in Morogoro region, Tanzania. *Electron. J. Inf. Syst. Dev. Ctries.* **42**(3), 1–15 (2010)
12. Mramba, N., Tulilahti, J., Apiola, M.: Bookkeeping for informal workers: co-creating with street traders. In: Parsons, J., Tuunanen, T., Venable, J., Donnellan, B., Helfert, M., Kenneally, J. (eds.) *DESRIST 2016*. LNCS, vol. 9661, pp. 97–113. Springer, Cham (2016). [https://doi.org/10.1007/978-3-319-39294-3\\_7](https://doi.org/10.1007/978-3-319-39294-3_7)
13. Kapinga, A.F., Suero, C.M., Mbise, E.R.: Mobile technology for women entrepreneurs in Iringa, Tanzania: user requirements and architectural design. In: *AFRICON*, Cape Town (2017)
14. Olukotun, A.G., James, S.O., Olore, I.: The role of record keeping in the survival and growth of small scale enterprise in Ijumu local government area of Kogi State. *Glob. J. Manag. Bus. Res.* **12**(13), 55–66 (2012)

15. Tanzania Communication Regulatory Authority, Quarterly Report for December 2017, Dar es Salaam, Tanzania (2017)
16. Jones, L., Snelgrove, A., Muckosy, P.: The double-X factor: harnessing female human capital for economic growth. *Int. J. Emerg. Mark.* **1**(4), 291–304 (2006)
17. United Republic of Tanzania. <http://worldpopulationreview.com/countries/tanzania-population/>. Accessed 29 Jan 2019
18. Kyrgidou, L.P.: Developing women entrepreneurs' knowledge, skills and attitudes through e-mentoring support. *J. Small Bus. Enterp. Dev.* **20**(3), 548–566 (2013)
19. Naser, K., Mohammed, R.W.: Factors that affect women entrepreneurs: evidence from emerging economy. *Int. J. Organ. Anal.* **17**(3), 225–247 (2009)
20. Milek, A., Stork, C., Gillwald, A.: Engendering communication: a perspective on ICT access and usage in Africa. *Info* **13**(3), 125–141 (2011)
21. Afrin, S., Nazrul, I., Shahid, U.A.: A multivariate model of micro credit and rural women entrepreneurship development in Bangladesh. *Int. J. Bus. Manag.* **3**(8), 169–185 (2008)
22. Fox, L.: Gender, Economic Transformation and Women's Economic Empowerment in Tanzania. Supporting Economic Transformation (SET), London (2016)
23. Lacerda, D.P., Antunes, J.A.V., Dresch, A.: Design Science Research: A Method for Science and Technology Advancement. Springer, Cham (2015). <https://doi.org/10.1007/978-3-319-07374-3>
24. Johannesson, P., Perjons, E.: An Introduction to Design Science Research. Springer, Cham (2014). <https://doi.org/10.1007/978-3-319-10632-8>
25. Gregor, S., Hevner, A.R.: Positioning and presenting design science research for maximum impact. *MIS Q.* **37**(2), 337–355 (2013)
26. Hevner, A.R.: A three cycle view of design science research. *Scand. J. Inf. Syst.* **19**(2) (2007)
27. Owen, C.L.: What it is. Why it is different. Where it has new value. In: Owen, C.L. (ed.) *Design Thinking. What It Is. Why It Is different.* The International Conference on Design Education and Research (2005)
28. Owen, C.L.: Design thinking: driving innovation. The Business Process Management Institute, pp. 1–5 (2006)
29. Hevner, A., Samir, C.: Design science research in information systems. In: *Design Research in Information Systems*, pp. 9–22 (2010)
30. Bryman, A.: *Social Research Methods*, 4th edn. Oxford University Press, New York (2012)
31. Kothari, C.R., Garg, G.: *Research Methodology: Methods and Techniques.* New Age International (P) Limited, New Delhi (2014)
32. Cozby, P.C.: *Methods in Behavioral Research.* McGraw Hill, New York (2007)
33. Creswell, J.W.: *Research Design: Qualitative, Quantitative and Mixed Methods Approaches.* SAGE Publications, Inc., London (2014)
34. Gomera, W.C., Mikko, A.: Improving MFI-MB interaction with technology: an explorative study in Dar es Salaam, Tanzania. In: IEEE, AFRICON 2015, Addis Ababa (2015)
35. Gomera, W., Oreku, G.: Mobile technology in training micro businesses: users' requirements and architectural design. *Int. J. ICT Res. Africa Middle East (IJICTRAME)* **5**(2), 14–24 (2016)
36. Agarwal, N., Brem, A.: Frugal and reverse innovation-literature overview and case study insights from a German MNC in India and China. In: 18th International ICE Conference (2012)



# Reimagining Refugee Identity Systems: A Sociological Approach

Shirin Madon<sup>1(✉)</sup> and Emrys Schoemaker<sup>2</sup>

<sup>1</sup> London School of Economics and Political Science, London, UK  
madon@lse.ac.uk

<sup>2</sup> Caribou Digital, London, UK

**Abstract.** This paper explores how the social identity of refugees shapes and is shaped through the process of registering with humanitarian organisations. Building on the recent advance of critical studies on digital identity systems for refugee management, we show how the lens of social identity is helpful in understanding the relationship between refugee information systems and refugee experiences of registration and accessing services. Identity is a key issue related to contemporary information systems yet remains an under-theorised area of investigation from a sociological perspective in the field of information systems, international development and refugee studies. Using qualitative data from refugees in Bidi Bidi refugee camp in Northern Uganda, this paper showcases the centrality of refugees' social identity in determining the journey of vulnerable individuals focusing on three key dimensions. First, how the identities of refugees based on home and family in South Sudan were carried over to refugees' new location in Uganda and were later transformed through the process of registration. Second, how work and career profile of their lives in South Sudan shaped the identity of refugees, and how the absence of education credentials limited the realisation of personal aspirations. Third, how interactions between institutions and refugees are both shaped by and shape refugee identity. Our findings point to important policy implications for designing and implementing refugee identity systems.

## 1 Introduction

Refugees are often seen as people who have lost what many regard as the most important form of identity – legal identification by the state. The right to recognise identity has long been an element in the human rights agenda but only relatively recently been identified as a development priority with the adoption of the SDGs in 2015 [23], and its more recent incorporation in SDG 16.9 by 2030 to provide legal identity for all including free birth registration. The loss of legal identity amongst the growing number of refugee communities around the world and their broader vulnerability has led many to explore how new forms of digital technology can empower and protect some of the most vulnerable populations in the world [7, 17, 24]. With its unique mandate for protecting refugees, UNHCR's registration database system called ProGres has become the de facto means of registering refugees [23].

UNHCR defines registration as ‘the process of recording, verifying and updating information on persons of concern to UNHCR’. In the initial stages of registration, basic household data is first collected for demographic estimates, followed by data collection to support basic planning and monitoring activities - here additional individual data is collected including sex; date of birth; current location; place of origin (address); date of arrival; special protection and assistance needs; marital status; citizenship; education level; occupation/skills; religion; ethnic origin (tribes/clans/sub-clans); photograph; biometric data if needed and crucially, permission to share information with other parties. However, this detailed personal information is still not sufficient for UNHCR to determine the legal status of individuals. For this, further personal information including names of spouse(s) father and mother; names of all children; place of birth; existing personal documents; documentation issued locally; property status in country of origin; voluntary repatriation status and intentions; resettlement case status; local settlement status; reasons for flight. In sum, extensive personal information is required for UNHCR to determine the legal identity of individuals. Over the years, acceptance of ProGres has grown and by the end of 2010 it had been deployed in more than 250 locations in 82 countries. The system has been updated, to include a suite of modular applications including Rapid Application (RApp) – which allows an offline data collection of refugees (later uploaded to ProGres), IDPs, and others; CashAssist – that enables registered refugees to receive cash assistance and GDT or Global Distribution Tool, allowing registered refugees to receive in-kind assistance (food, NFI, etc.). UNHCR has also adopted an integrated approach to data collection, which they call PRIMES (Population Registration and Identity Management EcoSystem). This includes all interoperable registration, identity management and caseload management tools and applications, and enables a centralised analytics platform, the PRIMES Dataport, which is accessed through a secure data interface<sup>1</sup>.

Views differ on the gains and risks of digital identity systems for refugees. On the one hand, formal recognition of an individual’s legal status as a refugee enables rights and protections whilst the identification systems that deliver this can also help build state capacity to deliver public services and social protection programmes more effectively [16]. On the other hand, concerns related to biometric information are linked to political context. In particular, security perspectives focused on migration and terrorism influence government approaches to biometric identification often conflicting with human rights protection for refugees [14] and biometric use often occurs in contexts lacking data protection legislation [11]. Over the past 10 years, UNHCR has developed a strong data protection policy regarding sharing personal data with governments [23] and other humanitarian organisations have followed suit. However, these policies have proved to be insufficient to ensure privacy and security of refugees. For example, a 2016 audit found that several organisations had limited knowledge of the data protection policy and considered it abstract and difficult to implement due to lack of staff with sufficient technical capacity and political sensitivity [18]. The systems

---

<sup>1</sup> <https://www.unhcr.org/3f8e96a04.pdf>.

<https://www.unhcr.org/blogs/wp-content/uploads/sites/48/2018/03/2018-03-16-PRIMES-Flyer.pdf>.

themselves are also vulnerable, with incidences such as World Food Programme's data base breach highlighting how even well-funded systems can be compromised [10].

A key tension for the sector arises between adhering to privacy and data protection laws, and service provision. In low income countries where the majority of refugees are found, the UNHCR typically serves as the response coordinator during the registration process and needs to work together with other partner organisations. The effectiveness of interorganisational data sharing required for coordinated refugee care in turn depends on the data management practices and culture of partner organisations [16]. For example, the ProGres system holds each refugee's unique identity number as well as demographic information which provides a powerful platform for data sharing with service providers. However, many organisations continue to share information via spreadsheets raising concerns over data privacy and security, which has prompted UNHCR and its regional partners in the Middle East to create the Refugee Assistance Information System (RAIS) a web-based regional platform designed to support UNHCR in accessing partner data. In addition to the technological challenge of developing and implementing systems in complex operating environments, the static nature of identities created by organisations to categorise and manage refugees is at odds with the ongoing, dynamic nature of the identity and social life of refugees. One of the key areas for further investigation which we take up in this paper relates to the experience of identity formation by refugees and organisations that work to support them as a result of digital identity systems [16]. In the next section, we commence by unpacking the concept of identity which is intrinsically linked to issues of power, value systems and ideology and which manifests itself through interaction with others.

## 2 Conceptualising Digital Identity Systems for Refugee Management

Identity and identification are central concerns of the modern state and bureaucratic systems. Managing, labelling and categorising individuals have long been described as central to the way the state sees and manages the complex social world [20]. The increased prevalence of cross-border movement makes the ability to recognise legal identity even more important and identity management systems have played a key role in many strategic applications including e-governance, e-commerce, business intelligence and homeland security [6]. The focus of advanced technical research has been on developing open standards that address interoperability, management of privacy and identity theft prevention [8]. On the social side, there have been claims that automation of the citizen-state interface can rebuild trust although the dangers of identity theft or fraud and possible threats to the privacy of individuals resulting from use of these systems have been recognised [4].

For social scientists the main question has been to improve understanding of what exactly constitutes identity and it is this literature that forms the backdrop for our investigation of digital identity systems for refugee management. The concept of identity has been employed to wide purpose across the social sciences, leading some to claim that as a broad term it is tasked with doing too much and as a result achieves too little [3]. An important distinction is between personal identity, taken to refer to

something that individuates us while social identity is seen as an individual's awareness of and affiliations with social groups [21, 26]. A sociological approach to identity assumes that personal and social identity are related through the concepts of 'sameness' and 'difference'. For example, we are the same human beings and therefore identical with ourselves from birth to death and at the same time share common identities as men, women, refugees, etc. An individual influences society through his or her actions thereby creating categories, groups, networks and institutions while society affects individuals through its shared language and norms [5]. This social interaction often takes on a functional role as one's degree of affiliation with an organisation is assumed to yield important organisational outcomes such as performance [9]. At the same time, we identify ourselves with more than one identity which interact with each other, sometimes in tension [15]. For example, I may ascribe to one common identification category such as a woman but I may dis-identify from certain features of that category such as women's role in marriage or affiliate myself with a certain type of woman.

While many studies of identity adopt a fairly static view of individual perceptions of self and organisational affiliation, a more sociological perspective sees identity as produced and embedded in social relationships and worked out in the practice of people's everyday lives [15]. This perspective rejects an account of refugees as passive recipients of aid but rather agents who seek to re-establish themselves often at the earliest opportunity [2]. Identity is thus seen as something dynamic, a continuous process of reformulation based on circumstances that vary over time and according to context. Others have described the complex interaction between social identities and the navigation of institutional labelling and categorisation of refugees and the way refugee communities navigate their lives [12]. For example, studies have described refugee agency in terms of the use of mobile phones for interpersonal communication and social networking amongst refugee communities [3]. Beyond interpersonal communication, studies have shown how ICT use enables refugee communities to exercise agency which contributes to their social inclusion into the host community [1]. Increasing demands for securitization of aid and adherence to privacy guidelines in handling personal data have led to humanitarian organisations and state governments placing more importance on identity in terms of biometric and genetic determination obscuring its social character. This is in contrast with sociological perspectives that emphasise the temporal constitution of identity through the narratives people use to make sense of and explain their lives [15] and the role of context, such as social, familial, and historical geographical locations in the formation of identity. For refugees, the role of home is dislocated, as they are forced to abandon their homes, possessions and loved ones, leading to an emphasis on social practices and roles over locations in the determination of identity [22].

As the discussion above suggests, refugee identities are complex as they are formed by social affiliations, feelings, beliefs, ethnic and cultural traditions. Moreover, there are external factors such as resettlement practices, policies and the overall socio-economic and political context of the country of origin and host country which affect

how identities are shaped. While identity is a profoundly social construct, expert knowledge and administrative processes produce categories and ultimately governance of refugees which get enshrined into systems by the ever-increasing sophistication of new technologies. The poor and dispossessed are often denied a right to negotiate an identity through social affiliations. On the contrary an identity is imposed on them with no official space where this can be contested or where a different identity affirmed. Ultimately, as Sen [21] argues, it is the privileging of discrete data stored in identity systems over the complex and emergent transformation process that leads to ‘an epistemic failure in understanding the nature of social identity and its plural aspects’. In this paper, we aim to shed light on how UNHCR’s digital identity systems affect the social identities of South Sudanese refugees in the host country of Uganda focusing on three aspects of refugee identity formation: (a) how refugee identity is shaped by home and familial environment (b) how refugees form identity through work and affiliations, and (c) how identity is created by refugees through their active efforts to forge new affiliations with social protection and service delivery organisations. In the next section, we describe our methodology which is followed by the presentation of empirical findings through stages of transformation in the lived experience of refugees from the time they flee their home, to the granting of refugee status, to the process of integrating within the host country [6]. The discussion and conclusion section draw on implications of our study for theory and practice.

### 3 Methodology

This paper draws on primary data collected by a team of researchers from Caribou Digital over a 9-month period from January to May 2018. Although the study involved interviews and focus group discussions (FGDs) in Lebanon, Jordan and Uganda, in this paper we draw exclusively on data from Uganda which has one of the most progressive policies towards refugees with the granting of legal recognition and household ownership of a small parcel of land. The Ugandan government, through its Office of the Prime Minister (OPM), has taken the lead in the registration and management of refugee data [19]. In February 2018, there were over 1.4 million refugees and asylum seekers in Uganda, 21% of which were in Yumbe which is the locality of the Bidi Bidi camp where we based our study [25]. The recruitment of participant refugees for the study took place through a combination of invitation by partner organizations, personal networks, and snowball sampling. Save the Children, an international NGO, provided logistical and initial recruitment support, inviting beneficiaries to participate in our study. We also drew on our research assistants’ personal networks to access community-based organizations active in supporting refugees. Table 1 shows the details of interviews held with refugees and local community members.

**Table 1.** Details of interviews with refugees/local community members

Respondent(s)	Type of interview
Former Governor & education minister in South Sudan	Individual
Male refugees (16)	Individual
Female refugee (17)	Individual
Local Ugandan builder and mobile operator	Individual
Ugandan Chairperson of Oruba parish	Individual
Refugee businessman	Individual
Refugee food distribution volunteer	Individual
Ugandan local businessman	Interview
Ugandan local business woman	Interview
Female refugee with sick child (2)	Interview
Sick refugee	Interview
Senior nurse, Bidi Bidi Health Centre 3	Interview
Data Officer, Bidi Bidi Health Centre	Interview
Ugandan businessman who sells phones and accessories	Interview

## 4 Findings

Civil war in South Sudan started in 2013 but perceptions of their identity after which it became increasingly difficult for civilians to escape. Through their narratives, we describe how identities of refugees were configured over time at different stages of their journey in the next three sections.

### (i) Refugees' perceptions of their identity from the moment they flee home in South Sudan

In 2011, although some people possessed some official forms of ID such as driving license, office ID cards, birth certificate, academic and employment documents and passports, it was only when nearly four million South Sudanese voted in a national referendum for independence from Sudan that the majority became familiar with the national ID card, going on to use it as the main form of identification for employment, receive salary, buy a SIM card, and travel. So when refugees arrived in Uganda, some had ID documents, but many fled with no, few or only the national ID'

'I had my education certificates in South Sudan but lost it due to fighting. They took all my certificates. We lost everything, even our clothes' (FGD Male Dinka Refugees)

Aside from formal credentials, identity for many fleeing refugees also found expression through the affiliation they had back in South Sudan,

'I am a theologian. Before becoming a politician, I was a pastor and knew how to counsel myself' (Former Governor & Education Minister in South Sudan)

'I was the Chairperson of the Village before becoming part of the Refugee Mobilisation Committee in Bidi Bidi camp' (FGD Male Refugees Bidi Bidi, Zone 1)



Respondents also described how these social identities were legible to others even when efforts are made to disguise it:

‘Your name reveals what tribe you belong to but even if you change your name, you can hear the language spoken and tell by looks and lifestyle who is a Dinka, Bantu, Nuer’ (FGD with Male Dinka refugees in Bidi Bidi camp)

Part of the identity of all refugees interviewed was shaped by the perilous and hugely political experience they endured to flee from their homes,

‘Coming from our village in South Sudan to the border took 3 months moving in the bush and hiding from rebels’ (Female Refugee travelling with sick children).

‘When you met soldiers or rebels in South Sudan during fleeing and you were asked where you came from and the exact territory, if the governor of the region didn’t support your locality, they would be hard on you’ (FGD with Male Dinka refugees)

‘Sometimes not having your ID was a good think as you didn’t want to reveal who you are if you were crossing into Uganda. If you had a Muslim surname, they would restrict you and ask several questions’ (FGD Bidi Bidi camp female refugees)

#### (ii) Refugees’ perception of identity as they are granted refuge in Uganda

While in South Sudan, the National ID was an important document for proving identity, when fleeing refugees arrived at the border with Uganda, various new forms of identification became important,

‘At the border, UNHCR asked where we came from and issued a wrist band as a form of identification tied to our hand but didn’t give us an ID number. They took us by bus to where you will sleep. The next morning, we were taken by bus to the reception centre where they checked our wrist band. Our names were sent from the border to the camp. Later at the camp, there was a word of welcome from OPM, an introduction, and a ration card for immediate food. The attestation card came later’ (Individual Male Refugee, Pastor)

For most of the refugees that we spoke to, the importance of identity credentials was directly linked to the benefits they enabled access to. So for example many described how the attestation card issued by the OPM in Uganda enabled access to vital services,

‘The attestation card is the most important document for us in Uganda because it proves you are a refugee and it is needed for getting a ration card, for going to hospital or for any activity outside the camp. If you lose your attestation card, it is a lengthy process to get a new one taking 1–2 weeks’ (Interview with Dinka refugee women)

‘ID documents are my farm. They can feed me, employ me. I struggled for them. When we go back to South Sudan, they will help us get a job’ (FGD, Male Refugees, Zone 1)

Refugees also described how in order to obtain a registration credential they had to go through long and complex processes and share very sensitive personal information with registration authorities, questions that exposed various different dimensions of identity of refugees,

‘OPM asked questions like your name, your father’s name, age, religion, tribe, your place of origin and the route you took to arrive in Uganda. Questions were also asked about hygiene, bodyweight, health leading to immunization by UNHCR, Red Cross, Plan, WFP WV and others. If you didn’t answer what they asked you, you were not registered. The whole process took 2–3 days and they sent you to so many places that some people got tired and just left the entire process and didn’t get registered’ (FGD Male and Female Refugees, Bidi Bidi)

For some refugees, it was not clear why they were asked some questions, including ones that added to their trauma,

‘They asked me how many people I had lost so far due to the war. I had lost my husband and it felt that my husband was a number. The day he was shot he was not even carried – we actually left him there’ (Female Refugee with sick children)

‘Some of us witnessed our parents being killed and they ask us why we are registering alone, where are our parents – you feel like crying’ (FGD Male Dinka Refugee)

On the other hand, some refugees commented that they were not asked about issues they felt were important,

‘Some questions which should have been asked were not asked. For example, I came alone from South Sudan and left my husband behind. They didn’t ask where my husband was although I was pregnant. They didn’t advise me to go to the protection desk that was managed by ARC. They just let me line up’ (Female Refugee FGD, Bidi Bidi Camp, Zone 5)

While the majority of refugees interviewed were registered upon arrival, some were not,

‘I came from South Sudan and crossed the border but nobody registered me. I just entered. I went to Arua and stayed there with my family for many weeks. Last week I came down to Bidi Bidi but when I arrived nobody registered me. I live with my sister in the camp’ (Interview with Unregistered Female Refugee)

‘I stay with my son and family but am not registered. The food I am eating is therefore shared with my son and his family as I don’t get my own rations’ (Interview with unregistered elderly male refugee)

‘I came with my brother’s 5 children but they didn’t ask me about them during registration. Their parents ran away during the war so they were left alone. I came with them to Uganda. They registered them with me together in one card but since then nothing has been done by any organisation to find the parents. IRC and STC have helped us. If a child is sick, you take him to the health centre and they give drugs. But more than anything, my neighbours help me’ (Female Refugees FGD Bibi Bidi camp, Zone 5)

(iii) Refugees’ perception of identity as they integrate with the host community and avail of services in Uganda

Various partner organisations operate in Bidi Bidi camp offering services such as employment, healthcare and ration to refugees of which 30% go to the host community. Adverts for jobs were typically posted on trees inside the camp. Some refugees were successful in obtaining a job. For example, one refugee was working as Secretary for Child Welfare,

‘We used to organise meetings for women so that we would know their position. One woman thought she was HIV positive but feared going to the health centre. I used to go to her house to counsel her and personally escorted her to the health centre where she was found HIV positive. I was with her every step until she was treated and I went to the complaint desk so that she could get more assistance as she had no house or husband’ (Interview with Dinka Refugee Woman)

Another refugee secured work as a volunteer with World Vision,

‘We help people calculate their food ration and direct people to the complaint desk if they have lost their ration card. The complaint desk verifies their name on the computer and gives them a chit enabling them to obtain their ration. We also organise queues with special ones for persons with special needs and ensure that the whole process of food distribution runs smoothly and people are not taking more than their quota’ (Interview with Refugee Food Distribution Volunteer, Bidi Bidi, Zone 5)

Some refugees started their own business,

‘I am a refugee and began my small business of selling biscuits, sugar, coffee, matchbox, fish, eggs, SIM and cigarettes for cash. I buy from traders in the centre. I started by business by keeping 2 kg. of corn back from my ration every month. This helped to start my business because corn doesn’t go bad’ (Refugee Businessman, Bidi Bidi)

Another of the Dinka women interviewed explained the relevance of partner organisations employing refugees in curbing domestic violence against women. Violence was often inflicted by male refugees who had arrived later than their wives and had consequently had become registered as head of household with control of household resources,

‘Every month in coordination meetings, all the partners working in Zone 1 including UNHCR and OPM will be there and we discuss all the issues. If cases are urgent such as domestic violence we go to the Chairman and complain and go to the police if the violence is too bad, otherwise the Chairman will resolve’ (Interview with Dinka Refugee Woman)

Some refugees encountered difficulties in securing a livelihood,

‘I arrived in Bidi Bidi in 2016 with my children. My husband is still in South Sudan. It is not easy to secure a livelihood by cultivating crops as there is no place to cultivate’ (Individual Female Refugee Community Activist)

‘If you have the academic diploma to show that you have the skills for the job, or a document to say you have gained experience then you have a chance. But if you have no documents and you see an advert and apply, they will not trust you and don’t care if you had to flee and didn’t have time to get your documents’ (FGD Male Refugee, Zone 1)

In some cases, refugees felt that despite collecting data from them, NGOs providing services did not fully understand what they want, and seemed to use the information for their own purposes:

‘They seldom interact with refugees – they should come down to ground level to get people’s ideas about what we are suffering from. They should reach out to our leaders like the Refugee Welfare Council to discuss our issues and what we need from these organisations. Instead they come with their own ideas like training our children in tailoring skills. We would rather they have an education which is something more permanent’. (Individual Female Refugee Community Activist)

The loss of education credentials surfaced as a key dimension affecting the identity of many of the refugees, particularly those who had previously studied in Uganda but had now become registered as refugees and faced difficulties in furthering their career aspirations. However, despite the fact that Window Trust was the organisation supporting education within Bidi Bidi camp and coordinated with UNHCR, there were several factors that prevented refugees from continuing their education,

‘I had my certificates in South Sudan but lost them due to fighting. They took my certificates – all of them. When we came here they tell us that if we have nothing to show that you have been to secondary school you have to start again from primary school. This discouraged us from going for further studies’ (FGD with Male Dinka Refugees)

‘While many refugees came to Uganda with school testimonials to certify that they had passed their exams, Ugandan authorities insisted on original documentation. It was also difficult to convert South Sudanese P8 certificate to Ugandan P7 and some refugees dropped out of school because of that’ (FGD with 7 Female Refugee Students)

In addition to the credentials needed to access education, many described difficulties around the use of credentials to access food rations. World Vision was responsible for providing rations in the camp, and used a megaphone to announce when food distribution would occur. Distribution protocols made it mandatory that the ration can only be collected by an individual named on the card,

‘For ration collection, before if you are not around to collect your food someone could get it for you using the ration card, but now they want the real person. This is bad because if the owner of the ration card has gone to the clinic, you will not get the food’ (FGD Male Refugee, Zone 1)

There has been growing trend among donor agencies to replace ration distribution with cash transfer direct to refugees although our interviews showed that this was not desired,

‘Money is nothing to us here. Food is more important than money. Men would say yes because they are drunkards and would use the money for drinking alcohol and smoking. They don’t mind if the children eat or not. In South Sudan, people would prefer money than here in the camp because both ladies and husbands were working but in Yumbe district there is food starvation. Even if we had money, we would wonder where to buy food from’ (Interview with Dinka women)

We also heard even after being identified as people with special needs, some respondents reported how services never arrived. According to protocols in place, PSN refugees were identified by CRS for special assistance. However, in practice, this assistance was not forthcoming,

‘CRS were moving from house to house to identify PSN refugees and the Chairman directed them to us. They promised to construct latrines and build houses but since that time they never came back (FGD with Female Refugee, Bidi Bidi, Zone 5)

Respondents described agency and independence as one of the biggest differences between their life before and their life since becoming a refugee. Overall, refugees felt that their living conditions in the host country were far more difficult than in South Sudan,

‘In South Sudan, we had our own food and we could cultivate for ourselves and could get ourselves tested at the health centre. But here there is no food, medicines or land’ (Unregistered Elderly Male Refugee)

‘I was working for Voices for Change in South Sudan. I was taking care of myself and could easily get everything I wanted. Here I am not working and depend on rations and if I sell some of it, it wont be enough, so living is more difficult here than in South Sudan’ (FGD Female Refugee, Bidi Bidi, Zone 5)

Feelings appeared mixed among refugees about how their new environment affected their political allegiances,

‘There is a lot of debate amongst the South Sudanese which takes place on forums like FB and WhatsApp. We have our own intellectual think tank group of 1–8 and we have a platform where we share and debate issues on South Sudan, especially the current negotiations in Ethiopia’ (Former Governor & Education Minister in South Sudan)

On the other hand, some refugees were more cautious about maintaining political affiliations,

‘For me, the topic I don’t talk about is politics because it is what caused us problems and made us refugees. Sometimes I feel that if I engage in such talk, someone might just come and attack me’ (FGD Male Refugee, Bidi Bidi, Zone 1)

‘I am not a rebel, but because I am no longer in my country I am regarded as non-aligned with the South Sudanese government and they would accuse me of being a rebel’ (Former Governor & Education Minister in South Sudan)

Despite being united with others in the broader identity category of being a refugee, social identities such as political and ethnic affiliation remained as markers of difference amongst refugees,

‘There are some tribes from South Sudan who hate us because they think that it is us who brought the war. The problem arose where tribes were mixed up in the camp. Now OPM is protecting the Dinka community by organising dialogues between all the refugees and the host community’ (Interview with Dinka women).

## 5 Discussion and Conclusion

In this paper, our main contribution has been to provide theoretical insights into the functioning of social identity as it applies to refugees from South Sudan who had to flee their country due to civil war and who have tried to reconstruct their lives and identities in the host country of Uganda. Our first analytical category related to how refugee identity relates to home and familial surroundings. Most refugees we studied experienced an abrupt and traumatic escape from violence. Together with leaving behind formal identification documents, the social bonds and cultural norms that the refugees had built up over time in their home country were disrupted. As refugees began the long process of registering their status as formal refugees in Uganda, their legal identity was transformed as a result of their new status as refugees and the attestation card which was important in helping them secure food and other services. We found that the

registration process was often stressful with questions asked by UNHCR and other organisations to satisfy their internal administrative and assessment needs often forcing refugees to relive the experiences of fleeing their homes and familial surroundings. For those refugees unable to register, their lack of formal status affected their ability to reconstruct a sense of 'home' in the host country. In some cases, our findings showed that identity reformulation for refugees was a constructive, positive process. For example, Ugandan respondents described in positive terms how the presence of refugees had improved their own life conditions creating a bond of reciprocity through the exchange of basic commodities. Even so, identity formation for registered refugees in Uganda has been a difficult process as living conditions were found to be far more difficult for them compared to their lives and surroundings back home in South Sudan. Moreover, differences in tribal identity, for example between Dinka and refugees from other ethnic groups with histories of ethnic conflict, were seen to carry over into their new habitat. Rather than a unified, single identity as refugees, ethnic tensions and earlier political allegiances came to shape the identity of refugees who fled their country in search of a better life. Finally, UNHCR's registration process restructured traditionally patriarchal families into female headed households thereby restructuring the family unit and enabling women to exercise a form of control over household resources that in their previous, patriarchal context had been impossible. Yet this experience of empowerment has not been without cost, as a number of people in service providing organisations described how the biggest cause of domestic violence was violence arising from men refusing to accept that their wives could make choices about what to do with food items and household resources.

Our second analytical category relates to identity formation through work and career aspirations. The loss of family, homes and possessions was often accompanied by the loss of work and career identity. Many of the refugees we interviewed had held positions of authority in South Sudan and in most cases, both men and women within a household would typically work and thereby contribute to the family income. One of the strongest common experiences from our findings was the loss of agency and self-worth as refugees described being unable to work and therefore dependent on others for the most basic everyday necessities. The absence of work opportunities and reliance on outside organisations for such basic requirements as food items reduced individuals sense of professional identity. For the refugees in this situation, in addition to the material benefits afforded by the additional income, obtaining employment was an important aspect of reconstructing a professional identity. Many respondents also described how the lack of education credentials was a significant barrier to opportunity which in turn limited the opportunity to pursue further education and livelihood opportunities as well as to pursue broader hopes for prosperity.

Our third analytical category relates to how refugees negotiate new identity relations through their interactions with organisations that provide protection and basic services to them. Our findings showed that some refugees who possessed educational and employment credentials were able to obtain work with partner organisations and thereby build bridges with the local community. However, most of the refugees we interviewed felt that implementing organisations had little understanding of their needs and, despite the use of digital identity systems, some refugees lack credentials and were unable to develop links with service organisations. There were also tensions between

the criteria that different organisations placed on the delivery of services. For example, if refugees were unable to present themselves on the day and time of ration distribution, or to present their identity credentials, they were unable to obtain food and other items that they needed.

Our analysis of refugee identity from a sociological standpoint has important implications for policy. At a time when increasing focus is placed on data-driven solutions to managing refugees, a social perspective reminds us that identities are ultimately produced and reproduced through the lived reality of individuals. Our findings show that there are numerous psychological, legal, geographical, economic and social factors that combine to shape the identity of refugees as identified by other scholars. Describes how rather than credentials, refugees highlighted the distance to facilities, extended waiting periods, privacy concerns, inconsistent quality of service, and staff attitudes towards refugees. Similarly, as [13] report, residents of Dadaab struggle with lack of capital and skills in their reconstruction of work identity. From our study, increasing refugee access to education is shown to be critical in enabling long-term development. Institutional support is needed to help particularly youth refugees to continue their education and develop skills that can help them generate income. Strengthening the portability and interoperability of education credentials would help overcome the challenges faced by individuals who have left their documents behind, and to support the transfer of certificates between differing institutional regimes. The digital identity registration systems of UNHCR and other humanitarian organisations afford very limited opportunities for refugees to exercise control over personal data, to amend or exercise choice over who has access to their personal information, increasing the sense of helplessness amongst already very vulnerable populations. As personal information is shared without their knowledge or agreement, this poses issues around personal privacy, security and safety from oppressive regimes and fundamental human dignity. Enabling greater refugee agency over the management and distribution of entitlements would make it easier for individuals with complex lives to access services and welfare as well as to increase the effectiveness of delivery. In the absence of this type of measure, refugees suffering from health ailments or with sick children fall further behind in terms of reconstructing their lives. Strengthening refugee identity management systems introduces wider developmental issues that need to be faced, as these systems always interact with other national identification systems, which have to be strengthened if the interaction is to be meaningful.

To conclude, increasing focus is being placed on data-driven solutions to refugee management in international public policy discourse. However, while new technologies have a role to play in increasing efficiency and effectiveness, can refugee identity be managed through a technical system alone? While the affordances of technology facilitate the linking of biometric identity systems with cash transfer mechanisms for refugees, the ground level realities suggest that caution is exercised before introducing new ways of delivering aid to refugees. In Bidi Bidi camp, we saw how limited mobile network coverage reduced the utility of mobile based service provision, with many 'dead spots' without any access to mobile network reception. Furthermore, we also heard how the absence of markets limited the utility of digital cash transfers. Ultimately, our research in Uganda highlights how technological systems and institutional efforts to make humans legible require further understanding of their interaction with

the lived experiences and social identities of refugees in order to help develop context specific responses to the needs of vulnerable refugee populations.

## References

1. Benton, M., Glennie, A.: Digital humanitarianism. how tech entrepreneurs are supporting refugee integration. Migration Policy Institute, Washington DC (2016)
2. Betts, A., Bloom, L., Kaplan, J., Omata, N.: Refugee economies: rethinking popular assumptions. Humanitarian Innovation Project, Oxford (2014)
3. Brubaker, R., Cooper, F.: Beyond 'identity'. *Theory Soc.* **29**, 1–47 (2000). <https://doi.org/10.1023/a:1007068714468>
4. Crossman, G.: The ID problem. In: Birth, D. (ed.) *Digital Identity Management: Technological, Business and Social Implications*, pp. 175–183. Routledge, Oxon (2007). [https://doi.org/10.1142/9789812837042\\_0015](https://doi.org/10.1142/9789812837042_0015)
5. Gelb, A., Diofasi, A.: Can Digital ID Be Harnessed For Development?. Centre for Global Development, Washington DC (2018)
6. Glasser, U., Vajihollahi, M.: Identity management architecture. In: Yang, C.C., et al. (eds.) *Security Informatics. Annals of Information Systems*, vol. 9, pp. 97–116. Springer, Heidelberg (2010). [https://doi.org/10.1007/978-1-4419-1325-8\\_6](https://doi.org/10.1007/978-1-4419-1325-8_6)
7. GSMA: Refugees and identity: considerations for mobile-enabled registration and aid delivery—mobile for development. GSMA, 20 July 2017. <https://www.gsma.com/mobilefordevelopment/programme/mobile-for-humanitarian-innovation/refugees-and-identity/>
8. Haddouti, S., El Kettani, M.: Towards an interoperable identity management framework: a comparable study. *Int. J. Comput. Sci. Issues* **12**, (2015). ISSN 1694-0784. <https://doi.org/10.1016/j.future.2018.09.025>
9. Haslam, A., Reicher, S.: Social identity and the dynamics of organisational life. In: Bartel, C., et al. (eds.) *Identity and the Modern Organisation*. Lawrence Erlbaum, Mahwah (2006). <https://doi.org/10.1111/ijmr.12035>
10. IRIN: Exclusive: Audit exposes UN food agency's poor data-handling. IRIN, 18 January 2018. <https://www.irinnews.org/news/2018/01/18/exclusive-audit-exposes-un-food-agency-s-poor-data-handling>
11. Jacobsen, K.L.: Experimentation in humanitarian locations: UNHCR and biometric registration of Afghan refugees. *Secur. Dialogue* **46**, 144–164 (2015). <https://doi.org/10.1177/0967010614552545>
12. Janmyr, M., Mourad, L.: Modes of ordering: labelling, classification and categorization in Lebanon's refugee response. *J. Refug. Stud.* **31**, 544–565 (2018). <https://doi.org/10.1093/jrs/fex042>
13. Kamau, C., Fox, J.: The Dadaab dilemma: a study on livelihood activities and opportunities for Dadaab refugees. DRC/UNHCR Nairobi (2013)
14. Kingston, L.: Biometric identification, displacement, and protection gaps. In: Maitland, C. (ed.) *Digital Lifeline? ICTs for Refugees and Displaced Persons*, pp. 35–55. MIT Press, Cambridge (2018)
15. Lawler, S.: *Identity: Sociological Perspectives*. Polity Press, Cambridge (2014)
16. Maitland, C.: Information systems and technologies in refugee services. In: Maitland, C. (ed.) *Digital Lifeline? ICTs for Refugees and Displaced Persons*, pp. 55–79. MIT Press, Cambridge (2018). <https://doi.org/10.7551/mitpress/10843.001.0001>



17. Oakeshott, N.: Empowering refugees and internally displaced persons through digital identity. *Voices*, 19 June 2018. <http://blogs.worldbank.org/voices/empowering-refugees-and-internally-displaced-persons-through-digital-identity>
18. Office of Internal Oversight Services: Audit of the Biometric Identity Management System at the Office of the United Nations High Commissioner for Refugees, UN, New York (2016)
19. OPM: Office of the Prime Minister. Refugee Management (2018). <https://opm.go.ug/refugees-management/>
20. Scott, J.: New Haven. Yale University Press (1998)
21. Sen, A.: The fog of identity. *Polit. Philos. Econ.* **8**, 285–288 (2009). <https://doi.org/10.1177/1470594X09105388>
22. Simich, L., Este, D., Hamilton, H.: Meanings of home and mental wellbeing among Sudanese refugees in Canada. *Ethn. Health* **15**, 199–212 (2010). <https://doi.org/10.1080/13557851003615560>
23. UNHCR: Policy on the Protection of Personal Data of Persons of Concern to UNHCR, UNHCR. Geneva (2015)
24. UNHCR: Opportunities in the New Digital Age - UNHCR Blog. 26 October 2017. <http://www.unhcr.org/blogs/opportunities-in-the-new-digital-age/>, <http://www.unhcr.org/blogs/opportunities-in-the-new-digital-age/>
25. UNHCR: Uganda (2018). <https://data2.unhcr.org/en/country/uga>
26. Van Tondler, C.L.: Exploring the identity and ‘sense of identity’ of organisations. *SA J. Ind. Psychol.* **32**, 12–25 (2006). <https://doi.org/10.4102/sajip.v32i3.433>



# ‘When Will You Start Teaching the REAL Curriculum?’

## Challenges and Innovations in Education for Rohingya Refugees

Azmina Karim<sup>1</sup> and Faheem Hussain<sup>2</sup>(✉)

<sup>1</sup> ConnectHer, Austin, TX, USA  
azmina@connecter.org

<sup>2</sup> School for the Future of Innovation in Society,  
Arizona State University, Tempe, USA  
faheem.hussain@asu.edu

**Abstract.** This paper explores key problems faced by different humanitarian agencies in educating Rohingya refugees from Myanmar seeking asylum in Bangladesh. The first half this research provides an overview of the challenges faced by different refugee communities globally in the Education sector, followed by the relevant ICT interventions. Then, based on our interviews and focus group discussions with Rohingya refugees, we highlight the roadblocks faced by them while accessing education services in their camps. Absence of coherent curriculum, challenges with language, lack of qualified teachers, and non-acceptance of ICTs as primary education tools for children are identified as some of the key challenges faced by Rohingyas. Based on our research, we recommend that enabling policies and an inclusive hybrid knowledge network, emboldened by pre and in-service teacher training, inclusive religious education, standardized curriculum, and tangible employment opportunities can pave the path for a better and an educated future for the persecuted Rohingyas.

**Keywords:** Education · Refugee · Rohingya · ICT4D

## 1 Introduction

For any nation to thrive, educating its people is a necessary key for development. However, if one does not have a medium for education, what can be done to address such challenge? If the only languages one knows are the languages that person is not allowed to learn in, how would it be possible to get an education? This paper explores the problems faced by the different humanitarian agencies in educating the Rohingya refugees seeking asylum in Bangladesh. Originating from Myanmar, Rohingyas are an ethnic minority group of Myanmar, and currently among the most persecuted people in the world. Since August 2017, around 700,000 Rohingyas took refuge in neighboring Bangladesh [1]. In camps where Rohingyas are rebuilding their lives, limited informational and educational services have negatively affected their well-being, dignity and living conditions. Education services are focused on non-formal education of young children and not adults.

In this paper, we highlight the struggles of the Rohingya refugees, especially in the education sector. Over the first half of this research, we provide literature review of similar challenges faced by different refugee communities all around the world and the existing technological interventions, which can provide better understanding about the commonalities and uniqueness of the challenges faced by Rohingyas. Then we focus on the relevance of Information and Communication Technologies (ICT) in making the education delivery and the learning process easier for the refugees. The second half of the paper covers a brief overview about the Rohingya crisis, followed by a description of our field research activities. Our paper is one of the very first research work that has incorporated the thoughts and aspirations of the Rohingya refugees directly from the field. At the end of this paper, we present a set of recommendations, which we believe can help in developing a relevant, inclusive, and participatory education system for the Rohingya refugees in Bangladesh.

## **2 Displacement of People and Refugee Crisis: The Present Magnitude and Impacts**

Since the end of the Second World War, we are witnessing the biggest forceful displacement of humans all over the globe, primarily due to political persecution, ethnic cleansing, armed conflict, socio-economic oppressions, and climate change. Till 2017, around 70 million people have been displaced both internally (within their own countries) and externally (to other countries). Among them, approximately 25 million people are formally recognized as refugees [2]. Amid such huge crisis, one of the most alarming issue is that among these ever increasing stream of displaced people, almost half of them are children, making such population even more vulnerable in the face of known and unforeseen adverse situations. Research shows that on average, refugees are in exile for two decades or more. Hence any quick fix to address major problems for refugees are bound to be unsuccessful [3].

## **3 Education for Refugees: Significance and Key Challenges**

According to UNESCO, large scale internal and cross-border human displacements, can leave millions of people underprepared for the challenges they are facing at present and near future [3]. Dryden and Peterson believe that in addition to the traditional humanitarian supports for refugees, education also needs to be given one of the highest priorities. Their research showed that in the short term, Education can usher in stability to the disrupted lives of the displaced millions [4].

### **3.1 Learner-Centric Challenges in Education for Refugees**

There are several challenges that can negatively impact the refugee students, irrespective of their age and demography. These include absence of basic literacy and knowledge about host community's language; Sufferings from severe trauma experienced while escaping the violence; Identity crisis, etc. Miller and Brown observed that

refugee students often lack competency in their own language and also struggle to integrate with the host community’s education system available for them [5]. This situation further worsens when the textbooks available for the refugees are also not properly customized, addressing their language needs and competency levels [6].

### **3.2 Organizational Challenges in Education for Refugees**

Another set of challenges faced by the refugees while accessing education are related with some of the inherent disconnections within the traditional educational system. A major challenge is the scarcity of trained, prepared, and qualified teachers in refugee-centered communities and camps. It is critical to ensure the psychological wellbeing of any students, especially if they are refugees [7]. Teachers also need to be trained for handling students with diverse education, socio-economic, and language efficiency backgrounds. UNHCR’s education strategy highlighted that in order to guarantee a conducive learning environment, the teacher-student ratio in any refugee camp should not be more than 1:40 [8]. The biggest obstacle towards establishing any long-term education initiative for refugees is the need for recognition, standardization, and accreditation. In many instances, the education centers and schools are being built and run on ad hoc style, with a short term goal of engaging school going children within a learning friendly environment. There are usually no education management systems in place to monitor the progress of the students, the performance of the teachers, the status academic performances, etc. [9], and no clear pathways for any refugee on getting higher education or employment (within the host community or outside) using the education she or he are receiving in their respective camps [10–12]. According to Gladwell, around the globe, on average, only 1% of refugees are enrolled in higher education programs, significantly smaller than the global higher education enrollment average of 34% [13].

## **4 Present Trends of ICT in Education for Refugees**

ICT applications for refugee education is relatively a new phenomenon worldwide. Research has showed that in present time, around 86% of the total refugee population in the world live in their host countries from global south. Globally, on average 32% refugee households have a basic mobile phone without any net connectivity [14]. In this section, we document some of the major ICT based initiative in the education services for refugees.

### **4.1 Learner-Centric ICT Solutions**

One of the major trends in ICT for refugee education is the diffusion of gamification. For example, the three winning education applications from the noted EduApp4Syria competition: Antura and the Letters, Feed the Monster, and SIMA focused on early childhood literacy issues for Syrian refugees in particular and gained huge popularity among the target audience. UNHCR furthermore found that, in addition to the mobile or online education games, it’s also very important to ensure an ample supply of books

in the refugee camps. In Tanzanian refugee camps, UNHCR with the partnership of an NGO Worldreader has delivered 30,000 e-books through e-reader devices [15]. The refugees can also have access to this huge digital library using their own mobile phones. There are efforts from different stakeholders to facilitate language learning for refugees without much overheads. Ankommen, a mobile based education application, developed by the German Federal Office for Migration and Refugees, is a one of such initiatives. This language learning app helps with the learning of numbers, counting, spelling of words etc. Gherbtana, MAPS.ME, Alarmphone, InfoAid are some of the other popular ICT applications being designed and used to make the lives of newly arrived refugees relatively easier [16].

## 4.2 Education Service-Centric ICT Solution

Kenya's Teachers for Teachers project offers a mix of offline-online resources: face-to-face training, and in-service support through instant messaging service. In Kenya, this project is training refugees to be educators as well, which is a rare sight in the refugee education domain [17]. The Borderless Higher Education for Refugees initiative in Kenya is another successful ICT project for refugee educators using online-offline combinations. Here, the main teacher training happens in the traditional face-to-face way, but the trainee teachers mostly use online education contents through their tablets as the main learning materials [18]. Monitoring and evaluation of any refugee-centered education initiative is very challenging. Work complexities with multiple stakeholders, conflict of interests, issues with acceptable performance benchmarking, and the volatile situation of the refugee camps have made such work quite difficult. Amid such situations, ICT options like Kmobile Schools gives us hope. It is ICT application designed by FHI 360 which can be used via android smartphones or tablets. This application can collect and analyze critical education related performance indicators from different refugee camps [19].

## 5 Current Status of Rohingya Refugees

Among the Rohingya refugees taking shelter in Bangladesh, there are over 530,000 children aged 3 to 17 who are in immediate need of Education in Emergency (EiE) services [20, p. 8]. Only a quarter have access to education and this is restricted for kids up to the age of 14 since secondary education is not available to them. In a joint assessment on EiE, agencies found that for primary aged children (6–14), 57% of girls and 60% of boys have attended learning centers since arriving in Bangladesh [20, p. 15]. It is estimated that in order to provide 614,000 children and youth education, 5,000 equipped classrooms, skilled teachers are required. Meanwhile about 1,805 teachers and 1,114 education centers are established [21]. Taught in both Burmese and English [20, p. 7], about 113,761 boys and girls under 14 are given informal education in these learning centers. About 78,285 students have received the education kit [21]. The Education Sector has faced additional challenges due to government restrictions preventing any formal or non-formal education programs being offered to the Rohingyas. On the contrary, Moktobs or Madrassahs (Islamic Education Centers) are running

in the camps that are neither recognized by the government or UNHCR. These Madrassahs are significantly better-attended than learning centers, with close to 80% of children age 6–14 attending since arrival, compared to 60% for learning centers and 50% report attending both facilities [20].

### 5.1 Rohingya Refugees and ICTs

The status of ICT infrastructure within the refugee camp areas is appalling. Mobile voice and data services are very infrequent. There is no ICT based information and communication applications or platform for the refugees. The Rohingyas, without any formal identification documents, are legally barred from purchasing any local SIM cards in Bangladesh. There is no official written form of the Rohingya language, though it is the main form of oral communication. Within the camp area, according to UN, only around 5%–17% refugees have some level of literacy [22]. Discrimination against women and children are rampant when it comes to access and usage of information and communication channels.

## 6 Research Method

For our research, in addition to the literature review, we collected firsthand information from the Rohingya refugees based in different camps at the border of Myanmar and Bangladesh. In order to have a comprehensive understanding about Rohingya refugees’ opinions on access to education and other related information services, we reached out to the refugee population in the UNHCR registered camps and the newly built makeshift camps. Registered camp’s respondents came to Bangladesh from Myanmar during the first wave of influx in 1992. In the makeshift camps, all the Rohingyas escaping the military crackdown in August 2017’s and 2016 crackdown are taking refuge. In these two different types of camps, we conducted seven focus group discussions (FGD). Among these FGDs, we had three male-only, three female-only, and on mixed group. In total, 54 refugees (25 females and 29 males) took part in FGDs. We conducted three in-depth key informant interviews as well. Our respondents were from a prominent NGO, a community leader in a camp, and an international humanitarian agency. We have recorded all of the responses with full anonymity to ensure the personal privacy and confidentiality of each of the respondents. The entire research work was conducted in the field between May and August of 2018, by one of the authors.

## 7 Initial Findings

In this section, we have thematically summarized the key issues that frequently came out during all these conversations. Some of these challenges resonate the problems faced by other refugee communities around the world. However, there are certain education issues which are unique to the Rohingya crisis, especially in relation to the

politics with choosing the language for education delivery, and the general perception of Rohingya about ICTs as educational tools.

### 7.1 (Lack of) Access to “REAL” Education

Feedback on the quality of education were taken from both the groups of refugees, the ones who came earlier and the ones came to Bangladesh from August 2017. According to the respondents, the temporary learning centers or TLCs running within their camps are not providing customized content or lessons appropriate for children of different age-group. The study contact hour per group per days is 2 h, with most of the TLCs holding 3 different sessions for different age groups of children per day. All the TLCs are providing informal education on English, Burmese, and Math at elementary levels. Students within the age bracket of 4 to 10 at the same time in the same classrooms. Hence both groups: the kids with advanced knowledge and the ones with very basic or no basic knowledge get frustrated with the confusing style of the pedagogy. One female respondent from a makeshift refugee camp mentioned that her family became frustrated with the confusing state of affairs in the education service and felt the need to be a bit proactive.

*My husband went to the “school” (where our children go) here in the camp and asked the teacher- “When will you start teaching the REAL curriculum?”*

According to our respondents, children who were studying in grade 5, 6, 7, or above have no activities or educational curriculum addressed for them. Especially the kids who studied till secondary level in Myanmar would like to continue their study but getting no opportunity. In a women group a participant mentioned,

*“Our children who studied in school in Myanmar, have forgotten everything here because they do not have those books or resources to learn those topic again.”*

### 7.2 Language Barrier in Education Delivery

For the refugees who came earlier, we found their situation to be even more challenging as far as access to quality education is concerned. Before the latest exodus of Rohingyas in 2017, these people were provided with NGO-managed regular education, where they were learning Bengali and English. They were given text books. Refugees from the first wave of influx could even access secondary and tertiary education. This helped them with better employability outside their camps as well. After August 2017, the Bangladesh Government banned the teaching of Bengali to Rohingyas in order to prevent further demographic assimilations [20, p. 28]. All the schools were forced to stop providing the language lessons or delivering any lectures in Bengali. Such a decision left thousands of Rohingya children from second wave of influx in a severe uncertain situation. As they were born in Bangladesh and have never been to Myanmar, the primary language for communication and having access to knowledge remained Bengali and not Burmese. At present, these groups’ education process is at halt as the related service providers are redesigning the curriculum in Burmese from Bengali. A male respondent of this group shared:

*At the beginning, Bangla was taught.... that was good. Boys and girls could read the newspapers as they were taught Bangla. Now as Bangla teaching is stopped, we are in big problem.*

Another woman said:

*The children who were born and brought up in Bangladesh for a long time. They now have huge difficulties in understanding Burmese lessons. Our children did not even hear Burmese since they were born.*

However in the newer camps, all schools are mostly focusing on English and Burmese. They are completely avoiding any Bengali curriculum.

### 7.3 Teachers’ Crisis for the Refugees

Another point of struggle for Rohingya refugees in education is the quality of the teachers. As we have seen in our literature review section, finding quality educators in refugees camps is always very challenging [20, p. 6]. One of our key informants who has been working with Rohingya education for last several years mentioned:

*Two types of teachers are present. One is from host community and another one is from Rohingya.*

According to our respondents, it is always challenging to find Rohingyas with higher level of education interested to be a part of the TLCs on a regular basis. On top, there is a consistent need to pre and in-service pedagogical training for all the TLC teachers, which in many cases are not provided on a regular basis, due to scarcity of time, or fund, or both. Another interesting trend we have observed in the field is the growing practice of Rohingya youths with higher level of education to be offering private tuition (in exchange of payments) to the younger Rohingyas, mostly the ones who are not being able to learn enough from the generic and informal education contents offered in the TLCs.

### 7.4 Gender (In)equality in Access to Education

The gender dimension plays an important role when it comes to access to education for Rohingya refugees. For all the Rohingyas, irrespective of the period when they fled Myanmar, access to education for girls was a challenge back home. As most of the state-run schools teach girls and boys together, Rohingya girls were required to be in the same space with local ethnic majority students. According to many respondents, that close proximity with local majority or Rakhaine population resulted in mental and physical harassments, racial attacks, and overt discrimination from the school authorities as well. And Rohingya girls were particularly targeted in most of those incidents. One female respondent shared:

*(Rohingya) Girls didn’t want to go to school because the Mong (Rakhaine) boys and girls used to create issues, used to quarrel, fight with them. There was no justice for them.*

In the refugee camps, many of the girls stop going to school within the camps after reaching puberty, hence hindering the diffusion strategies for basic education among young Rohingyas.



## 7.5 Aspiration for Higher Education

Amid all the challenges, it was quite evident that the Rohingya population value education very highly, especially for their younger generations. Among the refugees who arrived earlier, many were allowed (during pre-August 2017 period) to go to the local schools in Bangladesh. Some were even able to pursue tertiary education using fake Bangladeshi Citizen IDs and related information. One male respondent recalled:

*After NGO schooling, if someone can manage Bangladeshi id card/birth certificate, they can send their children to study further till college.*

The newly arrived Rohingyas are hopeful about getting good education which can help them to better survive and thrive. This type of optimism has been prevalent among most of our conversations with the refugees. One male respondent mentioned:

*It will be useful for the future if they get chance to go for higher studies in the universities step by step, or else only primary idea will be of no help. However, they are still happy by getting it.*

## 7.6 Popularity of Religious Education

Religious education has always played a critical role in the daily life of Rohingyas, both in Myanmar and in the refugee camps in Bangladesh. In Myanmar, where Rohingyas were systematically discriminated from basic citizens' rights to education, the religious education was their one consistent lifeline to preliminary literacy. During our field research, we have observed an ad-hoc network of makeshift mosques around all kinds of camps. Each of these mosques also function as Maktobs (informal religious schools) for the refugees living in the vicinity. Young girls and boys usually go to these places very early in the morning and in the late afternoon to get lessons on Quran and some basic Arabic, mostly managed and led by the local Imams or religious leaders. We have observed that some of these informal religious schools are also offering informal lessons of Burmese, English, and basic Math for the Rohingya children. In majority of such mosques, Imams are giving the lessons voluntarily without any payment or monetary transactions. We have also found a few of the areas, where the refugees raised money among themselves to pay the Imams for these extra Burmese, English, Math, and Arabic lessons. The other reason religious education gained popularity is the sudden exclusion of Bengali from the lessons plans (for the earlier refugees), which created a certain level of mistrust between the Bangladesh Government and the Rohingyas.

## 7.7 (No) ICT for Education

According to our data analyses, overwhelming majority of the respondents mentioned that they have easy access to mobile phones for communicating with each other even after the existing government restrictions on this issue. However, almost all the respondents expressed similarly that mobile phones and the corresponding online applications (e.g., Facebook, YouTube, WhatsApp, etc.) or any mobile phone based programs should not be used for educating their children as standalone options. One male respondent, who arrived after August 2017, said:

*We aren't interested to give children mobile phones for education because they can't operate. Also because mobile phones require charges, battery runs out. Mobile cannot be used for a longer period.*

Another female respondent stressed on the demerits of top-down, non-interactive educational technologies:

*Videos or any visual aid can only enhance knowledge at a certain level. If someone doesn't know the basic any visual aid can't be used as a substitute of classroom education for him. Because visual aids or videos are not interactive, our children can't ask question.*

There were also opinions on using ICT based education solutions for kids in higher classes. According to a Rohingya male respondents:

*The little children would not understand lessons through video or cannot relate. If the elder ones read that'd be good.*

At one hand, it has been evident that Rohingyas have been reluctant about solely relying on ICTs for education delivery for their younger generations. On the other hand, many respondents, especially the women have expressed their interest in getting audio-visual, informational, and instructional materials that address practical health (i.e., menstrual practices, reproductive health, maternal care, birth control) or energy (i.e., best energy usage practices, alternative fuel sources, environmental pollution, etc.) related topics.

## **8 Discussion and Recommendations**

In the following, we propose a set of recommendations to ensure a better performing, inclusive, and relevant education service for the Rohingyas, which would help them to get “REAL Education”.

### **8.1 Enabling Policies**

Continuous engagement with the Government of Bangladesh is critical to expand the humanitarian space for learning; achieve greater policy clarity in line with the provisions of the United Nations Convention on the Rights of the Child, which holds state parties responsible for educating the children in their jurisdiction regardless of their immigration status. Also, the access to SIM cards for Rohingyas need to be legalized at the earliest, so that they would not need to ensure such access through black market transactions. Legal and easier access to mobile phone network and high speed internet services can undoubtedly assist the diffusion of ICT-assisted interventions in education and other development domains.

### **8.2 Standardization and Reorganization of the Existing Education Service**

The current education services within the Rohingya refugee camps need to be re-designed at the earliest. The common classrooms catering all the children within the

age-group of 4 to 14 years are primarily helping the kids to be off the streets. But such education centers are not being able to offer customized and need based educations for the kids in need. The adolescent population are beyond the scopes for the present education plan implemented by the responsible humanitarian service providers. Audio-visual tools can be used to develop learning modules on different applied topics (i.e. Fake News, Mensural Health, Family Planning, Violence against Women, etc.), as mentioned by many respondents of our field interviews. Aside from that, ICT-aided monitoring and evaluation of the existing education or learning centers in all the refugee camps needs to be done urgently, based on certain learning goals and standardized benchmarks.

### **8.3 Pre and In-service Teacher Training**

There needs to be mechanisms in place for providing a set of standardized pre and in-service teacher training for all the educators involved in such missions. A significant part of such training (especially the in-service part), can be done online or through offline, self-paced learning modules, to be disseminated via tablets or mobile phones. Humanitarian service providers can pull resources together to develop a set of master learning modules in Rohingya, Burmese, Bengali, and English languages, which can be used for these pre and in-service training purposes, delivered by a joint group of Rohingya and local master trainers.

### **8.4 Employment and Entrepreneurship**

Hence employment opportunities for the TLC or refugee school graduates, even starting with some basic jobs, need to be available for the Rohingyas. Such opportunities can involve humanitarian services within the camps, and also online based, skill-specific opening for which one does not need to be physically present for delivering the work outputs. ICT-aided education can help the existing educational efforts to offer appropriate trainings. Rohingya refugees from different age-group can be eventually trained in certain ICT skillsets (i.e. coding, digital animation, debugging, web development, etc.) and then be guided to make their professional competencies for hire in different online market places.

### **8.5 Inclusive Religious Education**

The immense social acceptability and popularity of religious education system and the Imams (religious preachers) among the Rohingya refugees need to be utilized effectively while designing inclusive and participatory education system for this population. The voluntary works of the Imams related to teaching the Rohingya kids Arabic, English, and Burmese need to be recognized. Interested Imams can be provided pre and in-service pedagogical training in synchronization with the other educators of the regular learning centers in the camps. A common set of learning goals based informal curriculum can be proposed to be followed by both: the religious schools and the learning centers to make the education service more efficient within the refugee camps.

## 8.6 Hybrid Knowledge Network

The challenges stemmed out of poor internet and mobile network connectivity can be solved with some policy interventions. However, that can take some time to be fully addressed. In the meantime, ad hoc intranet based solutions can be established between the field level headquarters of the humanitarian agencies and the different types of learning centers. Such connectivity can at least help the mobile based education platforms to be functional and synchronized within a certain geographical area, thus helping in providing real time support in pedagogy, training, monitoring, and evaluation of the numerous education initiatives. The locally available community radio networks also need to be taken into confidence to co-design and co-develop audio programs addressing major socio-economic and rights based issues relevant for the refugee population.

## 9 Conclusion

Based on our literature reviews and field-level research, we can conclude that education is certainly not a standalone sector in any refugee crisis. In order to ensure an inclusive, sustainable, and quality education for the marginalized refugees, the related stakeholders should treat refugee education as a long term developmental service instead of a short term humanitarian crisis point. As reflected in our concluding recommendations, we envision ICT solutions to be integrated in a cross-cutting manner, transcending over traditional service and stakeholder related boundaries.

## References

1. BBC News: Myanmar Rohingya: What you need to know about the crisis, 24 April 2018. <https://www.bbc.com/news/world-asia-41566561>. Accessed 14 Oct 2018
2. UNHCR: Figures at a glance. In: Statistical Yearbooks. <http://www.unhcr.org/en-us/figures-at-a-glance.html>. Accessed 07 Oct 2018
3. A lifeline to learning: Leveraging technology to support education for refugees. United Nations Educational, Scientific and Cultural Organization, France, ISBN 978-92-3-100262-5 (2018)
4. Dryden-Peterson, S.: Refugee education: a global review. UNHCR Policy Development and Evaluation Service, p. 6 (2011)
5. Brown, J., Miller, J., Mitchell, J.: Interrupted schooling and the acquisition of literacy: experiences of Sudanese refugees in Victorian secondary schools. *Aust. J. Lang. Lit.* **29**(2), 150–162 (2006)
6. Kanu, Y.: Educational needs and barriers for African refugee students in Manitoba. *Can. J. Educ.* **31**(4), 923–924 (2008)
7. Kirk, J., Winthrop, R.: Promoting quality education in refugee contexts: supporting teacher development in Northern Ethiopia. *Int. Rev. Educ.* **53**(5/6), 715–723 (2007)
8. UNHCR. In: Education Strategy 2012–2016. Geneva, Switzerland (2012). <http://www.unhcr.org/4af7e71d9.html>. Accessed 07 Oct 2018

9. Syria Crisis Education Strategic Paper. In: London 2016 Conference - No Lost Generation/Supporting Syria and the Region (2016). [http://www.ooscimena.org/uploads/1/wysiwyg/160128\\_UNICEF\\_MENARO\\_Syria\\_policy\\_paper\\_final.pdf](http://www.ooscimena.org/uploads/1/wysiwyg/160128_UNICEF_MENARO_Syria_policy_paper_final.pdf). Accessed 10 Sept 2018
10. Lorisika, I., Cremonini, L., Safar Jalani, M.: Study to design a programme/clearinghouse providing access to higher education for Syrian refugees and internal displaced persons: Final Report. Brussels, European Commission (2015)
11. World Bank. ICT and the Education of Refugees: A stocktaking of innovative approaches in the MENA region. Washington, DC, p. 11 (2016). <http://elibrary.worldbank.org/doi/abs/10.1596/25172>. Accessed 10 June 2018
12. McBrien, J.L.: Educational needs and barriers for refugee students in the United States: a review of the literature. *Rev. Educ. Res.* **75**(3), 329–364 (2005)
13. UNHCR: Missing Out: Refugee Education in Crisis. Geneva, Switzerland (2016). <http://www.unhcr.org/publications/education/57d9d01d0/missing-refugeeeducation-crisis.html>. Accessed 11 May 2018
14. UNHCR: Connecting Refugees. Geneva, Switzerland (2016). <http://www.unhcr.org/5770d43c4.pdf>. Accessed 14 May 2018
15. Kwauk, C., Robinson, J.P.: Worldreader: creating a culture of E-reading around the Globe. Washington, DC. Center for Universal Education at Brookings. Brookings Institute (2016). <https://www.brookings.edu/wpcontent/uploads/2016/07/FINAL-Worldreader-Case-Study.pdf>. Accessed 12 June 2018
16. Stiftung Warentest: Apps zum Deutschlernen: Nur zwei von zwölf empfehlenswert [Apps for learning German: only two out of twelve are recommended]. Berlin (2016). <https://www.test.de/Apps-zum-Deutschlernen-Nur-zwei-von-zwoelfempfehlenswert-4989440-0/>. Accessed 11 May 2018
17. Mendenhall, M.: Interview with C. Pimmer and U. Gröbhiel, 21 March 2017
18. Dahya, N.: Landscape review: education in conflict and crisis – how can technology make a difference? Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH, Bonn, Germany (2016)
19. FHI 360: Mobile phone app increases access to education for refugees. Press release, 20 June 2013, Durham, NC. <https://www.fhi360.org/news/mobile-phoneapp-increases-access-education-refugees>. Accessed 03 Apr 2018
20. Education Sector: Joint education needs assessment: Rohingya Refugee in Cox’s Bazar. <https://reliefweb.int/report/bangladesh/joint-education-needs-assessment-rohingya-refugee-cox-s-bazar-june-2018>. Accessed 15 July 2018
21. IOM: Joint Response Plan for Rohingya Humanitarian Crisis (2018). <https://www.humanitarianresponse.info/en/operations/bangladesh/document/joint-response-plan-rohingyahumanitarian-crisis-2018>. Accessed 16 Aug 2018
22. ISCG Situation Report: Rohingya Refugee Crisis, Cox’s Bazar - 19 July 2018. <https://reliefweb.int/report/bangladesh/iscg-situation-report-rohingya-refugee-crisis-cox-s-bazar-19-july-2018>. Accessed 10 Aug 2018



# Refugees and ICTs: Identifying the Key Trends and Gaps in Peer-Reviewed Scholarship

Suzana Brown<sup>1(✉)</sup>, Faheem Hussain<sup>2</sup>, and Ali M. Masoumifar<sup>1</sup>

<sup>1</sup> Department of Technology and Society,  
Stony Brook University (at SUNY Korea), Incheon, Korea  
suzana.brown@stonybrook.edu, ali.masoumifar@gmail.com

<sup>2</sup> School for the Future of Innovation in Society,  
Arizona State University, Tempe, USA  
faheem.hussain@asu.edu

**Abstract.** The goal of this paper is to identify existing literature in the field that encompasses one contemporary crisis and one prevailing developmental implement: refugees, and the use of ICT in the development arena. A total of 35 research studies were identified that address these two topics. In the process, several main themes that dominate the field are identified. These themes are the assessment of refugee status and position, education, empowerment and identity, health, and risk of ICT for refugees. Subsequently, a discussion of the missing areas in this research domain is presented. In the authors' opinion, the missing themes that are urgently needed are ethics of ICT for refugees, longitudinal studies, gendering of ICT, comparative research, and entrepreneurial aspect of refugees. This missing research would help humanity to get a better understanding of this immense challenge and to design appropriate solutions that leverage ICT to alleviate the current refugee crisis.

**Keywords:** ICT · Refugees · Metastudy

## 1 Introduction

The multifaceted challenges faced by refugees and displaced populations, are on the rise worldwide. Even before the latest Rohingya refugee crisis that worsened in mid-2017 [1], the total number of displaced people worldwide was 65.6 million. Among these people, around half are formally designated as refugees, and they spend up to 1/3 of their household income on ICT connectivity<sup>1</sup>. According to Hussain [2], globally refugees are 50% less likely to have access to internet-enabled phones in comparison with the general population, and 29% of refugee households have no phone connectivity. “Where is the Wi-Fi?” and “Where do I get a SIM card?” are two of the top five questions asked by refugees landing in Europe. Researchers have also reported that refugees use net and mobile networks more than the respective host communities [3]. Numerous initiatives are being taken to include different ICTs to address various challenges faced by refugees and displaced population in different parts of the world. In

<sup>1</sup> UNHCR “Figures at a Glance 2018”, <http://www.unhcr.org/figures-at-a-glance.html>.

academia too, researchers have seen the emergence of an array of investigations looking at the refugee issues and relevant ICT-centered solutions. However, until now, there has been no significant work that focuses on examining the key trends of such scholarships. Such research is needed to better understand the relevance, applicability, and impact of ICTs to address the refugees and displaced population related current and future challenges. In this paper, the authors have tried to provide a comprehensive snapshot of the key trends as well disconnections in the scholarship domain of “ICTs for refugees and displaced population”. Afterwards, the paper highlights some of the major areas where more academic research is needed. For the future reference within this paper, by using a term refugee, we intend to understand the situation of both: refugees as well as people being displaced from their homes for other reasons.

## 2 Research Methods

In this paper, the authors have conducted a meta-literature review, which is accomplished by identifying existing literature in the field that encompasses one contemporary crisis and one prevailing developmental implement: displaced population, mainly refugees, and the use of ICT in the development arena. The authors of this paper searched the existing literature using the following search engines: Google Scholar, Web of Science, IEEE xplora database. The terms of search were: refugees, displaced population, ICT applications. A surprisingly limited number of high-quality scientific papers that have found and almost no compelling results identified. In total 35 research studies were identified that address both topics: ICT applications and refugees. In order to analyze the direction in which scientific community is moving several main themes that dominate the field are identified. Subsequently, a discussion of the missing areas in this research domain is presented.

## 3 Review of Existing Literature

The literature about refugee and ICT is in a germinal stage and not as developed as topics addressing refugees independently of ICT tools. Therefore, the number of high quality papers is limited. However, it was possible to find existing literature and generalize the themes of the research. The themes are presented in the next five subsections.

### 3.1 Using ICT Tools in the Assessment of Refugee Conditions and Status

The largest portion of the literature on refugees and ICT is about assessing conditions of refugees; however, the assessed conditions vary significantly. The topics vary from performing the infrastructure assessment by examining the mobile network service quality, particularly in the type of service provided and its reliability in terms of being able to access the network on the first try [4]. The same study [4] has an overview of refugee youth mobile phone and internet use by surveying 157 youth in Za’atari Refugee Camp on the border of Jordan close to Syria.

Another two assessments are about service delivery of ICT [5, 6]. One study [5] explores how UNHCR Malaysia and other refugee assistance stakeholders could integrate mobile ICT innovation into their standard operating procedures for improved service delivery. The other study [6] identified a huge gap in the provision of relevant, reliable and timely digital news and information for refugees on their journeys and upon arrival in Europe.

Assessment of ICT support for refugees was topic in many conferences and one panel on a conference of the Association of Information Systems in 2017 discussed [6] refugees' empowerment with technology by talking about best practices. A research by New Zealand researcher [7] explains how resettled refugees use information and communication technology to respond to their changed circumstances. The authors identify eight patterns of ICT use: learning about a new environment, keeping informed, transacting online, communicating with others, managing everyday life, sustaining support networks, maintaining transnational ties, and expressing cultural identity [7].

As a part of SDG #10 (Reduce inequality) GSMA launched the Refugees and Connectivity portal to demonstrate how mobile technology is making a difference to the lives of refugees [8]. Another report claims that "so much is written about refugees but little by or for them" [9]. That report [9] aim was to assess whether the provision of news and information for refugees was adequate to their needs.

Impact of ICT technologies on refugees is investigated by a case study [10] about Iranian refugees' settlement in Australia. The authors performed a thematic analysis of interviews with two groups of participants (51 Iranian refugees and 55 people with a role in assisting refugees).

Since mobile applications are dominating mobile development, research on refugees is no different, and as an outcome there is literature regarding mobile applications and refugees. For example, a paper that surveys mobile applications aimed to help refugees in Portugal [11], an Atlantic article how technology helps in a humanitarian crisis [12], and the importance of mobile technology and applications for refugees [13].

A technical approach is represented by a study [14] that develops a framework for the design of refugee camp which considers the requirements needed and allows the participation of refugees in the design process; while another study [15] looks at factors and practices that influencing the resilience, which people develop in response to disruption—an emergent phenomenon dubbed transition resilience. A more specific approach is about technology-enabled social innovation regarding acceptance of refugees in Canada [16] and a paper on ICT design to help refugees navigate new communities [17].

### **3.2 Using ICT Tools for Refugee Education**

The next most common topic is education, and this section reviews the literature related to ICT and education. The critical need to address interruptions in schooling caused by displacement, has driven a large number of existing studies in the broader literature to examine the increasingly heavy interest in the potential of mobile services to overcome the many challenges of providing education to refugees [18]. Previous studies have shown that the use of smartphones and other mobile devices, abundant even between



impoverished refugees, can offer a platform that educators can leverage to reach marginalized children and youth [18, 19]. A number of authors have recognized the use of mobile technology as the starting point for refugee use of, and interactions with, ICT [18]. The main focus of such research has been to provide a clear and concise view of the role that ICT has played, the potential it holds, the projects that are currently under preparation, and what more might be done [18, 19].

Assessments of these programs have found that digital education services need to be planned with care and require appropriate commitments of time and money to deliver [18]. ICT can replace teachers and organized learning only in rare instances; but it can provide effective support to education, especially when supplemented with teacher training [19].

Alternatively, a different approach taken by researchers has been to explore the potential of innovating technology-assisted teaching methods to engage with refugees in identifying and combating barriers to employment. For example, a recent study by the University of Nottingham, presented a framework on how to optimally use the previously developed platform of resources using a blended pedagogical framework to maximize learning and to provide a package that caters for the needs of a wide variety of users.

However, most studies have relied on projects in the early stages and have not provided rigorous external evaluations, making it difficult to identify and replicate best practices. Many seek evidence that technology-assisted approaches are effective, but little has been gathered with respect to ICT in education generally, let alone in emergency situations [19]. The present situation affords numerous opportunities to build the evidence base necessary, even carry out randomized control trials, and thereby improve ICT interventions and bring them to scale.

### 3.3 Empowerment and Identity

In the context of our civilization experience today, apart from individual identity, we have developed the concept of a broader identity, something that fixes us to our regional, cultural and social roots. Advances in digital technology and ICT have prompted researchers to look at this topic in a new light. Numerous studies have set out to investigate the role ICT technology can play in empowering refugees and internally displaced persons through digital identity.

Previous research showed that ICTs opened up opportunities for some of the youth to resist more assimilationist expectations of positive settlement. However, positive settlement and identity making are far more nuanced and arguably often in tension with dominant expectations held by those working in the youth settlement sector [18]. In this regard researchers believe that for refugee youth settlement policy and practice to embrace more global perspectives, digital literacy and opportunities to engage in digital media production and distribution should be recognized as an essential component of settlement policies and services [18, 19].

Several theories have proposed that in realizing five valuable capabilities through ICT use, refugees exercise their agency and enhance their well-being in ways that assist them to function effectually in a new society and reclaim control over their interrupted lives. These include: (1) to participate in an information society, (2) to communicate

effectively, (3) to understand a new society, to be socially connected, and (4) to express a cultural identity [20–22, 24, 30].

Social inclusion is a multidimensional, relational, and dynamic process, in which the agency of those to be included is a central concern. Interventions that ignore this are susceptible to the imposition of dominant societal norms and values in ways that do not recognize diversity in human lives [25]. For many individuals in contemporary society, ICTs facilitate the maintenance of transnational connections and identities that matter to them. The promotion of social inclusion for such people, therefore, needs to recognize that their lives are not restricted to their local context [22, 25]. Furthermore, any consideration of social inclusion in an information society needs to include the ICT-enabled capabilities that individuals value in constructing meaningful lives [25, 26].

Access to digital resources plays a crucial role in the planning and navigating of their dangerous passages, as well as in their protection and empowerment after arrival in Europe. However, notwithstanding their usefulness, mobile phones have a paradoxical presence in the lives of refugees – a resource and a threat at the same time. The digital traces that refugees’ phones leave behind make them vulnerable to surveillance and other dangers [16, 21, 23, 26]. E-skills provide opportunities on many different levels, such as education, employment, and housing, and contribute to the refugees’ feeling of social inclusion [23].

Prior research suggests that a major contribution of mobile phones was to the development of bridging social capital, and especially with regard to facilitating economic integration. However, indications were strong that even in the initial stages of social capital development and thence integration into the society, there was considerable obstruction by both the authorities and the private sector. This lack of integration was also attributable, in part, to the refugees’ own attitudes and behavior [27, 28].

### **3.4 Risk of ICT for Refugees (the Dark Side of ICT)**

Very few papers address the risks ICT could present for refugees. However, there are some notable exceptions. One of them is a paper on digital inequalities in the community-level physical access divides in the context of a Syrian refugee camp [29]. The authors find patterns that demonstrate three community level divides: an inter-carrier congestion divide, a spatial distribution divide, and an inter-network divide. They also identify a number of linkages between these divides and the social, organizational and humanitarian context of the camp.

In addition, there is a study [30] on human trafficking enabled by ICT. The authors coin a term “Sinai Trafficking” and it involves the abduction, extortion, sale, torture, sexual violation and killing of men, women and children who are migrants. A tenuous link they make to technology is because the migrants ransoms are collected by mobile phone. Another study [26] that discusses a growing number of digital resources designed for refugees, among other existing issues points out that most of digital resources are unsustainable, and that they can do more harm than good if they disseminate misinformation. They make a strong statement that despite their utility, mobile phones have a paradoxical presence in the lives of refugees – they are both a resource and a threat, mostly because of the digital traces that refugees’ phones leave which make them vulnerable to surveillance and other dangers.

Finally, only one study [31] concentrates mainly on risks of ICT to refugees and according to Mr. Barros, who in 2016 interviewed 40 refugees, the main issues are privacy and data risks refugees are exposed by using mobile technology.

Above studies are just scratching the surface of risks ICT presents to this vulnerable population and more should be done to properly assess those risks and recommend solutions.

### 3.5 Health and ICT for Refugees

There is a myriad of studies that considers health aspect of the refugee crisis. For example, a study [32] looks into oral health status among newly arrived refugees in Germany, while a very recent study [33] considers impact of placement type on educational and health outcomes of unaccompanied refugee minors on health outcomes. There is also a study about mental health of Bhutanese Refugees in Australia [30], and one about risk for chronic hepatitis B infection into care and peer-education [34]. In addition, two studies [35, 36] evaluate community preconceptions about nutritional supplements. One of them [35] about folate supplementation to prevent birth abnormalities and the other [36] about food choices in order to identify nutrition education needs of refugees.

However, not many studies combine all three aspects: refugees, health and technology. To our knowledge, the only in-depth study that looks into digital health for refugees [37] is done in the context of Syrian refugees in Lebanon. That study [37] identifies contextual and cultural factors that can inform the design of digital technologies to support refugee in access to antenatal care.

## 4 Identifying the Missing Themes

The present meta-literature review on ICTs and refugees related research papers highlighted on the current themes or trends within the relevant scholarships. In authors' opinion, given the severity of this global crisis, more revelatory research needs to be done in this domain, covering issues or themes in addition to the ones documented here. Multiple stakeholders related to different refugee crises worldwide (e.g., development practitioners, humanitarian service providers, refugees/displaced population, host communities, policymakers, etc.) need to be engaged in such knowledge building process. In the following, in accordance with our observations and field experience on enforced human displacement, the paper is going to briefly elaborate on the topics (in no particular order), which the authors believe need to be addressed in the future scholarships of ICTs and refugees/displaced population.

### 4.1 Ethics of ICT for Refugees

The need of an ethical framework or a set of applied guidelines for using any ICT option ethically has always been important [38]. Availability of such benchmark is even more critical in a challenged environment. The higher than usual level of uncertainty and the customary scarcity of resources make an average refugee crisis to

be an exceedingly challenged scenario. Several types of key questions can be asked covering issues related to the privacy, security, and risks (physical and mental, short and long term) for any refugee at a personal as well as at the collective level. Are there any ethical guidelines for ICT applications in a refugee camp? How is privacy of the refugees taking part in any ICT experiment protected? How secure is the private information shared by the refugees about their ordeals? – All these questions need to be addressed to ensure an ethical ICT application and usage ecosystem for any refugee crisis. For example, even though there have been studies on the ICT adaptation issues by the Syrian refugees, no significant academic research has been conducted to define a set of best ethical practices ICT based solution design, development, and deployment phases. This aspect of refugee struggle needs a significant improvement.

## **4.2 Scarcity of Longitudinal Studies**

Overwhelming majority of the ICT and refugee research papers evaluated in this paper are either short-term impact studies or exploratory studies, scoping out the feasibility of any particular set of ICT-centered options on any given human development dimensions. As researchers have identified, there is a significant need of evidence based, longitudinal research in ICT for Development within the refugee space [39]. This kind of scholarly work would be able to provide a better perspective on the multi-level effectiveness of an ICT solution addressing any refugee crisis. Field studies, both qualitative and quantitative, can then guide the policymakers and the practitioners to avoid the reinvention of the wheel during the time any new crisis emerges. Such works furthermore assist in making sustainable and long-term solutions for the developmental challenges faced by any group of refugees.

## **4.3 Gendering ICTs for Refugees**

Absence of gender equitable ICT solutions, especially in the Global South has always been a challenge for the related development agencies and other stakeholder communities. Research shows that irrespective of the nature, geolocation, and intensity of any refugee crisis, women of all age are always among the most affected groups. Researchers reported the prevalent discrimination against women when it comes to access to humanitarian resources (allocation and planning), information, communication, and other development activities [40]. Women are in general on the backseat in terms of affordable ICT access. Recent reports from the Rohingya refugee crisis in the border of Myanmar and Bangladesh showed the extensive disparity in ICT access and usage between men and women, with the latter being consistently deprived [41]. Despite such findings, there has been no systematic and in-depth research in place to identify the key challenges and opportunities faced by refugee women for accessing and actively using ICTs. There are also no gendered communication or ICT dissemination policies available to address the complexities of the displaced population.

#### 4.4 Absence of Comparative Research

In ICT for Development research, the trend of comparative analyses is common [42], especially to analyze the relative effectiveness of similar ICT interventions in diverse contexts or the other way around. There are many comparative research frameworks in place, backed up by numerous development and economic theories. The primary objective of such research projects is mostly to find the most effective and sustainable solutions for a similar set of challenges across a disparate range of socio-economic and geopolitical backgrounds. However, very few (if any) research studies exist in the domain of ICT for Refugees, which are long-term, cross-sectional, comparative, and can transcend traditional political borders. In order to better address major problems faced by any refugees on healthcare, access, energy, education, etc., it is imperative to coordinate humanitarian and developmental initiatives between multiple refugee populations. Such knowledge and experience sharing can help in avoiding squander resources on duplicating solutions for similar problems, and also assist in avoiding any forced technological adaptation. Given the rapid rise of refugee crisis globally, there is a need for more comparative research to better understand and address this unfortunate phenomenon.

#### 4.5 ICT, Entrepreneurship, and Refugees

Beyond surviving a humanitarian crisis, it's important for a refugee to work with the relevant development stakeholders to design, develop, and deliver livelihood specific solutions. Such outputs would help them to be entrepreneurial, self-reliant, and a part of productive human resources. Until recently, no adequate research has been conducted on the prospect of refugee entrepreneurs. In some refugee camps in Sub-Saharan Africa, refugees are being provided financial aid through mobile money transfers [43]. These people are also legally allowed to be a part of the regular workforce and innovate freely, especially in the ICT space. We need more detailed case studies and long-term research analyzing these initiatives. Findings from these projects can help the policy-makers and the practitioners to come up with more innovative, inclusive and entrepreneurial human resource development plans for the refugees, aided by ICTs.

### 5 Conclusions

The goal of this research has been to provide an overview of scholarships related to ICTs and refugees. Authors have found that a significant portion of the existing studies are about initial case studies, exploratory research, and disproportionately about life style adaptability of different ICT options by refugee communities around the globe. In other sectors like Education, Health Care, Communication strategies for refugees, ICT related scholarly studies primarily focus on the supply-side based findings, and hardly had any systematic analyses of the demand-side inputs. Moreover, authors could not locate any considerable number of scholarly works addressing other major issues, i.e. gender, ethics, entrepreneurship, empowerment, etc. The authors believe that such void in scholarship needs to be filled up rather quickly, as the refugee and displacement

crises are alarmingly on the rise in all the continents, thus adversely affecting our contemporary socio-economic ecosystems and development cycles. Furthermore, refugees actively need to be the parts of the design and implementation of such future scholarly initiatives, which can help the humanity to get a better understanding of such immense challenges and to design appropriate solutions.

**Acknowledgement.** This research was supported by the MSIT (Ministry of Science and ICT), Korea, under the ICT Consilience Creative Program (IITP-2017-R0346-16-1007) supervised by the IITP (Institute for Information & Communications Technology Promotion).

## References

1. Myanmar Rohingya: What you need to know about the crisis. In: BBC News. <https://www.bbc.com/news/world-asia-41566561>. Accessed 20 Oct 2018
2. Hussain, F.: Digital access isn't a luxury for refugees. it's a necessity. In: Slate Magazine (2018). <https://slate.com/technology/2018/06/digital-access-isnt-a-luxury-for-refugees-its-a-necessity.html>. Accessed 20 Oct 2018
3. Connecting Refugees: How internet and mobile connectivity can improve refugee well-being and transform humanitarian action - world. In: Relief Web. <https://reliefweb.int/report/world/connecting-refugees-how-internet-and-mobile-connectivity-can-improve-refugee-well-being>. Accessed 20 Oct 2018
4. Cukier, W., Jackson, S.: Welcoming Syrian refugees to Canada technology-enabled social innovation. In: 2017 IEEE Canada International Humanitarian Technology Conference (IHTC), 21 July, pp. 32–36. IEEE (2017)
5. Maitland, C., et al.: Youth mobile phone and internet use January 2015 Za'atari camp, Mafraq, Jordan. Penn State College of Information Sciences and Technology, 19 October 2015
6. Almohamed, A., Vyas, D.: Vulnerability of displacement: challenges for integrating refugees and asylum seekers in host communities. In: Proceedings of the 28th Australian Conference on Computer-Human Interaction, 29 Nov 2016, pp. 125–134. ACM (2016)
7. Baldi, V., Ribeiro, A.: Conceptualization of a mobile application aimed at refugees in Portugal. In: 2018 13th Iberian Conference on Information Systems and Technologies (CISTI), 13 June 2018, pp. 1–6. IEEE (2018)
8. Daher, E., Kubicki, S.: Technologies in the planning of refugees' camps: a parametric participative framework for spatial camp planning. In: 2017 IEEE Canada International Humanitarian Technology Conference (IHTC), 21 July 2017, pp. 207–212. IEEE (2017)
9. Weiss-Meyer, A.: Apps for refugees: how technology helps in a humanitarian crisis, Atlantic, May 2017
10. Barros, G.: Central American refugees: protected or put at risk by communication technologies? *Forced Migr. Rev.* (56), 20–22 (2017). <https://www.fmreview.org/latinamerica-caribbean/barros>
11. Bacishoga, K.B., Hooper, V.A., Johnston, K.A.: The role of mobile phones in the development of social capital among refugees in South Africa. *Electron. J. Inf. Syst. Dev. Ctries.* 72(1), 1–21 (2016)
12. Schmitt, P., Iland, D., Belding, E., Tomaszewski, B., Xu, Y., Maitland, C.: Community-level access divides: a refugee camp case study. In: Proceedings of the Eighth International Conference on Information and Communication Technologies and Development, 3 June, p. 25. ACM (2016)

13. Peterson Bishop, A., Fisher, K.E.: Using ICT design to learn about immigrant teens from Myanmar. In: Proceedings of the Seventh International Conference on Information and Communication Technologies and Development, 15 May 2015, p. 56. ACM (2015)
14. Maric, J.: The valleys of death in refugee crisis. In: 2017 International Conference on Social Media, Wearable and Web Analytics (Social Media), pp. 1–7. IEEE, June 2017
15. Cravero, C.E.: Mobile technology for refugee resilience in urban and peri-urban Malaysia. In: Proceedings of the Seventh International Conference on Information and Communication Technologies and Development, p. 34. ACM, May 2015
16. Gillespie, M., et al.: Mapping refugee media journeys: smartphones and social media networks (2016)
17. AbuJarour, S., et al.: Empowering refugees with technology: best practices and research agenda. In: Proceedings of the 25th European Conference on Information Systems (ECIS), Guimarães, Portugal, 5–10 June 2017, pp. 3263–3273 (2017). ISBN 978-0-9915567-0-0 Panels
18. Díaz Andrade, A., Doolin, B.: Temporal enactment of resettled refugees' ICT-mediated information practices. *Inf. Syst. J.* **29**, 145–174 (2018)
19. Andrade, A.D., Doolin, B.: Information and communication technology and the social inclusion of refugees. *MIS Q.* **40**(2), 405–416 (2016)
20. Van Reisen, M., Rijken, C.: Sinai trafficking: origin and definition of a new form of human trafficking. *Soc. Incl.* **3**(1), 113–124 (2015)
21. Gifford, S.M., Wilding, R.: Digital escapes? ICTs, settlement and belonging among Karen youth in Melbourne, Australia. *J. Refug. Stud.* **26**(4), 558–575 (2013)
22. Lee, J., Schwartz, L., Long, E., Naseem, M.: Using experiential-learning and iterative design to benefit Colorado's Refugees. In: Proceedings of the DIS 2018 Companion Publication of the 2018 Designing Interactive Systems Conference, pp. 259–263. ACM (2018)
23. Granberry, P.J.: More social than capital: social capital accumulation through social network exchange among legal and unauthorized Mexican migrants. *Soc. Sci. J.* **51**(4), 590–597 (2014)
24. Shariati, S., Armarego, J., Sudweeks, F.: The impact of e-skills on the settlement of Iranian refugees in Australia. *Interdiscip. J. e-Ski. Lifelong Learn.* **13**, 59–77 (2017)
25. Dosono, B., Britton, L., Semaan, B.: Regaining normalcy after war: ICT-enabled 'transition resilience' in veterans and refugees. In: Conference 2016 Proceedings (2016)
26. GSMA report: The importance of mobile for refugees: a landscape of new services and approaches (2017). <https://www.gsma.com/mobilefordevelopment/programme/mobile-for-humanitarian-innovation/the-importance-of-mobile-for-refugees-a-landscape-of-new-services-and-approaches/>. Accessed 3 Sept 2018
27. Lewis, K., Thacker, S.: ICT and the education of refugees: a stocktaking of innovative approaches in the MENA region (2016)
28. AbuJarour, S., Krasnova, H.: Understanding the role of ICTs in promoting social inclusion: the case of Syrian refugees in Germany (2017)
29. Bates, M., Breheny, A., Brown, D., Burton, A., Standen, P.: Using a blended pedagogical framework to guide the applications of games in non-formal contexts. In: 2014 International Conference on Interactive Technologies and Games (iTAG), pp. 79–83. IEEE (2014)
30. Sievert, K., O'Neill, P., Koh, Y., Lee, J.H., Dev, A., Le, S.: Engaging new refugee in Australian communities at risk for chronic hepatitis B infection into care: a peer-educator intervention. *Health Soc. Care Community* **26**(5), 744–750 (2018)
31. Lumley, M., Katsikitis, M., Statham, D.: Depression, anxiety, and acculturative stress among resettled Bhutanese refugees in Australia. *J. Cross-Cult. Psychol.* **49**(8), 1269–1282 (2018)

32. O'Higgins, A., Ott, E.M., Shea, M.W.: What is the impact of placement type on educational and health outcomes of unaccompanied refugee minors? A systematic review of the evidence. *Clin. Child. Fam. Psychol. Rev.* **21**, 1–12 (2018)
33. Solyman, M., Schmidt-Westhausen, A.M.: Oral health status among newly arrived refugees in Germany: a cross-sectional study. *BMC Oral Health* **18**(1), 132 (2018)
34. Wachter, G.G., Fleischmann, F.: Settlement intentions and immigrant integration: the case of recently arrived eu-immigrants in the Netherlands. *Int. Migr.* **56**, 154–171 (2018)
35. Stevens, A., et al.: Folate supplementation to prevent birth abnormalities: evaluating a community-based participatory action plan for refugees and migrant workers on the Thailand-Myanmar border. *Public Health* **161**, 83–89 (2018)
36. Burge, C., Dharod, J.M.: What are the nutrition education needs of refugees: assessment of food choices, shopping and spending practices of South-Asian refugees in the USA. *J. Int. Migr. Integr.* **19**, 1–10 (2018)
37. Talhouk, R., et al.: Syrian refugees and digital health in Lebanon: opportunities for improving antenatal health. In: Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, pp. 331–342. ACM (2016)
38. Mthoko, H.L., Pade-Khene, C.: Towards a theoretical framework on ethical practice in ICT4D programmes. *Inf. Dev.* **29**, 36–53 (2012). <https://doi.org/10.1177/0266666912449456>
39. A lifeline to learning: leveraging technology to support education for refugees - world. In: ReliefWeb. <https://reliefweb.int/report/world/lifeline-learning-leveraging-technology-support-education-refugees>. Accessed 20 Oct 2018
40. United Nations the world's largest minority - women and girls in the global compact on refugees (Extended). In: UNHCR. <http://www.unhcr.org/events/conferences/59e5f4447/worlds-largest-minority-women-girls-global-compact-refugees-extended.html>. Accessed 20 Oct 2018
41. Bangladesh Should Legalize SIM Cards for Rohingya Refugees. In: Freedom House (2018). <https://freedomhouse.org/blog/bangladesh-should-legalize-sim-cards-rohingya-refugees>. Accessed 20 Oct 2018
42. Kang, H.: Revisioning information and communication technology (ICT4D) at comparative & international education society (CIES): a five-year account (2009–2013). *Int. J. Educ. Dev. Using ICT* **10**, 6–18 (2014)
43. United Nations phone technology gives refugees in Uganda a cash lifeline. In: UNHCR. <http://www.unhcr.org/en-us/news/latest/2017/10/59e07fe24/phone-technology-gives-refugees-uganda-cash-lifeline.html>. Accessed 20 Oct 2018



# **Local Technical Papers**



# Rate Adaptive Congestion Control Using Lookup Table Scheme to Enhance Quality of Experience

Jane Lissah<sup>(✉)</sup> and Mercy Mbise

University of Dar es Salaam, Dar es Salaam, Tanzania  
janelissah@gmail.com, mercymbise@gmail.com

**Abstract.** In recent years video communication has occupied a large percentage of Internet traffic and the trend is expected to increase. Many services are offered via the Internet use video content to reach millions of users. Real time video services in the Internet are mostly done by using User Datagram Protocol (UDP). UDP is preferable because it is fast, but has a weakness of not supporting congestion control mechanisms; hence it usually floods the channel it is using causing congestion which then leads to packet loss, excessive delay and jitter. To support good quality of experience (QoE), packet loss, delay and jitter must be kept at accepted values.

This paper presents part of an ongoing MSc. research work whose aim is to develop a rate adaptive congestion control scheme using a lookup table. The scheme use Real Time Transport Protocol (RTP) and RTP Control Protocol (RTCP) to provide end to end network transport service which is not provided by UDP and control service. The proposed congestion control scheme comprises of two components:- a lookup table and congestion control equation. The lookup table is created at the beginning of sender's application and keeps a record of fraction loss and Inter Packet Gap (IPG), which is the interval in time between sending packets. Upon receiving a report the lookup table is searched to see if there is a match for the report's fraction loss value and returns, the appropriate IPG value. If there is no match a congestion control equation is used to compute a new IPG value, which is then added to the lookup table and used for rate adjustment.

Simulation of the proposed work was done using NS3, where by the Quality of Service (QoS) parameter which affect the Quality of Experience (QoE) such as delay and jitter were observed. Elvavid, a video quality evaluation tool is used to measure the quality of video by using Peak Signal Noise Ratio (PSNR) and Mean Opinion Score (MOS) measurements.

**Keywords:** UDP · RTP · RTCP · QoE · QoS ·  
Rate-adaptive congestion control

## 1 Introduction

In recent years video communication has occupied a large percentage on the Internet and the trend is expected to increase [1, 2]. Many services are offered via the Internet use video contents to reach millions of users. Real time video services in the Internet

transported is done using the User Datagram Protocol (UDP) [3] because of its unreliable nature which does not require it to retransmit lost packets. UDP is preferable because it is fast [4], but has a weakness of not supporting congestion control mechanism: hence it usually floods the channel it is using causing congestion to occur which then lead to packet loss, excessive delay and jitter.

To support good Quality of Experience (QoE), packet loss, delay and jitter must be kept at accepted values. Real Time Transfer protocol (RTP) is a protocol which works on top of UDP with the aim of providing end to end connection services between systems. The RTP was designed to be used for audio and video transmission over the Internet, it perform packet loss detection and reorder packets at destination. RTP works with Real Time Control Protocol (RTCP) which monitors the Quality of Service (QoS) parameters and provides different feedback reports [5].

Though the RTP/UDP work well with real time video delivery, it is subjected to high packet losses, excessive delay and jitter since it has no congestion control and tend to congest the network by sending data at a rate higher than available bandwidth. A large number of packet losses, excessive delay and jitter affect the quality of video thus affecting the Quality of Experience (QoE) of end user. According to [6, 7] in order to assure a good QoE to end user, a certain level of QoS must be provisioned.

This paper presents a rate adaptive congestion control which uses a lookup table. The congestion control is designed to work with RTP/RTCP protocols and is based on using QoS parameters (delay, jitter and packet loss) as observed in the RTCP report to find interval value being kept in the lookup table to adjust sending rate by adjusting interval between packets being send over the Internet.

The paper is organized as follows; Sect. 2 gives a review of relevant literature for rate adaptive congestion control for video streaming. Section 3 gives the description of the model, Sect. 4 gives the outline of simulation setup, Sect. 5 give the results observed and finally Sect. 6 concludes the paper.

## 2 Related Works

Congestion in real time multimedia transmission affect the quality of media as perceived by user, in voice transmission voice is not hear properly and may be characterized by noise or alternation while in video quality of picture may suffer as well as voice and picture synchronization [8]. Congestion in the network may be due to buffer length in the intermediate nodes, slow processor speed at router even though line capacity is high and mismatch of bandwidth between different parts of network [9].

Congestion control includes techniques which are used to control or/and prevent congestion. The aim of congestion control is to allow for efficient use of bandwidth and support fairness among different flows in the link. There are two approaches for congestion control, end to end congestion control and network assisted congestion control [10].

A number of researchers have investigated congestion control for video streaming. The studies are divided into network-centric congestion control and application level/end user congestion control [11]. A survey by [12] covers a number of network-centric congestion control schemes where routers are also involved in congestion

control throughout the communication channel, while the application layer congestion control schemes are implemented on top of the Transport layer to facilitate video streaming by adapting the sending rate depending on network conditions. Works proposed in [13–16] are some of the examples of schemes proposed to be implemented at the application layer using different techniques to support video streaming.

### 3 Methodology

A proposed rate adaptive congestion control scheme comprises of two components; a lookup table and congestion equation. The lookup table is made of associative array using hash table data structure. The hash table data structure uses indices to store key-value data pair. Fraction loss is used as key values while the IPG (Inter Packet Gap) value is used as a value. Congestion control equation is used to calculate the IPG value for rate adjustment whenever there is no value for the fraction loss (key value) obtained from the RTCP receiver report.

Fraction loss is one of the parameters included in the RTCP receiver report and it represents the ratio of number of lost packets between the intervals of transmitting RTCP receiver report to total packets sent within that interval. Other parameters in the RTCP receiver report are number of packets lost, delay and jitter [5]. The RTCP receiver report is sent by the receiver every 5 s so as not to flood the channel with feedback packets.

The congestion control Eq. (1) uses QoS parameters (delay, jitter and fraction loss) which are in the RTCP receiver report to compute a new Inter Packet Gap (IPG). IPG is used as a basis for rate adaptation in order to limit the number of packets sent by UDP application depending on the condition of the network.

The congestion control equation is defined as:

$$IPG = (d * j * fl) / 10^{13} \quad (1)$$

Where *IPG* represents interval between packets, *d* represents estimated delay experienced by the last packet before sending a new RTCP packet, *j* represents jitter experienced and *fl* represents fraction loss. The product of delay, jitter and fraction loss is divided by  $10^{13}$  to obtain IPG value in microseconds. The congestion control equation is used whenever the value is not found on the lookup table (Fig. 1).

A lookup table created using a hash table uses *key* and *value* pair for its functionality. The fraction loss is used as *key* value while the IPG is used as the *value*. When a new RTCP receiver report is received by the sender, the sender uses fraction loss to search if there is a value which is associated with the key value (fraction loss) in the lookup table. If there is no value, the IPG value for that fraction loss is calculated and used for rate adjustment and stored at the lookup table for future use.

At the start of sender application, the lookup table is initiated with default value of IPG which is used throughout the program when fraction loss is zero and before the sender starts receiving the RTCP receiver report. This is one of the components which

make the scheme give good results during simulation. The lookup table is implemented using hash table because it takes a constant time  $O(1)$  to search the table even when the table is very much populated. Hash table supports fast search and one index can be used to store multiple pair of key values.

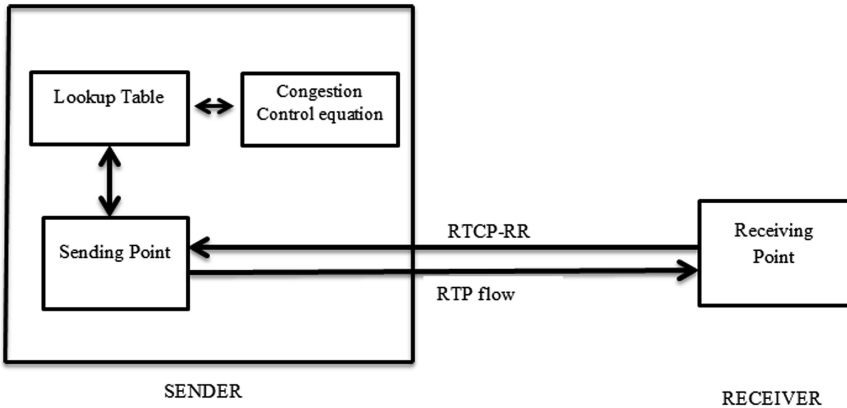


Fig. 1. Proposed rate adaptive congestion control scheme

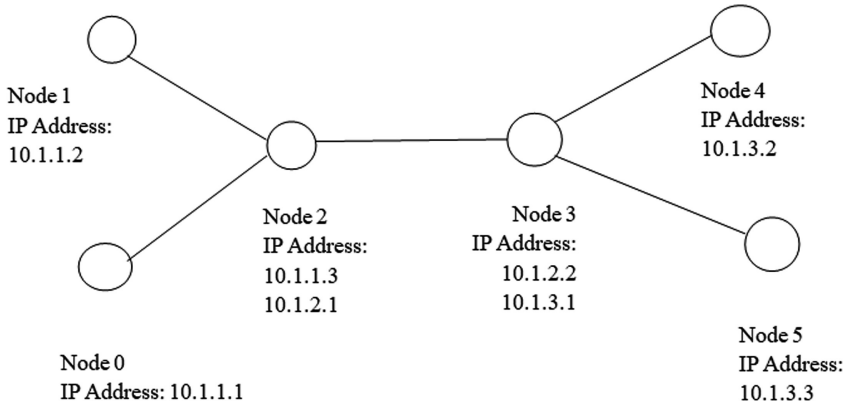
The sender (sending point) encapsulates video stream data packets with RTP which provides means to track the number of packets sent and a timestamp for tracking delay. The packets are then encapsulated with UDP and are sent to the receiver (Receiving point) via the Internet. At the receiver, packet sequence numbers are captured to determine the number of packets received and lost and the time stamp is used to obtain the delay and jitter values. Then the RTCP receiver report header is created at the receiver and encapsulated with UDP, and then sent over the Internet to the sender after every five seconds.

Upon receiving the RTCP receiver report packet, the sender extracts the values captured by the receiver. The values contained in the report are packet loss, maximum packets received, highest sequence number observed, jitter and fraction packet loss. These values are then used by the proposed congestion control scheme for rate adjustment at the sender by either increasing or decreasing the IPG value. Only three values (delay, jitter and fraction loss) are used in the congestion control equation since fraction loss is derived from packet loss value, maximum packet received value and highest sequence number observed.

#### 4 Simulation Setup

Experiments are conducted by simulating different scenarios using NS3. A simulated topology was set up which included three network subnets of Local Area Network (LAN) as shown in Fig. 2. Subnet one is comprised of Node 0, Node 1 and Node 2 with link capacity of 100 Mbps. Subnet two is made up of Node 2 and Node 3 with

link capacity of 4 Mbps, and subnet three is made up of Node 3, Node 4 and Node 5 with link capacity of 100 Mbps. The link in subnet two is set to a small value to reflect the scarcity of resource in links which are shared by many nodes.



**Fig. 2.** Simulated network topology

Three applications were used to send video stream data obtained from [17], which provide video data prepared for simulations. A high motion video sequence “highway” is used. Highway video sequence is in YUV format with a duration of 80.1 s. The resolution of the video clip is  $352 \times 288$  pixels which is known as the common intermediate format(CIF). The videos are encoded at 25 frames/s with the *ffmpeg* [18] video encoder. *ffmpeg* generates three types of frames namely intra-frame (I), predictive frame (P) and bi-directional frame (B). Frames are organized in groups, called group of pictures (GoP). Each GoP consists of one I frame, some P frames and some B frames between I and P frames, the value of GoP at the *ffmpeg* encoder is set to 12. In the original MPEG-4 format the encoded video files cannot be used in the NS3. Using Evalvid framework [19] the encoded video clip is converted to trace file which is used in NS3. The trace file is then stored at a sender node (Node 0) and transferred to the receiver node(Node 4) using topology in Fig. 2.

Video stream data were sent from Node 0 to Node 4 while TCP traffic was sent from Node 1 to Node 5. The first part of experiment involved three application demonstrate the responsiveness of the proposed scheme in UDP flow (Fig. 3). First application did not contain any additional mechanism for congestion control; the second application contained rate adaptive congestion control mechanism which was used to regulate the time interval between packets using UDP. The rate adaptive congestion control uses the data obtained from the RTCP receiver report to find the appropriate interval to be used. The third application used the proposed rate adaptive congestion control scheme; a lookup table is created upon the start of the application.

The second part of the experiment involved integrating evalvid video quality evaluation tool into NS3, integrating the proposed congestion control scheme into the evalvid application and performing the simulation. The evalvid tool records delay, and jitter which are experienced by each video frames (Figs. 4 and 5 respectively) as well as give QoE measurement in terms of Peak Noisy Signal Ratio (PSNR) values and Mean Opinion Score (MOS) (Figs. 6 and 7 respectively).

## 5 Results and Discussions

Experiments were conducted using NS3, whereby applications were modified to accommodate the use of RTP and RTCP protocols. RTP is used to add sequence number and timestamp to datagram packets whereas RTCP is used for control. Applications used RTCP receiver reports which were sent by the receiver after every 5 s to perform sending rate adjustment [5]. Simulation result obtain was compared to related work by [16] as this work also used Evalvid video quality evaluation tool and experiment parameter were made to be similar to this work. Here are the observed results:

### 5.1 UDP Flow

Figure 3, presents the UDP flow when the same congestion is used with lookup table and without lookup table. It is observed that the number of packets sent within the interval is decreased for the video stream sent by the application using the proposed scheme.

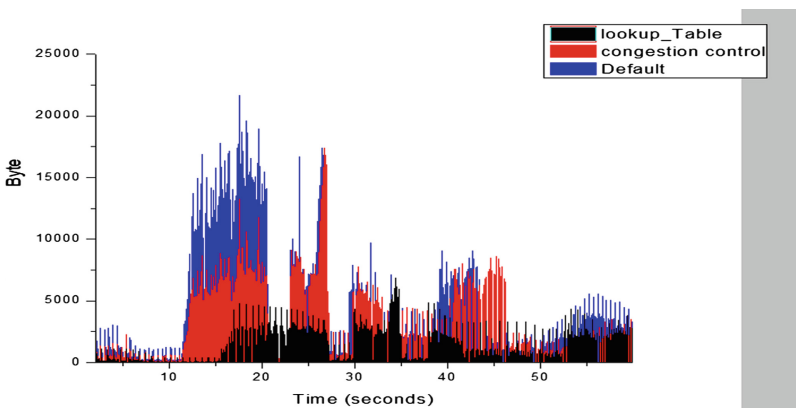
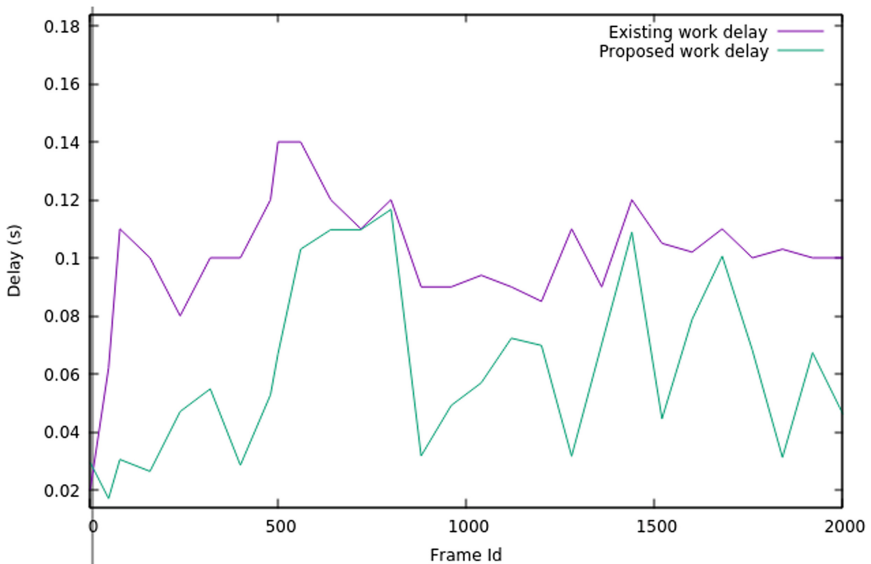


Fig. 3. UDP flow

The application using the proposed scheme was able to be more responsive in the changing rate of the channel. This allowed the application to increase or decrease the sending rate by increasing or decreasing the IPG value between sending packets. This has led to the decrease of amount of bytes (total number of packets) which are sent out at one instance.

## 5.2 Delay

Delay value for video frames which arrive at the receiver was also observed (Fig. 4). There is improvement in delay value observed where by the existing work by [16] recorded and average delay of  $77.7 \mu\text{s}$ , the proposed congestion control scheme recorded average delay of  $50.1 \mu\text{s}$ . The existing work recorded highest delay of  $147.55 \mu\text{s}$  and lowest delay at  $20.35 \mu\text{s}$  while the proposed work recorded highest delay at  $136.10 \mu\text{s}$  and the lowest delay at  $10.3 \mu\text{s}$  (Fig. 4). This improvement can be explained as a result of reducing congestion in the links which connect the devices. When links are congested with a lot of packets, it takes a long time for packets to reach the destination, hence improvement in delay value signify the performance of the proposed scheme.

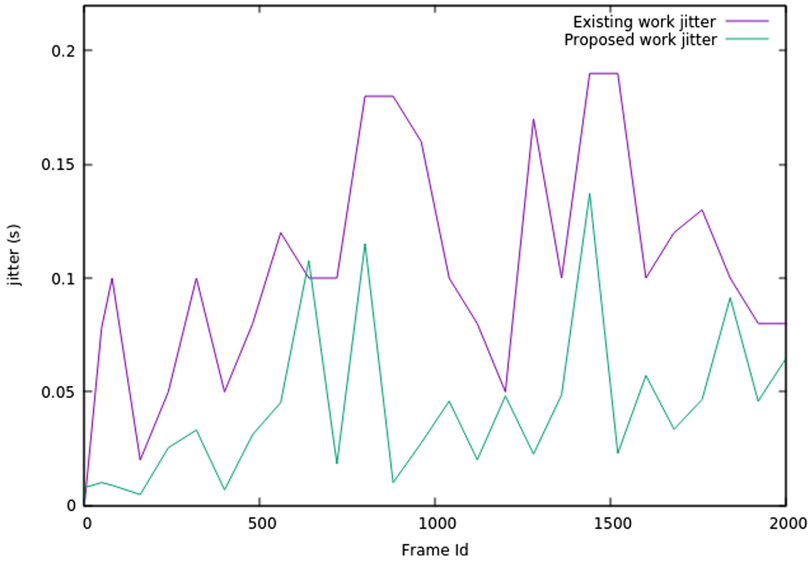


**Fig. 4.** Delay as observed between existing proposed and proposed congestion control scheme in video streaming



### 5.3 Jitter

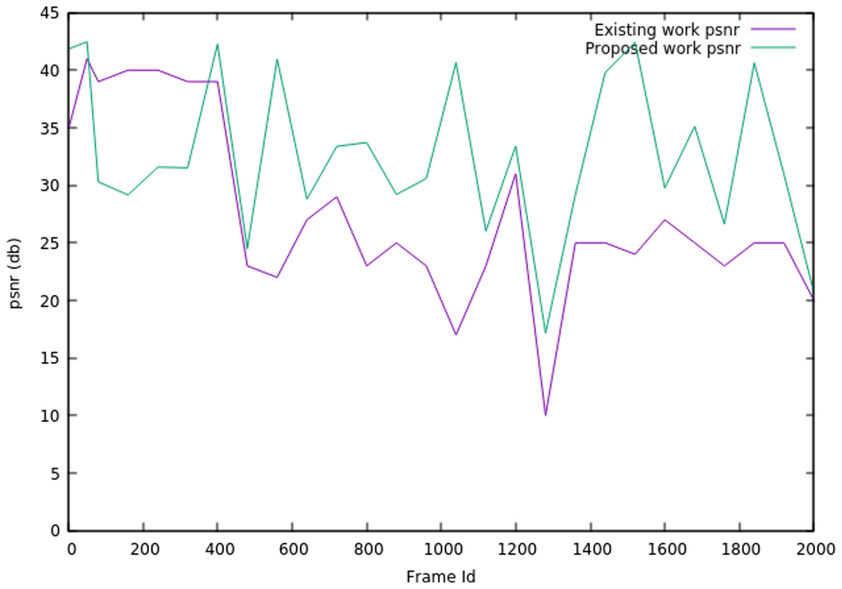
Cumulative jitter values were also observed. The proposed scheme observed the improvement of jitter values, where by low cumulative jitter value were observed when the proposed congestion control scheme is used as compared to existing work by [16]. The proposed congestion control scheme performed well as all observed jitter for video frames was below 150 ms (Fig. 5).



**Fig. 5.** Jitter as observed between existing proposed and proposed congestion control scheme in video streaming

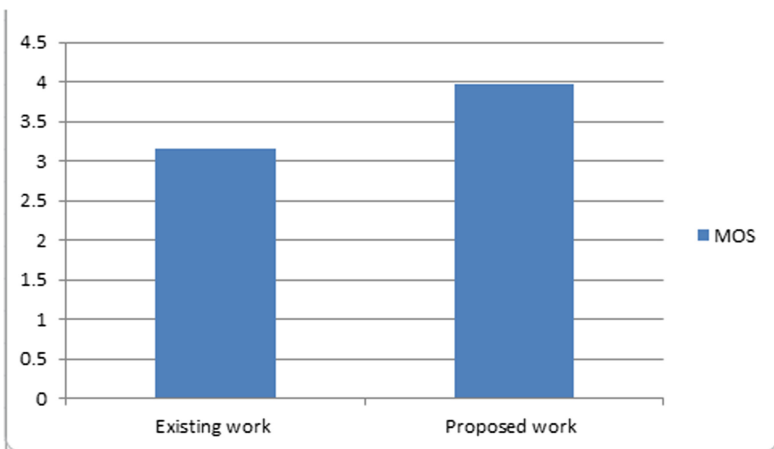
### 5.4 PSNR Value and MOS Value

The video quality was measured by means of Peak Signal Noise Ratio (PSNR) and Mean Opinion Score (MOS). The Evalvid evaluation tool uses full reference quality evaluation method. Where by original video is compared to video constructed after being transmitted over the communication channel frame by frame. There is observed improvement in PNSR value, where by the existing work observed an average of 31.25 db whereas the proposed scheme observed an average PSNR value of 34.49 db. Figure 6 shows psnr values obtained for 2000 frames.



**Fig. 6.** PSNR as observed between existing proposed and proposed congestion control scheme in video streaming

MOS measures how human perceive quality of video. It is calculated using a combination of number of lost packets in percent, the average delay, average jitter and R-value which is expresses the subjective quality of connection. MOS value ranges from 1 to 5, 1 being worse and 5 excellent. The observed average MOS by the proposed work is 3.98 as oppose to 3.15 which was observed by [16].



**Fig. 7.** Average MOS as observed between existing proposed and proposed congestion control scheme in video streaming

## 6 Conclusion

This paper has presented a new rate adaptive congestion control scheme which uses lookup table to regulate packet sending rate at the sender by using QoS values obtained from the RTCP receiver reports. From these results, it is observed that there is improvement of delay and jitter value experienced by the frame during the transmission of video over the Internet. The improvement in delay and jitter also lead to the improvement of the QoE as it was witnessed in the delay PSNR and MOS values. The proposed scheme has indication of good performance but has limitation as it only focused on unicast wired network. Further research will be performed using the scheme for wireless networks as well as implementing it on multicast applications.

## References

1. Solomon, D., Motta, G.: Handbook of Data Compression, 5th edn. Springer, London (2010). <https://doi.org/10.1007/978-1-84882-903-9>
2. Carlucci, G., De Cicco, L., Holmer, S., Mascolo, S.: Congestion control for web real-time communication. *IEEE/ACM Trans. Netw.* **25**, 1–14 (2017)
3. Bari, P., Holmer, S., Bari, P.: Analysis and design of the Google congestion control for web real-time communication (WebRTC) (2016)
4. Li, Z., Drew, M.S.: Fundamentals of Multimedia, 2nd edn. Springer, Switzerland (2014). <https://doi.org/10.1007/978-3-319-05290-8>
5. Schulzrinne, H., Casner, S., Frederick, R., Jacobson, V.: Real time transport protocol. Internet Standard (2003). <https://tools.ietf.org/html/rfc3550>. Accessed 10 Oct 2018
6. Stankiewicz, R., Jajszczyk, A.: A survey of QoE assurance in converged networks. *Comput. Netw.* **55**(7), 1459–1473 (2011)
7. Ma, K.J., Bartoš, R.: A survey of schemes for internet-based video delivery. *J. Netw. Comput. Appl.* **34**, 1572–1586 (2011)
8. Chandra, E., Subramani, B.: A survey on congestion control. *Glob. J. Comput. Sci. Technol.* **9**(5), 82–87 (2010)
9. Afanasyev, A., Tilley, N., Reiher, P., Kleinrock, L.: Host-to-host congestion control for TCP. *IEEE Commun. Surv. Tutor.* **12**(3), 304–342 (2010)
10. Forouzan, B.A.: Data Communications and Networking, 5th edn. McGraw-Hill Companies, Inc., New York (2013)
11. Yuvaraju, B., Chiplunkar, N.N.: Picco : protocol independent congestion control method using mobile relays for ad-hoc networks. In: Second International Conference on Computer and Network Technology, pp. 93–97 (2010)
12. Adams, R.: Active queue management: a survey. *IEEE Commun. Surv. Tutor.* **15**(3), 1425–1476 (2013)
13. Papadimitriou, P., Tsaoussidis, V.: SSVP: a congestion control scheme for real-time video streaming. *Comput. Netw.* **51**, 4377–4395 (2007)
14. Wang, L.: Research on resource service of multimedia network. In: 2011 International Symposium on Computer Science and Society, pp. 4–6 (2011)
15. Jun, Y., Lei, S.: Research on adaptive transmission mechanism of video data. In: 2015 International Conference on Computational Intelligence and Communication Networks Research, pp. 570–573 (2015)

16. Ferguson, K.L.: RRB-SIMD: RTP rate-based SIMD protocol for media streaming applications over the internet. In: 2011 Ninth Annual Communication Networks and Services Research Conference (2011)
17. Institute of Telecommunication Systems: MPG-4 and H.263 Video Traces for Network Performance Evaluation. <http://www2.tkn.tu-berlin.de/research/trace/trace.html>. Accessed 10 Oct 2018
18. FFmpeg. <https://www.ffmpeg.org/>. Accessed 15 Jan 2019
19. Klaue, J.: Evalvid - A video quality evaluation tool. <http://www2.tkn.tu-berlin.de/research/evalvid/fw.html#bin>. Accessed 05 Jan 2019



# Enhancing Faults Monitoring in Secondary Electrical Distribution Network

Yona Andegelile<sup>(✉)</sup>, Godfrey Chugulu, Ally Bitebo,  
Hadija Mbembati, and Herald Kundaeli

University of Dar es Salaam, Dar es Salaam, Tanzania  
yona.andegelile@gmail.com

**Abstract.** Inefficient fault management in electrical Secondary Distribution Network (SDN) is one of the major challenges facing most power utility companies around the world including Tanzania. Currently, faults management processes from detection to clearance are done manually due to the lack of visibility in SDN resulting to long Mean Time To Repair (MTTR) and high operational costs. Advancements in Information and Communication Technology (ICT) and sensing technologies have made it possible to have cost effective electrical power network visibility solutions. This study proposes algorithms that enhance fault detection and monitoring in the Tanzania SDN based on distributed processing architecture. The proposed algorithms include sensing and data acquisition, fault detection, localization and visualization. The algorithms were deployed and tested on live network at University of Dar es Salaam (UDSM), Kijitonyama Campus.

**Keywords:** Fault detection · Fault clearance · Distributed processing · Secondary distribution network · Remote sensing unit · Monitoring · Visibility · Algorithms · Distributed architecture

## 1 Introduction

Electrical power Secondary Distribution Network (SDN) provides last mile connectivity to the end customers [1]. Its primary task is to ensure a secure and efficient energy delivery to consumers [2]. For this to be possible, power from generation sites is transmitted to the primary substation through the transmission network and delivered to the secondary distribution network through Medium Voltage (MV)/Low Voltage (LV) transformers [3].

Most power utilities maintain the emergency desk to ensure supply continuity and customer safety hence guarantee the quality of service. In Tanzania, the electrical SDN is under Tanzania Electric Supply Company Limited (TANESCO). Defects and faults are reported by customers to the TANESCO's emergency desk and through visual inspection (line patrol) which are time consuming and inefficient [4]. The delays in fault clearance are mainly attributed by the lack of efficient and automated systems which continuously monitor the electrical SDN parameters so as to detect, report, classify and locate faults whenever they occur. Ineffective faults clearance mechanisms employed by the utility company have been the major cause of inefficient power supply

in Tanzania resulting to increased complaints from customers and significant losses of revenue to both customers and utility.

There have been utility company initiatives to automate fault monitoring and detection in transmission and primary distribution parts of the electrical network using Supervisory Control and Data Acquisition (SCADA) and Distribution Management System (DMS), which are largely centralized [5, 6]. Due to the complexity and ubiquitous nature of the SDN, cost effective automations are still challenging. Few studies [7] have been conducted in LV distribution network in which controller at the transformer was used as a decision maker. However, advancements in ICT and sensing technologies have made it possible to have cost effective electrical power network visibility and faults handling throughout SDN [8, 9]. Therefore, this study proposes algorithms to enhance visibility and automatic faults monitoring in the Tanzania SDN based on distributed architecture.

The main contribution of this paper is the design and implementation of algorithms that extend monitoring capability of Tanzania's SDN. The proposed algorithms offer the ability to process data from the data sources as well as at the control center based on distributed processing. Tanzania utility company SDN was used as the case study, and was carried out at University of Dar es Salaam (UDSM), Kijitonyama campus. Moreover, Challenge Based Learning (CBL) [10, 11] approach was adopted in this study to identify and refine the problem through involvement of stakeholders. The use of CBL approach enhanced the cooperation among industry and academia in the solution development. Furthermore, CBL allows people from different background, competences and disciplines to work together in accomplishing the objective of the study. In this way, products from academic addresses real problems of the society.

This paper is organized as follows: Sect. 2 discusses fault handling and management techniques. Section 3 describes the approach used for developing distributed algorithms for data acquisition, processing and visualization. Section 4 discusses the design of algorithms for fault handling. Section 5 describes system integration. Section 6 describes results and discussion. Finally, Sect. 7 provides conclusion and future work.

## 2 Fault Handling and Management

### 2.1 Fault Detection, Classification and Localization

Electricity supply networks are subjected to various disturbances depending on the potential of production, atmospheric conditions, and industrial loads which affect them during the transmission and distribution of the energy produced. Disturbances in the electrical SDN may result into faults which are referred to as the discrepancy between the reference value and the measured value for any given network parameter [12].

Faults in overhead distribution system can be classified into two main types, i.e. series (open conductor) faults, and shunt (short circuit) faults. Series faults can be identified easily by observing the voltages on each phase. Short circuit faults can be identified easily by observing the current values on each phase. Short circuit faults are divided into two main types depending on the lines under short circuit, i.e. asymmetrical faults, and symmetrical faults [13]. Having known the exact fault type after classification

as discussed [14, 15] in the electrical SDN, it is equally important is to determine the fault location. This will assist the maintenance crew to easily locate the fault areas rather than relying on information from reporters which are sometimes not accurate. The fault location techniques can be categorized into four main groups: automated outage mapping, impedance-based methods, expert systems, travelling waves and voltage sag measurements [16]. For efficient fault localization in distribution network, the process can be done in two stages. The first stage involves faulty branch identification and second stage is distance calculation to the faulty point. Fault branch identification normally starts, followed by distance calculation to eliminate the problem of multiple estimation during distance calculation [17, 18]. This study aims at detecting faults, classifying and finding the faulty branch using the expert system and then visualizing the fault location on the map.

Advancement of data acquisition, storage, processing, transmission and sensor technologies have enabled availability of low cost devices such as microprocessors, Field Programmable Logic Arrays (FPGA), Arduino, Raspberry Pi [19] and wireless sensors. This has facilitated the deployment of distributed algorithms to enhance automated fault detection and monitoring using distributed.

## 2.2 Applications System for Fault Monitoring

The past 20 years have seen the rapid deployment of various management techniques, Intelligent Electronic Devices (IEDs), sensors and tools for detection, classification and location of faults in power systems [20]. To leverage advancement of these technologies, ICT industry also had to catch up with the speed of these developments by allowing seamless adoption of information systems for visualizations and analytics into power systems through design of algorithms and software applications [9]. Among many features of software applications, Graphical User Interface (GUI) plays a significant role to allow users interaction with the system, if well designed. This has fundamentally changed the management and control of power systems at large by allowing improved range of display capabilities consistent with Human Computer Interaction principles [21]. In particular, SCADA systems have opened up to a wide range of user community by embracing the idea of distributed computing, which addresses issues of mobile SCADA Human Machine Interfacing [22, 23] and provision of Application Programming Interface (API) for other systems. For the case of Tanzania, limitation still exist particularly for SCADA system which is not exposed to external systems.

## 2.3 Related Works

There has been a number of similar studies done on this area, such as authors in [24] who presented faults detection and location in LV grids based on RF mesh network. Their study demonstrated the distributed architecture with sensor nodes placed along the networks and uses the mesh network to relay the measurements to the Distribution Transformer Controllers (DTC) placed on each secondary substation. Fault detection and faults location algorithms were developed to run on the DTC which were used as the “decision maker”. Furthermore, a study done by [25] demonstrated the use of SCADA and PLC to monitor and diagnose the distribution system. The proposed architecture in this study

used on-line monitoring system which integrated a solid state device named Programmable Logic Controllers (PLC) and sensor packages which were mainly installed on distribution sub stations. The PLC and SCADA allows to detect the exact location of fault and without waiting SCADA to give an alarm to the operators for identifying and prevent it. Moreover, a study by [26] demonstrated a cost-effective fault management system in MV distribution systems and [27] considered the use of high-performance computing in theft detection of electricity by implementing parallelized algorithms for processing large data set with convincing results. However, most of the works done previously focused much on primary distribution network monitoring based on centralized approaches such as PLC and SCADA systems where the number of sensors and processors are relatively low, and programming were mainly done using low level languages with limited flexibilities and features. This study focuses on the SDN where the nature of the network is complex and sensors are installed ubiquitously along the network and hence enhanced algorithms are required to efficiently monitor the network. In addition, the study makes use of state of the art processors using high level programming languages allowing for easy deployment of complex and flexible algorithms.

### 3 Implementation Approach

#### 3.1 Study Area

The study was conducted at University of Dar es salaam, College of Information and Communication Technologies, herein referred to as Kijitonyama campus. The campus has three main building blocks namely, administration block (Block A), teaching block (Block B) and engineering block (Block D). The campus has one installed secondary distribution transformer and one main distribution panel rated 800 A, at the main power room, three subpanels installed at each building block. The rated values for block A, block B and block D are 200 A, 400 A and 150 A respectively.

#### 3.2 Challenge-Based Learning

This study adopted the use of the CBL approach where users who are the challenge owners (the utility company) were involved from the challenge identifications to the solution development. Out of Eight identified challenges [10], one challenge namely “*Inefficient faults clearance system in electrical secondary distribution*” was taken for consideration in this study. In achieving the objective, the solution was broken into three parts namely detection, communication and application. In each part, a number of researchers, depending on their expertise, were allocated specific tasks to handle and contribute to the solution development. A number of meetings among researchers, supervisors and stakeholders were held on weekly basis for brainstorming and presenting the progress.

#### 3.3 Data Flow Architecture

The proposed system for automatic faults detection and monitoring consists of Remote Sensing Units (RSU), Distribution Control Units (DCU), hybrid communication



network and control center as shown in Fig. 2. The system deployed the concept of distributed processing by having a number of processing units at different substations in the SDN namely, DCU. Through hybrid communication networks, the DCUs collect data from different RSUs, process the data and send to control center. RSUs are equipped with current sensors and voltage sensors placed on different remote branches or nodes on electrical SDN. RSU sensors collect data from the network and send them to the DCU. DCUs are equipped with a number of sensors including voltage, current, temperature and transformer oil level. The DCU in each secondary substation processes different types of faults including short circuit faults, overcurrent faults, over/under voltage faults, earth faults, transformer oil level faults and temperature faults. The processed information is sent to the control center for further analytics, storage and visualization through the communication network.

## 4 Fault Monitoring and Processing Algorithms Design

### 4.1 Sensing and Data Acquisition

Sensors form a very significant part of the automatic systems for faults detection, monitoring and control in electrical SDN by capturing the real-time states of systems or processes. In this study, sensors at RSU capture voltage and current parameters and those at DCU capture voltage, current, transformer temperatures and oil levels. Sensors provide analogue output voltage whose variations correspond to the variations on the physical parameters under monitoring. The output values are then conditioned and converted to digital values for further preprocessing before being transmitted to the DCU for processing as summarized in Fig. 2. The RSU has internal storage to temporarily store the recorded data when there is no communication. Current sensors and voltage sensors rated at 600 A and 600 V respectively were used at RSU while current sensors, voltage sensors, oil level sensor and temperature sensor rated at 1000 A, 600 V, 55 cm probe and 80 °C respectively were used at DCU. All sensors were calibrated prior to installation; Table 1 shows calibration values for current sensor rated at 600 A. These sensors were able to make the SDN visible and captured all types of faults under considerations in this study.

### 4.2 RSU Processing

RSUs consist of Data Acquisition (DAQ) module and Wi-Fi module. DAQ module is used for acquiring data from the sensors and the wireless (Wi-Fi) modules for enhancing communication between DCU and RSUs. The DCU Wi-Fi module sends data to the control center through wired network. The flow chart showing the basic program framework implemented at the RSU is shown in Fig. 1.

RSU establishes connection with the server at DCU, if the connection is successful it starts to read the data from the sensor and send data to the server continuously. If the error occurs, the system starts over to the initial point as shown in Fig. 2.

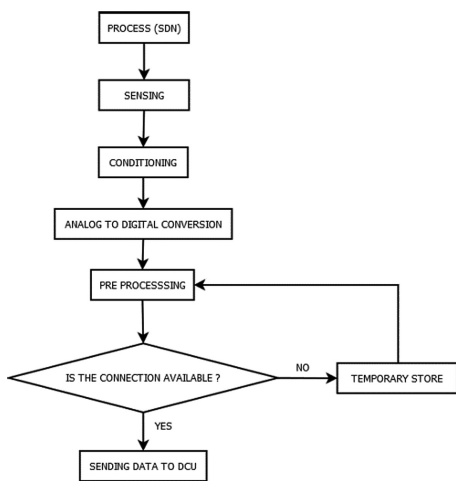


Fig. 1. The RSU processing algorithm

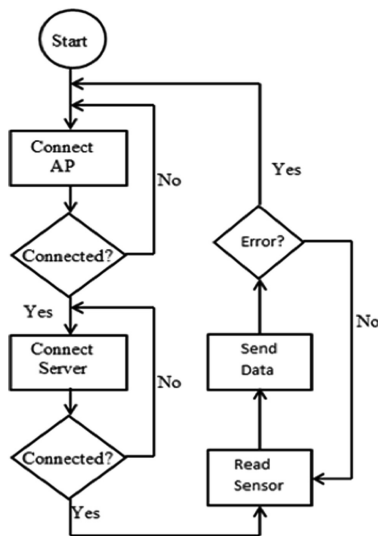


Fig. 2. DCU processing algorithm

Table 1. Calibration values of 600 A sensor

CHK600E KA5S2	Forward direction	Input current	0 A	100 A	200 A	300 A	400 A	500 A	600 A
		Output	2.5 V	2.5 + 0.33 3 V	2.5 + 0.66 6 V	2.5 + 1.0 V	2.5 + 1.33 3 V	2.5 + 1.66 6 V	2.5 + 2.0 V

### 4.3 DCU Processing

The DCU consists of Mini-computer (Raspberry Pi), DAQ module (Arduino Mega 2560) and Wi-Fi module. Each DCU has its respective RSUs which are connected as clients. The Mini-computer performs many functionalities and services in parallel. The program starts a server by which RSUs will connect to the DCU. The *Scan New Client* thread keeps waiting and validates the clients requesting for services from the server. The *Data Handler* acquires data, process data and temporarily store data into the database. Data is acquired from the local sensors at the DCU and from the remote RSUs. Data processing includes running fault detection algorithms, formatting the data for storage etc. The *send data thread* reads from database, send data to the control center and delete data from the database. The *Time Synchronization* thread is responsible for requesting the synchronization time from the control center and updates the DCU system clock.

### 4.4 Fault Detection, Classification and Localization

Figure 3 gives details of algorithms for fault detection and classification. Detection of different types of faults was done by comparing the threshold values and the measured values as shown in Table 2. Thresholds values for current, voltage, temperature and oil level for each fault were identified with the help of stakeholders and other relevant technical documentations. After fault detection and classification, the fault localization algorithm was triggered as shown in Fig. 4. The aim of the fault localization was to identify and visualize the area under the fault on the map.

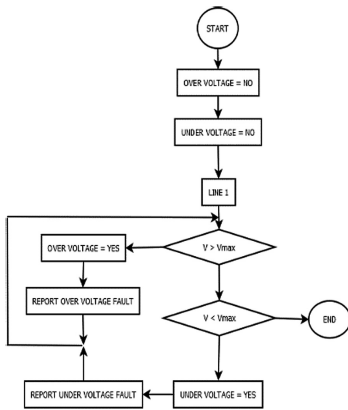


Fig. 3. Over/under voltage algorithm

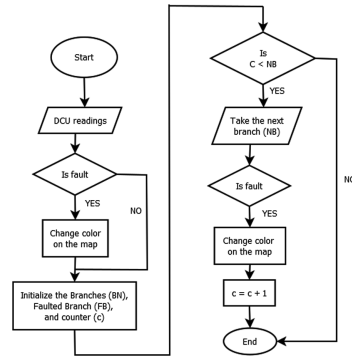


Fig. 4. Localization algorithm

Table 2. Reference threshold values in volts

Over/under voltage			
Condition	Voltage range(V)	Operating voltage(V)	Operations
Normal	230–220	252–242	Normal operations
		208–198	Normal operations
Under voltage	Below 198	Below 198	Fault
Over voltage	Above 252	Above 252	Fault

## 5 System Integration

### 5.1 Subsystems Integration

DCU, RSU and Control Center are considered as subsystems. The output of the RSU is the input of the DCU and the output of the DCU is the input of the Control Center. The wireless communication was used between RSU and DCU due to complexity and ubiquitous nature of the SDN while wired communication was used between DCU and Control Center for taking advantage of the existing infrastructure of the utility under the study.

## 5.2 Data Integration

The database architecture of the implemented system is comprised of two parts. The first part is the DCU database, which is designed to capture, aggregates and temporarily store real-time voltage and current measurements from RSUs, real-time voltage, current temperature, and oil level measured at the DCU. The second part of the database located at the control center (the main database) stores, copies and aggregates data from the DCUs through Message Queuing Agent (MQA) for permanent storage, analytics, visualization, and report generation.

## 5.3 External Systems Interfacing

The proposed system for automatic faults detection and monitoring was designed to collect data and store them to the system database. However, this developed system has to interact and communicate with other existing systems available at the utility company like customer call center and Geographic Information System (GIS) database, which hosts electrical network equipment information as well as customers' information. To enable this interoperability, a Representational State Transfer (REST) API to support information sharing was developed. However, due to the nature of the prototype only Hypertext Transfer Protocol (HTTP) based protocol was used such as HTTP GET and HTTP POST all database tables. The GET HTTP REQUEST returns a JavaScript Object Notation (JSON) file with the data from the database according to the given request when a correct API security key is supplied as shown in Fig. 5.

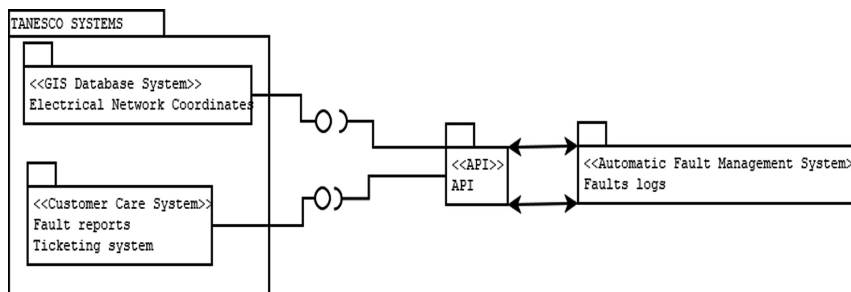


Fig. 5. External interfacing

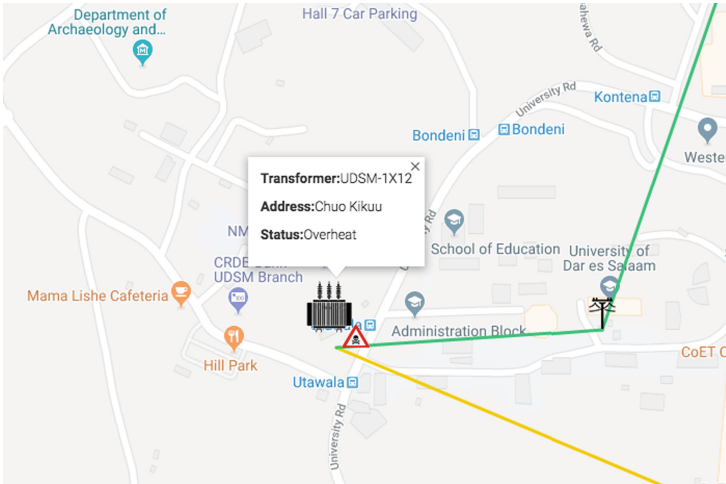
## 6 Results and Discussion

### 6.1 CBL Contributions

The discussions and meetings with stakeholders were useful in identifying the challenge, breaking down and allocation the tasks to researchers, and development of the solution. The process revealed a number of fault types which are commonly affecting the SDN. These faults were over/under voltage, over current, low oil level and high temperature. Thresholds were also identified for these types of faults.

## 6.2 Detection and Localization

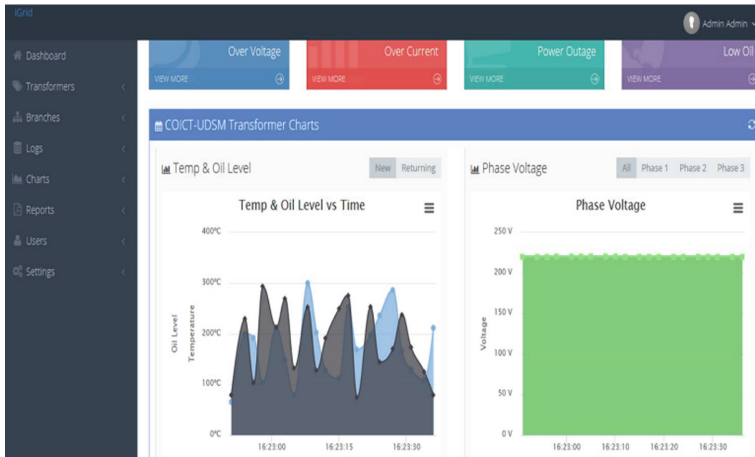
After implementing the algorithms represented by flowcharts in Sect. 4 the one line diagram for the distribution network at the demonstration site. Different fault types were identified, and faulty branch was differentiated from the normal branch by color codes as clearly stipulated in Fig. 6. Lines with faults were coded with red color, green color code for warning and black color for normal status. Upon clicking on the lines with color codes, further information can be obtained.



**Fig. 6.** Fault detection and location

## 6.3 Visualization

Owing to the nature, size and complexity of electric grid networks, visualizations provide means to comprehend the structure, functions and other crucial issues of the grid. In this work, two modules of visualizations were implemented. (i) Data analysis and summarization module, which is for analyzing live and the archived data. It interprets and notifies fault situations through screens at the control center as shown in Fig. 7. (ii) Presentation module pictorially presents current and history information regarding fault status and functionality using conventional graphs and other relevant metrics.



**Fig. 7.** Visualization modules

In this prototype visualization dashboard, the user, through menus, can graphically select the interested resources and metrics to view. One should be able to view status summary and fault information. Moreover, the prototype dashboard allows user to generate various reports, summary and other statistics of interest. The system can also monitor real time status of crucial equipment of the network like transformers, relays etc.

#### 6.4 System Integration

The developed REST API was able to provide interface to and from other existing systems. The system will send requested data between systems when a correct API call accompanied with correct security key were supplied. On the other hand, the incorrect API calls will cause a system to send a respective error, where incorrect security key was supplied. The security key was used to prevent unauthorized access to application data from other systems or third-part applications like mobile applications.

## 7 Conclusion and Future Work

In this paper, distributed algorithms for enhancing fault detection and monitoring in the electrical secondary distribution network have been presented. By adopting distributed processing architecture, sensing and data acquisition, fault detection and localization, and data processing and visualization, algorithms were prototyped and deployed in live network. Challenge based learning was adopted throughout development phases. The proposed system was able to remotely acquire and process data, then forward to the control center through hybrid communication system for further processing, visualization and storage. Simulated faults could easily be identified and analyzed. This shows that, distributed fault management systems based on distributed algorithms can

greatly enhance the monitoring of the SDN. Future work will focus on improving the system by adding control, resiliency, security, actualization and other intelligence-enhancing features. The system will also add extra integration mechanisms with other external systems such as GIS, DMS, SCADA, etc.

## References


1. Zidan, A., et al.: Fault detection, isolation, and service restoration in distribution systems: state-of-the-art and future trends. *IEEE Trans. Smart Grid* **8**(5), 2170–2185 (2017)
2. Palfi, J.: Localization of faults in low voltage networks by graph method. *IEEE Int. Symp. Appl. Comput. Intell.* **11**, 397–400 (2016)
3. Xu, Y., et al.: DGs for service restoration to critical loads in a secondary network. *IEEE Trans. Smart Grid* **PP**(8) (2017)
4. Bashier, E., Tayeb, M.: Faults detection in power systems using artificial neural network. *Am. J. Eng. Res.* **02**(06), 2320–2847 (2013)
5. Ferreira, E.F., Barros, J.D.: Faults monitoring system in the electric power grid of medium voltage. *Proc. Comput. Sci.* **130**, 696–703 (2018)
6. Kihwele, S., Hur, K., Kyaruzi, A.: Visions, scenarios and action plans towards next generation Tanzania power system, pp. 3908–3927 (2012)
7. Nunes, M., et al.: Fault detection and location in low voltage grids based on RF-mesh sensor networks. In: *CIREN Workshop*, no. 0389, pp. 1–4 (2016)
8. Shahidehpour, M., Wang, Y.: Parallel and distributed processing of power systems. In: *Communication and Control in Electric Power Systems*, pp. 47–100. Wiley, Hoboken (2005)
9. Ramesh, V.C.: On distributed computing for on-line power system applications. *Int. J. Electr. Power Energy Syst.* **18**(8), 527–533 (1996)
10. Ibwe, K.S., Kalinga, E.A., Mvungi, N.H., Tenhunen, H., Taajamaa, V.: The impact of industry participation on challenge based learning\*. *Int. J. Eng. Educ.* **34**(1), 187–200 (2018)
11. Hogfeldt, A.K., Gumaelius, L., Lantz, A., Lujara, S.: Understanding engineering education change with the introduction of challenge driven education in Tanzania. In: *IEEE Global Engineering Education Conference (EDUCON)*, April 2018, pp. 1335–1343 (2018)
12. Tatietsa, T.T., Voufo, J.: Fault diagnosis on medium voltage (MV) electric power distribution networks: the case of the downstream network of the AES-SONEL Ngousso sub-station. *Energies* **2**(2), 243–257 (2009)
13. Prasad, A., Edward, J.B., Ravi, K.: A review on fault classification methodologies in power transmission systems: part—I. *J. Electr. Syst. Inf. Technol.* **5**(1), 48–60 (2017)
14. Hao, X., Meng, Z., Huang, W., Tao, T., Wang, Y.: The fault location method of distribution network with fault indicators based on impedance. In: *International Conference on AMCCE 2015*, pp. 386–391 (2015)
15. Estebasari, A., Pons, E., Bompard, E.: An improved fault location method for distribution networks exploiting emerging LV smart meters. In: *IEEE Workshop on Environmental, Energy, and Structural Monitoring Systems*, pp. 1–6 (2016)
16. Majidi, M., Arabali, A., Etezadi-Amoli, M.: Fault location in distribution networks by compressive sensing. *IEEE Trans. Power Deliv.* **30**(4), 1761–1769 (2015)
17. Adewole, A.C., Tzoneva, R., Behardien, S.: Distribution network fault section identification and fault location using wavelet entropy and neural networks. *Appl. Soft Comput. J.* **46**, 296–306 (2016)

18. Liao, Y.: Identification of faulted feeder section in distribution systems using overcurrent information from switching devices. *Int. J. Emerg. Electr. Power Syst.* **15**(2), 171–176 (2014)
19. Green, R.C., Wang, L., Alam, M.: Applications and trends of high performance computing for electric power systems: focusing on smart grid. *IEEE Trans. Smart Grid* **4**(2), 922–931 (2013)
20. Popovic, T., Kezunovic, M., Krstajic, B.: Implementation requirements for automated fault data analytics in power systems. *Int. Trans. Electr. Energy Syst.* **36**, 51–66 (2014)
21. Ponsa, P., Vilanova, R., Pérez, À., Andonovski, B.: SCADA design in automation systems. In: 3rd International Conference on Human System Interaction, HSI 2010, May, pp. 695–700 (2010)
22. Randy Miller, H.: Advances in SCADA and RTU technology for next generation operators. *Automation* (2014)
23. Sooley, B.P.: The future of SCADA system. *Florida Water Resour. J.* **1**, 30–34 (2011)
24. Ubirajara, J., De Nunes, N., Bretas, A.S.: An extended fault location formulation for unbalanced distribution feeders with distributed generation, no. 1 (2010)
25. Divyapradeepa, T.: Fault diagnosis on distribution system using PLC & SCADA. *Int. J. Innov. Res. Sci. Eng. Technol.* **6**(11), 21393–21401 (2017)
26. Teng, J.-H., Luan, S.-W., Huang, W.-H., Lee, D.-J., Huang, Y.-F.: A cost-effective fault management system for distribution systems with distributed generators. *Int. J. Electr. Power Energy Syst.* **65**, 357–366 (2015)
27. Depuru, S.S.S.R., Wang, L., Devabhaktuni, V., Green, R.C.: High performance computing or detection of electricity theft. *Int. J. Electr. Power Energy Syst.* **47**, 21–30 (2013)





# Handover Management in Femtocell LTE Networks Under Fast Varying Channels

Catherine Protas and Kwame Ibwe<sup>(✉)</sup> 

College of ICT, University of Dar es Salaam, Dar es Salaam, Tanzania  
catherineprotas@yahoo.com, kwame.ibwe@udsm.ac.tz

**Abstract.** To increase network capacity of a mobile communication system, three main ways can be derived from Claude Shannon equation. These are the use of smaller cells, increase of bandwidth and improvement of communication technology. Since there is only a finite amount of radio spectrum available and it is also required by other applications, there are limits to bandwidth increment. Combining the later and former, LTE small cells method is best practical way to increase system capacity of mobile communication system. However, deployment of femtocells with small coverage range leads to frequent handover initiation. The problem escalates when femtocells operate in open access mode while accommodating highly mobile users who initiate unnecessary handovers as they stay in a femtocell for short time. To tackle these challenges, a hybrid handover decision algorithm is presented. The proposed algorithm selects the most appropriate target femtocell for handover using velocity of the user, throughput gain and adaptation of signal averaging and hysteresis margin methods. Simulation results show 1.7 times reduction in the amount of handovers in comparison with the traditional handover schemes.

**Keywords:** LTE network · Femtocell · Throughput · Velocity · Hysteresis margin · Femtocell to femtocell handover · Open access · Received signal strength · Quality of service

## 1 Introduction

To increase network capacity of a mobile communication system, three main ways can be derived from Claude Shannon equation. These are the use of smaller cells, increase of bandwidth and improvement of communication technology. Since there is only a finite amount of radio spectrum available and it is also required by other applications, there are limits to bandwidth increment. Combining the later and former, LTE small cells method is best practical way to increase system capacity of mobile communication system. These small cells are called femtocells [1]. Femtocells are used to improve the signal quality indoors where the signal from the nearby Macrocell Base Station (MBS) is weak. The femtocell is a miniature base station with very low power connected to the MBS using broadband wireline connections, optical fibers or optical wireless last mile technologies [2–4]. In the femtocell coverage area, the user can access the network through three main ways. These are open, closed and hybrid. The open access allows maximum share of the full capacity of the femtocell by all users in

its coverage area. The advantage of this method is on the offloading the MBS by serving several outdoor users in areas with heavy traffic or those users which are far from the MBS. For closed access, only mobile equipment belonging to the owner of the femtocell or a small group of users is allowed to access the network. Other users cannot access the network through these femtocells. The hybrid access is combination of both, open and closed accesses. This means part of the femtocell bandwidth is dedicated to a small group of users and the rest is shared by other users [5]. Femtocell increases capacity by offloading traffic from the macrocell base station. Typical coverage area of a femtocell is a few tens of meters. In densely populated areas deployment of femtocells is an ultimate objective. However dense deployment of these small cells in a small coverage area, causes strong interference and frequent handovers. As the coverage of femtocells and macrocell overlap, the handover is initiated more frequently since user equipment (UE) can receive signal from both cells. To support seamless mobility in femtocell networks, efficient handover mechanisms are essential since the traditional handover algorithm used in macrocell cannot cope with user mobility in these networks. Three different handover scenario can be distinguished in femtocell networks: inter-femtocell (handover between two femtocells), hand-in (handover from the macrocell to femtocell) and hand-out (handover from femtocell to macrocell). In hand-out scenario the UE has only one possible target to handover which simplify the process. But inter-femtocell and hand-in handovers are complex due to many candidates to which the ME can be handed over. UEs encounter frequent handovers due to small coverage range and high density of deployed femtocells. The frequency of handover increases for high moving MEs since these users stay in a femtocell coverage area for a short time. Frequent and unnecessary handovers cause increase in the signaling overhead and reduction of both users's Quality of Service (QoS) and system's capacity [6]. In conventional handover techniques, decisions are made solely on signal levels i.e. Received Signal Strength (RSS) or Signal to Interference plus Noise Ratio (SINR). Thus proposing an efficient handover decision algorithm is essential, which will ensure unaffected QoS for mobile users, improve network performance and minimize the number of frequent handovers in femtocell networks. Efficient handover means handover technique that is fast and not initiated redundantly but only in cases where it is necessary to maintain higher QoS, to the target base station that will maintain the longest connection and improve the network performance. In order to maintain network performance and reduce the number of initiated handovers, the velocity of the user and throughput gain acquired by performing the handover should be considered.

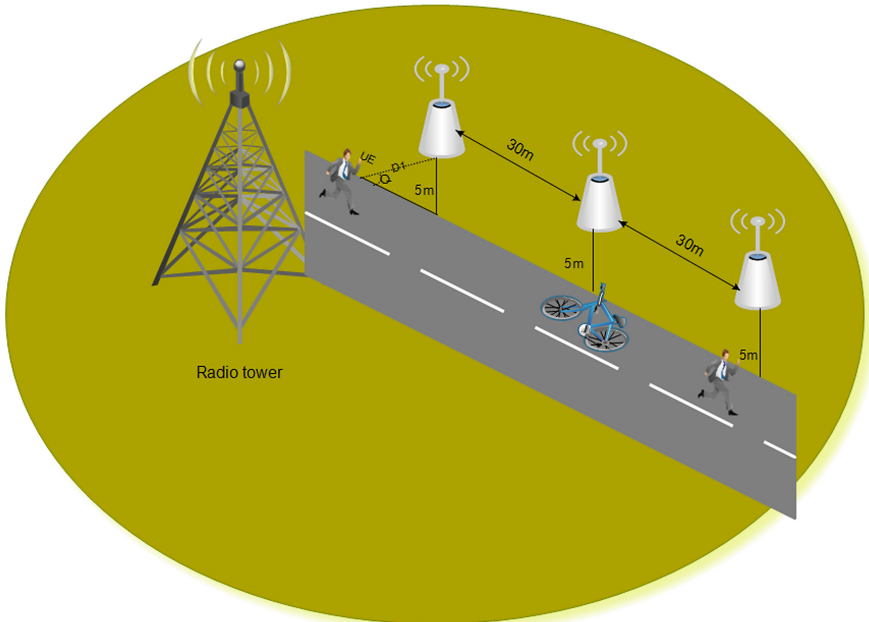
In conventional networks without femtocells several techniques have been introduced to eliminate redundant handovers. These are Hysteresis Margin (HM), Handover Delay Timer (HDT) and Windowing (also known as signal averaging). Authors in [7, 8] suggest that these techniques can be implemented in femtocell networks. Both papers demonstrate reduction of an amount of redundant handovers but could not account on a negative impact of the techniques on drop of throughput. In [9] adaptive HM is proposed which uses Carrier to Interference plus Noise Ratio (CINR) levels for

adaptation of the actual value of HM. The approach strengthens throughput but does not decrease the amount of handovers. The authors of [10] propose an efficient handover algorithm which uses available data volume as a decision criterion to eliminate frequent handovers in integrated macro-femtocell networks. Reference [11] suggests an asymmetric handover scheme which uses the Double Threshold Algorithm (DTH) and the call admission control scheme to reduce the number of unnecessary handovers between macrocell and femtocell. Both are successful in reducing the frequency of handovers but at an expense of throughput drop. The authors in [12] propose a handover strategy to minimize the number of handovers which considers the RSS, SINR, bandwidth and velocity of UEs as handover decision criteria. Reference [13] analyses an LTE based handover decision criteria and proposes a reactive mechanism to reduce frequent handovers and postpone handovers as long as possible. The handover is triggered if the UE almost loses the signal from serving femto access point. Reference [14] further proposes handover decision scheme for femto/macrocell overlay networks that includes the velocity and the RSS into the handover decision to reduce unnecessary handovers to a femtocell. Authors in [15] proposes femtocell – to – femtocell handover algorithm in an LTE-based network with open access mode. The authors assume random distribution of femtocells on both sides of a direct street within the coverage area of a macrocell. The target femtocell is chosen in such a way that the time interval between successive handover triggers is extended and consequently reducing the number of handovers during a call connection. The algorithm manages to reduce the number of handovers but fail to adapt the threshold parameter according to the channel quality related to the user's position in the cell.

In this paper a hybrid handover decision algorithm based on the work done in [10] is proposed. The aim is to reduce the number of femtocell – to – femtocell handovers in an LTE – based network. The proposed method uses velocity of the user, throughput gain and adaptation of windowing and HDT methods proposed in [4] and [6] respectively, for choosing appropriate target femtocell. The handover decision is based on the investigation of user's velocity, throughput gain estimated from the evolution of the signal levels of all involved cells measured by the UE and dynamic threshold power level based on the adaptation of windowing and HDT methods. The rest of the paper is organized as follows: the next section describes the system model and the principles elimination of redundant handovers. The third section presents the proposed algorithm which reduces the number of unnecessary handovers in LTE femtocell networks. The section four evaluates the performance of the proposed algorithm and finally section five presents the conclusion remarks.

## 2 System Model

The proposed handover algorithm, in this paper, considers an LTE macrocell-femtocell network that consist of one mobile user equipment,  $N$  femtocells and one base station illustrated in Fig. 1. The first femtocell is deployed at a distance  $D$  meters from the user



**Fig. 1.** Design overview of femtocell/macrocell in LTE system model

equipment (UE) and the other  $N - 1$  femtocells at a distance of 30 m from each other, mimicking true urban environment. It is assumed the transmit power is 2 dB and the user equipment moves with different velocities i.e.  $V_1, V_2, V_3$  etc. along the street. All femtocells operate in the open access mode in which any UE is allowed to access any femtocell that is close to it. It is also assumed that femtocells and the base station are synchronized and occupy the same spectrum in communicating to user equipment. Redundant handover represents a case when the handover is initiated but it is not completed before the next handover decision criteria is met. It is also caused by short time channel variation, fast fading or the movement of user along the edge of two neighboring cells. In handover decision it is assumed that the UE periodically sends its position to the serving femtocell when the user is moving. All femtocells will be registered with an ID for identification, the velocity of the user and all other important parameters was observed. Obtained information is kept in a database in order to know the target femtocell with minimum received signal strength as the serving cell seeks all possible target cells. The UE will also record the cell ID, RSSI value and the time of encounter for all femtocells as it moves across the street shown in Fig. 1. This information will be recorded in set denoted in this work as Set 1. The instantaneous distance of the UE from any femtocell is governed by the following equation:

$$D = \sqrt{\left( \left( d_F - \left( \frac{U_o + V}{2} \right) t \right)^2 + 25 \right)} \tag{1}$$

where  $D$  = UE-Femtocell distance,  $t$  = time in seconds  $U_o$ = Initial velocity,  $d_F$  = initial UE - femtocell distance  $V$  = Velocity at time  $t$  The handover process is triggered when power of the serving femtocell falls below threshold. Hence, the process is initiated by comparing the average power of the served,  $P_{av}^{Tar}$  and the target,  $P_{av}^{Ser}$  femtocell;

$$P_{av}^{Tar} > P_{av}^{Ser} \tag{2}$$

From the inverse square law, the received power decreases in proportional to the square of the distance from the transmitting antenna. Taking into consideration the transmitter and receiver antenna gains, and the Doppler effect due to user mobility, the received power is given as;

$$P_{rx} = P_{tx} G_{tx} G_{rx} \left[ \frac{c^4}{\left( 4\pi \left( d_F - \left( \frac{U_o + V}{2} \right) t \right)^2 + 25 \right)^2 [(C + V \cos \theta)^2] f_o^2} \right] \tag{3}$$

where  $C$  is speed of light,  $G_{tx}$  and  $G_{rx}$  are transmit and receive antenna gains respectively,  $\lambda$  is the wavelength,  $d$  is the transmitter-receiver separation,  $P_{tx}$  is the transmitted power,  $P_{rx}$  is the received power and  $C$  = speed of light,  $f_o$  = fundamental frequency. The comparison of the average values of power in Eq. 2 are taken using specific number of samples as;

$$\frac{\sum_{i=1}^{WS} P_{av,i}^{Tr}}{WS} > \frac{\sum_{i=1}^{WS} P_{av,i}^{Ser}}{WS} \tag{4}$$

The Window Size (WS) is obtained as shown in [5] as;

$$WS = \max \left\{ WS_{\max} x \left( 1 - 10^{\frac{CINR_{act} - CINR_{\min}}{CINR_{\min} - CINR_{\max}}} \right)^4 ; 0 \right\} \tag{5}$$

The value of WS is obtained based on the user’s position in the cell coverage. The signal characteristics depend on the user’s position in the cell, hence, carrier to interference noise power ratio (CINR) is used to estimate WS value. The CINRact depend on actual channel state, while CINRmin and CINRmax are derived from all cells in Set 1.

The estimation of the target and serving femtocell power in (4) is done to eliminate the instantaneous variations due to varying channel power profile. The channel model used in this work is presented in [9] as;

$$h(t, \tau) = \sum_n a_n(t) e^{j\varphi_n(t)} \cdot e^{j\varphi_n(t)} \cdot \delta(\tau - \tau_n) \quad (6)$$

The channel in (6) is modelled as wide sense stationary uncorrelated scattering process, where the time variability is independent of that of frequency variability. Traditional handover practice chooses the strongest candidate after satisfying Eq. (7). However, handover is not completed until the hysteresis margin (HM) test is passed as presented in [6];

$$P_{av}^{Tar} > P_{av}^{Ser} + HM \quad (7)$$

But assigning threshold values of HM does not consider the user's position in the cell. This practice assumes constant channel power profile leading to erroneous triggering or dropping of the call. Further the adaptation of HM proposed in [4] is also not realistic as the cell radius of the cell and the instantaneous distance from the cell is not known. The best alternative is to introduce the handover delay time (HDT) as proposed in [5].

$$P_{av}^{Tar} > P_{av}^{Ser} | t \in t_{ho}, t_{ho} + HDT \quad (8)$$

The actual value of HDT should be estimated as;

$$HDT = \max \left\{ HDT_{\max} \cdot x \left( 1 - 10^{\frac{CINR_{act} - CINR_{\min}}{CINR_{\min} - CINR_{\max}}} \right)^4 ; 0 \right\} \quad (9)$$

In [10] the faraway target femtocell is chosen after condition (8) is met and the velocity is below 15 km/h otherwise the macrocell is taken. The authors in [10] do not show how the faraway cell will be selected if more than three femtocells have been visited. To avoid this weakness, the time records of the visited cells are used in this work to select the faraway cell. Hence, when condition in (8) is met and velocity is below 15 km/h, the farthest femtocell with minimum power is selected in Set 1 with recent time record. The time records selected should not be more than 40 s old. The received power selection criteria will be:

$$P_{av}^T = \left\{ \min \left( P_{av,i}^T \right) \geq P_{th} \right\}, \quad i \in \{0, 1, 2, \dots, N\} \quad (10)$$

The algorithm in Table 1 summarizes the proposed seamless femtocell to femtocell handover algorithm ideal for highly changing channels.

If neither of the conditions in step (8) through (10) are not met and serving received power is below threshold, the user is handed over to macrocell.

**Table 1.** Proposed femtocell-femtocell handover algorithm

---

1. Initialize: RSS values from available femtocells  
 UE is connected to the first femtocell

**Start**

2. Measure and record RSS and time values of nearby femtocells storing them in Set 1.

3. Handover is triggered if  $P_r^S < P_{th}$

4. Handover process initiated by comparing  $P_{r,av}^T > P_{r,av}^S$ . The average values are estimated as  $\frac{\sum_{i=1}^{WS} P_{r,i}^T}{WS} > \frac{\sum_{i=1}^{WS} P_{r,i}^S}{WS}$  and window size estimated as

$$WS = \max \left\{ WS_{\max} \times \left( 1 - 10^{\frac{CINR_{act} - CINR_{\min}}{CINR_{\min} - CINR_{\max}}} \right)^4 ; 0 \right\}$$

5. Handover Delay Time (HDT) is set:

$$HDT = \max \left\{ HDT_{\max} \times \left( 1 - 10^{\frac{CINR_{act} - CINR_{\min}}{CINR_{\min} - CINR_{\max}}} \right)^4 \right\}$$

6. Handover is not implemented until HDT check is implemented to avoid short channel changes:  $P_r^S < P_r^{Tar} \mid t \in (t_{HO}, t_{HO} + HDT)$

7. When  $t_{HO} + HDT$  elapses AND condition (4) holds then handover is made.

8. Velocity of the user is examined, if  $v \geq 15km/hr$ , the user is handed over to macrocel.

9. Step (2) is repeated and Set 1 is updated.

10. If the RSS value from Set 1 is minimum (equal to threshold or just above;  $P_{tar} \geq P_{th}$ ) and the time label is current, the selected femtocell is the target.

**11. End**

---

Figure 2 shows the flow chart illustrating the flow which was carried out during the algorithm development.

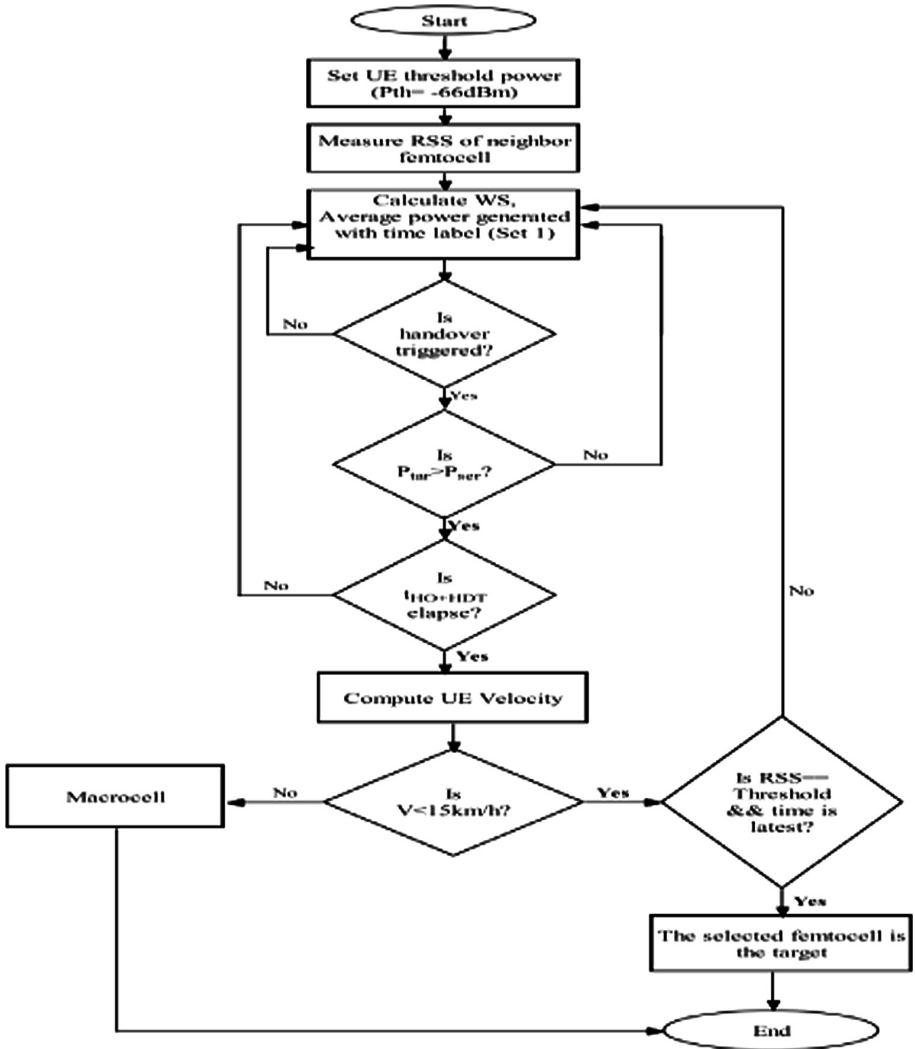


Fig. 2. Flow chart of developed algorithm

### 3 Simulation Results

In this section, the performance of the proposed algorithm is evaluated based on the setup shown in Fig. 1. The proposed seamless handover algorithm is simulated using MATLAB software. It is carried out with the support of LTE Simulink. LTE Simulink provides different functions like MCS, bandwidth, selection of macrocell and femto-cell, transmit power, transmit antenna port and number of downlink RB. Therefore, simulation is done by selecting the appropriate parameters as provided in MATLAB LTE Simulink. The simulation parameters are summarized in Table 2.

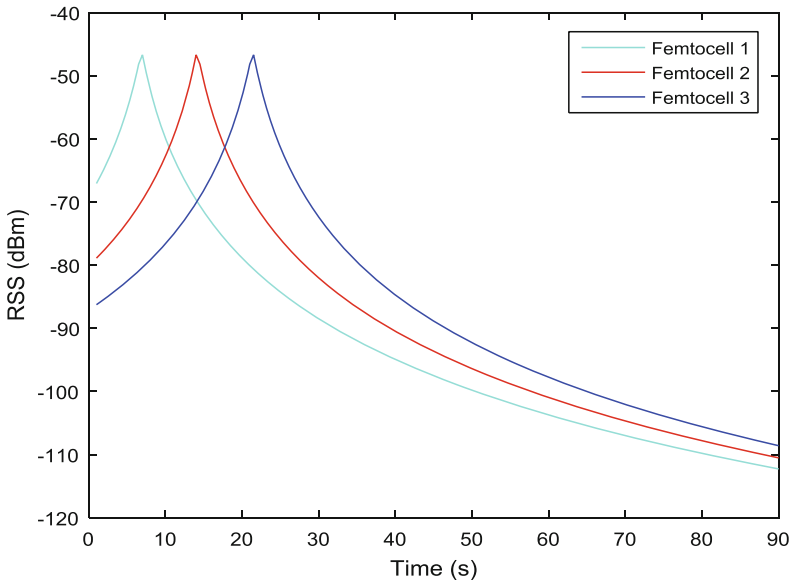


During simulation process, results are gathered and all important data collected after averaging 100 simulation runs for each experiment. Results for all performance parameters are collected and presented in plot forms. It is assumed that the user moves with an initial speed  $v$  along the straight street shown in Fig. 1 and all handovers are performed successfully.

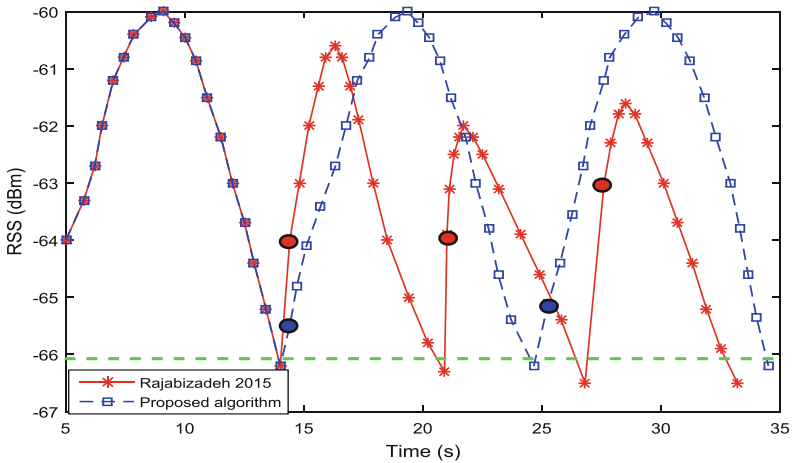
**Table 2.** Simulation parameters for handover setting in Fig. 1

Parameter	Assumption/value
Femtocell transmit power	20 dBm
Macrocell transmit power	48 dBm
Velocity of the UE	1 km/h–15 km/h
Window size	5
Frequency	2 GHz
Handover delay time	65 ms
Initial distance	15 m
Threshold power ( $P_{th}$ )	-66 dBm
Femtocell coverage (Radius)	30 m
Macrocell coverage radius	1 km

In Fig. 3, the effect of speed is examined on the received power profile of the first three femtocells in the direction of the user. When the user crosses the first femtocell the power profile starts to increase, the UE attains its maximum power for the second femtocell at  $t = 14.2$  s, at a distance of 30 m from the peak of the first femtocell. Also UE attains its maximum power at  $t = 21.2$  s at a distance of 30 m from the second femtocell and 60 m from the first femtocell. Once the user is moving away from femtocell one, the power profile starts to decrease, the same apply to femtocell 2 and femtocell 3. These closely time spaced handovers are termed as frequent handovers due to their close proximity. Employing the proposed algorithm which is the improved version of the work done in [10], reduces the frequency of the handovers as observed in Fig. 4. The assumption for Fig. 4 is that the first serving femtocell is the same for both proposed and existing algorithms. The first handover is initiated at 14.4 s for both the proposed and the existing algorithm, this is shown by black circles with blue face color for proposed and black circles with red face color for the existing. After performing the first handover, the proposed algorithm selects the farthest femtocell (femtocell with minimum threshold) and also implementing HDT and WS to avoid instantaneous variations, it takes 11.1 s to trigger for next handover at 25.5 s with minimum RSS of -65.1 dBm nearly the threshold value. The existing algorithm takes 6.6 s to trigger the next handover at 21 s with RSS value of -62.2 dBm. Thus, for the proposed algorithm the UE stays in the serving femtocell coverage area for longer duration before triggering for the next handover. The proposed algorithm allows the UE to stay longer duration by extending time to trigger handover while the existing algorithm takes shorter time, hence proposed algorithm reduce redundant handovers by 1.7 times compared to existing ones.



**Fig. 3.** Received power profile for user moving at 15 km/hr



**Fig. 4.** The received power profile for serving femtocell versus time

In Fig. 5, throughput efficiency is examined as the user moves at a speed of 11 km/hr. The throughput is measured as the number of packets transmitted successfully per unit time. The defined time indicates the time elapsing after handover has been initiated. When the handover is initiated the UE is connected to the farthest serving femtocell and throughput is observed, as the user is moving towards the femtocell, throughput starts to increase to its maximum value. It takes 6 s for the UE to attain its

maximum value of 0.959 Mbps for the proposed algorithm as the UE is closest to the femtocell but the existing algorithm takes longer time to converge at 8 s for 0.788 Mbps, that shows 17% throughput improvement. It takes 3 s after throughput has reached its maximum value to deteriorate for the proposed algorithm and 1 s for the existing system, as the user is approaching the edges of the cell coverage and expecting another handover to take place.

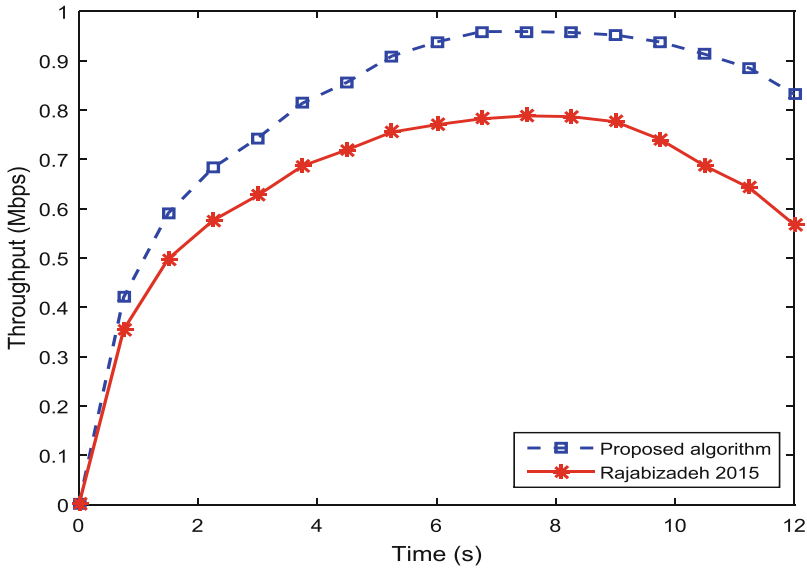


Fig. 5. Throughput performance with user speed of 11 km/hr

## 4 Conclusion

In this paper, the problem of frequent femtocell to femtocell handover in LTE network is addressed. The setup consisted of one macrocell and several femtocell in an open access mode. The seamless handover algorithm is proposed whose decision is based on the velocity, time, RSS value, window size, hysteresis margin and the set HDT. This is an improvement made on the works of [10]. Simulation results show that proposed algorithm reduces the unnecessary handovers by increasing the time intervals 1.7 times compared to existing one. It also improves throughput performance by 17% compared to existing algorithm when the user moves at a speed of 11 km/hr.




The proposed system reduces handover in femtocells when a UE is moving at a speed less than or equal to 15 km/h, this is because the coverage area of femtocell is very small that makes a UE to stay in a femtocell for a very short time. The future work will be focused on reducing handover for very high speed users at a speed greater than 15 km/h in order to increase performance and efficiency of the system.

## References

1. Ahammad, P., et al.: Claude shannon and a mathematical theory of communication, 1–12 (2004)
2. Amsalekha, P.: Seamless handover for integrated LTE macrocell-femtocell. **3**(1), 6–11 (2015)
3. Antipolis, S.: ETSI TR 136 912, 1 (2012)
4. Becvar, Z., Mach, P.: Adaptive hysteresis margin for handover in femtocell networks (2010)
5. Becvar, Z., Mach, P.: Adaptive techniques for elimination of redundant handovers in femtocells., pp. 230–234 (2011)
6. Becvar, Z., Mach, P.: Mitigation of redundant handovers to femtocells by estimation of throughput gain. *Mob. Inf. Syst.* **9**, 315–330 (2013)
7. Beming, P., Frid, L.: LTE-SAE architecture and performance. *Ericsson Rev.* **3**, 98–104 (2011)
8. Bhargavi, P.V.: A novel handover algorithm for LTE N based macro-femto heterogenous networks **6**(4), 25–33 (2015)
9. Chavan, M.S., Sawant, S.R.: Multipath fading channel modeling and performance comparison of wireless channel models. *Int. J. Electron. Commun. Eng.* **4**(2), 189–203 (2011)
10. Rajabizadeh, M., Abouei, J.: An efficient femtocell-to-femtocell handover decision algorithm in LTE femtocell networks, pp. 213–218 (2015)
11. Chen, J., Rauber, P.: Femtocells – Architecture & Network Aspects, pp. 1–7 (2010)
12. Chowdhury, M.Z., Haas, Z.J.: Cost-effective frequency planning for capacity enhancement of femtocellular networks, pp. 1–22 (2011)
13. Chowdhury, M.Z., Jang, Y.M., Haas, Z.J.: Network evolution and QOS provisioning for integrated femtocell/macrocell networks, August 2010
14. Cox: An introduction to LTE and 4G mobile Communication (2012)
15. Ekwe, O.A.: Effective fading reduction techniques in wireless communication system. *IOSR J. Electron. Commun. Eng.* **9**(4), 35–43 (2014)



# Trends and Opportunities for Traffic Engineering Paradigms Across Mobile Cellular Network Generations

Khadija Mkocha<sup>(✉)</sup> , Mussa M. Kissaka , and Omar F. Hamad 

University of Dar es Salaam, Dar es Salaam, Tanzania  
kmkocha@udsm.ac.tz, mkissaka@yahoo.com,  
omarfh@gmail.com

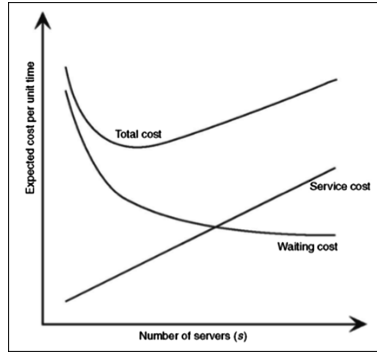
**Abstract.** Traffic engineering is at the heart of telecommunications engineering. In telecommunication engineering, we have recently experienced a revolution in the form of mobile cellular network generations. History shows a close relationship between the advancements in both telecommunications networks and their corresponding engineering methods. This survey employed qualitative document analysis to chronologically explore the evolution of, and interrelationships between traffic engineering and the mobile cellular networks from 1990s to date. It is evidently a case of the causality dilemma on which of the two influences the other. Nevertheless, we are currently at the right point in time to make giant leaps in both traffic engineering methods and network technology revolution. This study points out the opportunities that the current state of affairs avails to research in these fields.

**Keywords:** Teletraffic engineering · Mobile cellular generations · Erlang · Engset · Next generation networks

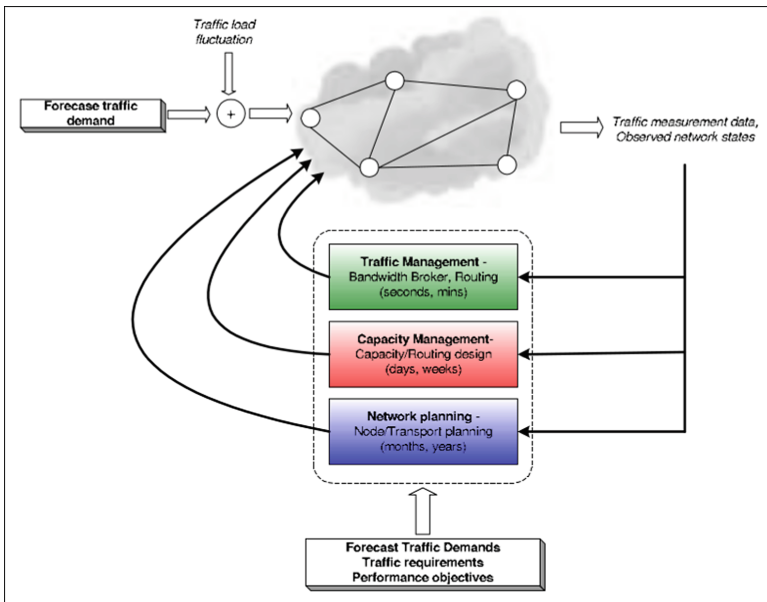
## 1 Introduction

Traffic engineering (TE) has its roots in voice telephony as a result of groundbreaking work by Erlang [1]. Its usefulness is however still as important in today's telecommunications systems if not more [2]. Although the general objective has remained the same, there are significant changes to how TE is implemented across networks available today. The main objective of TE is to optimize the service demands to the available resources without compromising the service quality [3]. This concept is illustrated in Fig. 1.

Queuing theory is consequently a useful tool that meets the previously mentioned objective in the analysis and design of telecommunication networks [3, 4]. It allows for the analytical determination of the relationships existing among the three aspects of the performance triangle, namely the demand (traffic), the system performance (QoS), and the network capabilities [3]. In the context of telecommunications queues, this field has advanced into a discipline commonly referred to as teletraffic engineering. Figure 2 is a summary of the processes involved with emphasis on the relevant timescales of operation within the network.



**Fig. 1.** Network planning as an optimization problem (Source: [1])



**Fig. 2.** Traffic engineering concepts and activities (Source: [5])

In mobile cellular networks (MCNs), TE has shown evolution slower than the speed of the deployment of advances in the networks where the most important concerns for network operators have been making wireless transmission possible with adequate coverage [6]. Moreover, value has shifted from service quality to service ubiquity, and this shift together with bureaucracies involved in wireless resource acquisition, has made design with overprovisioning and short term mobile station set ups more lucrative than the trouble of TE.

As a result of the complex relationship between the evolution of mobile cellular technologies and the corresponding shifts in TE paradigms, challenges have kept emerging on both sides. TE concepts, tools and methods have driven technology change

at one point, and at a pivotal point in history, technology has taken over, with TE trying to catch up. This is one opportunity where TE can be revolutionized to earn back its reputation as it was during Erlang’s era. On the other hand, the extremely fast evolution of technology, higher network capacities and much better network availability signal for a new era in service design and the consequent birth of new usage scenarios. There is also a significant opportunity in the definition of standards in the next generation networks, especially for African standardization organizations which have so far not actively participated in this exercise before. The next killer up is on the horizons.

This paper examines the changes in TE paradigms across mobile cellular network generations, emphasizing on the interrelationship between the changes in TE practices and the cellular generation changes. It attempts to predict possible future directions in both. The study will help to point out opportunities that are available to researchers in these fields.

## 2 Literature Review

### 2.1 The Evolution of Mobile Cellular Networks

MCNs have evolved from the first generation analog cellular systems (1G) in 1980s to the anytime, anywhere, any service fifth generation (5G) networks to be launched in 2020 [7]. 1G networks were essentially the PSTN’s Wireless Local Loops with mobility. The second generation (2G) saw the now digital MCNs becoming commercially viable, though still predominantly voice centric. The speedy and deep proliferation of connectivity, the demand for better and more demanding services resulted into the data centric, packet switched third generation (3G) of MCNs [7, 8, 10]. In Tanzania, and most other places in Africa, this is the predominant implementation of mobile technology. The fourth generation (4G) brought about even higher data transmission speeds, allowing inter-networking between mobile networks and other wireless access technologies, seamlessly, across multiple, different devices. These

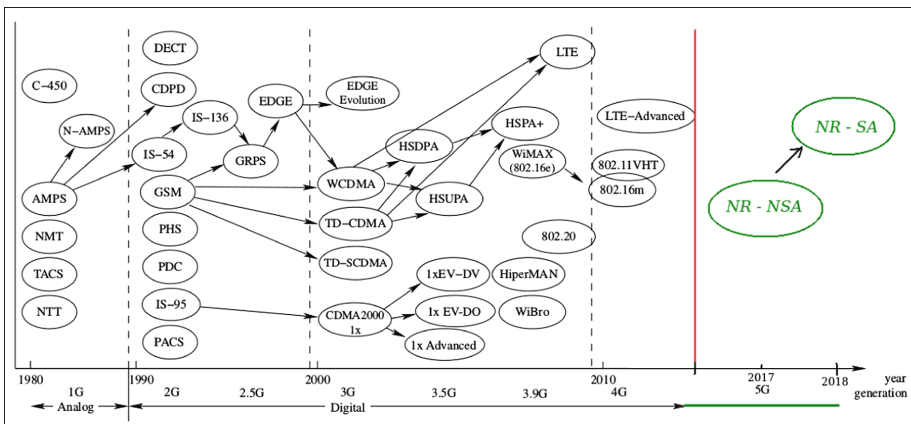


Fig. 3. The evolution of mobile cellular networks (Source: [7])

capabilities are expected to be even more enhanced in the fifth generation (5G) [7, 8]. Figure 3 illustrates the evolution of these standards.

Across the generations, one sees a shift from voice centric, to data centric, and potentially, user centric networks. From being circuit switched networks, these networks have also adopted packet switching to accommodate the increasing multimedia, and even hypermedia traffic data traffic. Previously these changes, had been driven by advances in technology, whereas now user demand drives the advances in technology. Table 1 summarizes the important features of the mobile cellular systems across their generations.

**Table 1.** Salient features of mobile cellular systems across generations (Source: [9, 37]).

Generation	Year	Services	Technology	Speed	Frequency	Description
0G	1960s (pre-cellular wireless system)	Voice only	Mobile radio telephone system	14.4–19.2 Kbps	160 MHz	Large high power cells. No communication away from the boomer cell coverage area
1G (AMPS, NMT)	1980	Voice only	Analog	1–2.4 Kbps	800–900 MHz	Introduction of cellular concept
2G	1990	Digital Voice	TDMA, CDMA digital wireless	14–64 Kbps	850–1900 MHz	SMS + voice calls, roaming, call forwarding and call hold introduced, cellular communications commercially
2.5G (GPRS, CDMA 2000)	2000	MMS, Internet	GPRS	115 Kbps	850–1900 MHz	MMS, mobile gaming, access to emails
2.75G (EDGE)	2003	MMS, Internet	EDGE	384 Kbps	850–1900 MHz	Services similar to those of 2.5G
3G (UMTS)	2000	Voice, data, Internet, videos, gaming at high speed	CDMA, Broadband	384 Kbps to 2 Mbps	8–2.5 GHz	Low cost, high data transmission, multimedia services
3.5G (HSDPA, HSUPA (HSPA 3.6), CDMA EV - DO)	2003	Voice, data, Internet, videos, gaming at high speed	HSDPA	14 Mbps	8–2.5 GHz	Services similar to 3G
3.75G (HSPA + (HSPA 7.2))	2003	Multimedia and Internet at high speed	HSPA+	84 Mbps	8–2.5 GHz	Services similar to 3G
3.9G (HSPA 14, LTE)		Multimedia and Internet at high speed	HSPA+	168 Mbps		Services similar to 3G

(continued)



**Table 1.** (continued)

Generation	Year	Services	Technology	Speed	Frequency	Description
4G, 4.5G (LTE – A, LTE - Pro)	2010	Gaming, HD TV, wearable devices, cloud, anywhere web access	LTE, Wi MAX (OFDMA)	100 Mbps to 1Gbps	2–8 GHz	Combined mobile cellular technology with WLAN
5G	2020	web access, Artificial intelligence, remote diagnostics, parallel services, availability of network at high altitudes	IPv6	1–10 Gbps	3–300 GHz	It will provide more device connectivity, less energy usage by the network and more signal efficiency
Beyond 5G	2030 -	Smart homes, super fast Internet, home automation, Satellite communication, global roaming	Combination of 5G with satellite technology	Expected to be very high (not defined)	Not defined	Possibly roaming even in space

## 2.2 Traffic Engineering in the Context of Mobile Cellular Networks

**Standardization.** TE standardization of MCNs has been under ITU – T section, as specified under its E. 750 series of Recommendations. The recommendations specify the physical and logical architectures, as well as high level descriptions of different functionalities. They also stipulate the required performance of the specified technology. The TE recommendations specify different aspects, including how to measure traffic and subsequently characterize traffic as service demand. In addition, the standards specify the GoS and the QoS requirements of the corresponding technology. In MCNs, matching the GoS to the QoS is assured through Service Level Agreements (SLAs). Thereafter, traffic management mechanisms are put in place to make sure that the SLAs are fulfilled. To this end, the recommendations stipulate the traffic control and dimensioning proposals, with emphasis on the radio resources [11].

**Traffic Demand Processes and Prediction.** In MCNs the arrival process needs to account for new calls, calls handed over from adjacent cells, as well as calls overflowed to other cell layers in a multi-tiered cell structure. The service time, is no longer necessarily equal to the duration of the call since a call may be serviced over a particular cell for a while and get handed off to an adjacent cell, having released the channel on the first serving cell even before the entire call duration. This aspect makes it important to also model the spatial and temporal behavior of traffic arrivals in addition to the intensity. Whereas previously one could estimate traffic intensity using demographical data alone, it is more accurate now to estimate traffic demand from tracking the individual daily routines, movements and social undertakings; it is all about personal communications.

In earlier generations, fresh traffic arrivals could be safely assumed to be Poisson but with microcells the Poisson estimation underestimates the network performance. Overflow traffic, on the other hand, is super-exponential hence making the Poisson assumption overestimate performance as soon as the overflow traffic is about 10% of the total traffic [13]. Otherwise, in later mobile cellular generations, a mixture of service demands (traffic types) is usually implied, including Poisson fresh calls (random, Erlang), Binomial overflow traffic (smooth, Engset) and Pascal hand over traffic (bursty) [14]. Traffic is characterized by its peakedness as well (variance/mean). Usually in blocking systems, the analysis is insensitive to the distribution of service times which are in turn assumed to be exponential since this definition is important in waiting systems. The traffic streams of different demands are combined by the convolution operation.

**QoS and GoS Concepts.** QoS represent the users' point of view of the system performance, and GoS, the network's point of view. These are specified in the ITU-T Recommendations E.800 and E.600 respectively [15]. With respect to QoS, in addition to call blocking (when all channels in a cell are occupied), a call can be dropped, due to either the ever changing channel fading characteristics, or when being handed over to an already full adjacent cell. With data streams, parameters such as throughput, packet loss, delay and jitter, typical of Internet networks, are now also important. Specifically, real – time traffic and streaming traffic are more sensitive to packet level delay and end – to – end delay, respectively. QoS is in turn provisioned by employing bearer services. These are the predetermined performance provisioning packages that the network promises to offer for a specified type of user traffic. Figure 4 illustrates this evolution of QoS provisioning architecture, comparing bearer service architectures from 3GPP Release '97/98, Release 5, general UMTS and that of the Evolved Packet Core.

**Tools and Methods.** With MCNs, drive testing has been the go to method of traffic and system performance measurement from the beginning. The proliferation of data services has made traffic trace collection and analysis important as well. Drive testing gives a very realistic but narrow view of user perceived network performance since it only serves users in the sites visited. More comprehensive measurements are available with the network service provider. Usually this data is very sensitive and hence not very readily available for use in, for example, academic research. Similarly, network monitoring is usually done by either the service providers or the regulatory authorities. There is an opportunity of collaboration between academic institutions and the data collection entities for improved service engineering.

Erlang introduced mathematical analysis in network optimization. Here it was possible, knowing any two parameters of the performance triangle, to predict the third parameter. Assuming the arrivals to be Poisson and infinite, mathematically tractable analytical models have been developed. The choice of the analytical model would depend on whether rejected calls are blocked out indefinitely, allowed to retry the call or wait in a queue. Table 2 outlines these models and the assumptions that were made. It should be noted that computer simulations have also been employed in TE analysis.

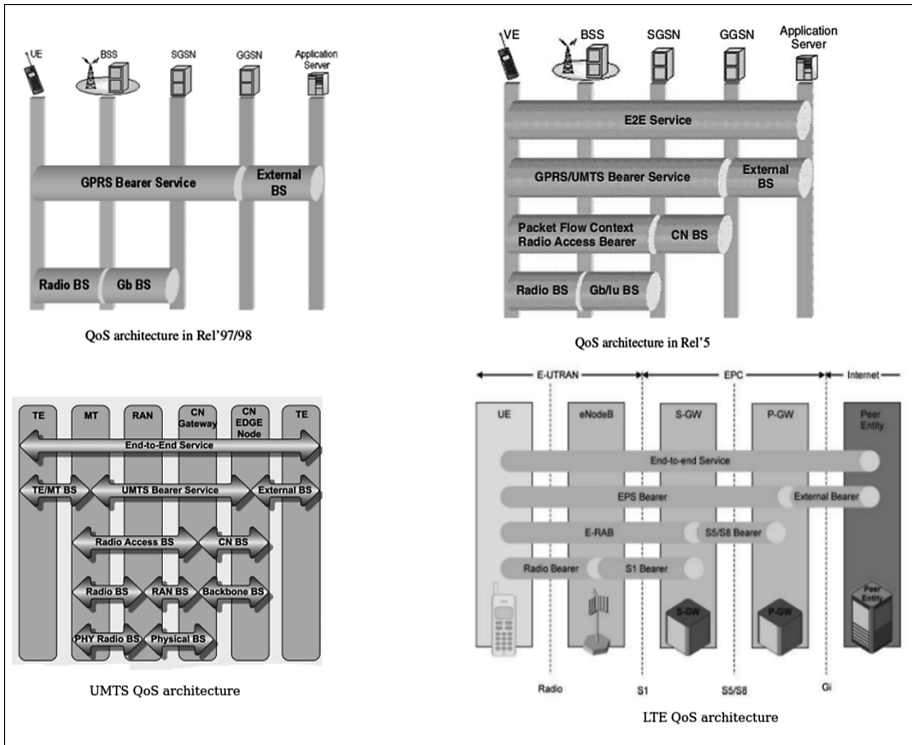


Fig. 4. The evolution of bearer services in mobile cellular networks

Table 2. Teletraffic engineering analytical models. (Sources: [1–4])

Model	Performance formula		Assumptions	Limitations
	Loss system	Waiting system		
Poisson	$P = 1 - e^{-A} \sum_{i=0}^{N-1} \left(\frac{A^i}{i!}\right)$	NA	If blocked, calls wait for the entire service duration	In cellular networks users attempt calling multiple times after rejection
ErlangB	$P_j = \frac{a^j}{j!} / \sum_{k=0}^N \frac{a^k}{k!}$	$P(s, a) = \sum_{j=s}^{\infty} \frac{a^j}{j!} e^{-a}$	Infinite number of sources create a Poisson stream; Service time is exponentially distributed	In cellular systems there is only a few callers per cell hence sources not infinite
Engset	$P(b) = \frac{\left[ \frac{(s-1)!}{N!(s-1-N)!} \right] M^N}{\left( \sum_{x=1}^N \left[ \frac{(s-1)!}{x!(s-1-x)!} \right] M^x \right) M^N}$	$C(s, a) = \frac{\frac{a^s}{s!(1-a/s)}}{\sum_{k=0}^{s-1} \left( \frac{a^k}{k!} + \frac{a^s}{s!(1-a/s)} \right)}$	There is a finite number of sources	Cellular calls still assumed to be a Poisson process, contrary to reality
Pascal (Palm - Wallström)	(Same as Engset)	NA	Arrivals more bursty than random traffic (Pareto inter-arrivals)	A complex, multi-parameter model

**Related Work.** Surveys on the teletraffic aspects of MCNs began with the 2G revolution of these networks. Jabbari [19] gave an extensive cross sectional review of works in all aspects of the network functionality. It was noted that with circuit switched voice only traffic, traditional Erlang models for traffic intensity and arrival, as well as estimates for blocking probabilities could be used. Slight modifications would be made to the traffic intensity and the traffic process to include handoff traffic, overflow traffic, database traffic and control traffic, where applicable. Also performance parameters would increase to also include those that are either influenced by user mobility, position within the cell, as well as the variations in the wireless channel characteristics. New QoS measures emerged with the addition of different network functionalities. Moreover, Poisson traffic sources evolved into multi-state Markov modeled sources to signify either heterogeneous traffic, multi-tiered cell structures, or multi-priority traffic classes. Mathematical analysis was however dominant in the period, with computer simulations used to implement algorithmic solutions in a few instances.

Wirth [36] noted that the evolution of MCNs across the generations has brought about the merging of telephony with computing, and an equal acceleration in the device manufacturing industries. The resulting new challenges in the engineering of mobile cellular networks have completely disrupted traffic engineering practices. She urges for a new look into the fundamental traffic models as well as the subsequent provisioning mechanisms.

Basharin [38], surveyed the modeling of unicast, multicast and elastic network links serving video, telephone and data signals. Here it was noted that the links were usually modeled as queuing systems, including First Come First Serve queues (unicast), Transparent Queues (multicast) the Processor Sharing Queue model (elastic). It was further noted that the extended multiservice Erlang model could be used to analyze the performance of the unicast queues whereas multicast queues employed the numerical Kaufman – Roberts method for numerical solution of performance equations. These studies failed to outline the relationship between advances in network technologies and TE practices.

### 2.3 State of the Art

Currently, MCNs are at the point of standardizing the fifth generation. One prominent traffic engineering paradigm that has kept evolving since the 3G era has been Cross Layer Optimization. To optimize resources, the physical layer characteristics have been noted to affect the upper layers. Moreover, since TCP traffic is now significant in mobile cellular networks, its dynamics affect the traffic profile of the network. As a result, solutions now advocate for channel aware scheduling, application aware traffic classification, as well as TCP implementations that are aware of both the channel conditions and the MAC layer flow controls. Furthermore, the current multiple service networks adhere to SLAs through service differentiation like in the Internet. The shift nowadays is towards dynamic bearer set up, where, for example, a user may be provisioned according to their most demanding application, and when relatively inactive but still online, dynamically assign this user's resources to other users.

Also, as noted previously, traffic engineering is moving away from mathematical analysis, towards simulation. Traffic engineering is an optimization problem, the more

the parameters, the more complex the optimization problem and the more difficult it is to solve the problem analytically; hence algorithms are designed, that guarantee the network reaching an optimum operating point while in operation.

### 3 Methodology

This survey relied heavily on qualitative document analysis. Through purposive sampling, Google Scholar was chosen as the source database for surveyed works since it is believed to contain almost 88% of all published works [39]. A comparison with a search in Microsoft Academic showed only 3 articles missing from Google Scholar among the top 20 most relevant articles. The units of data analysis included theses and dissertations, journal articles, conference papers as well as book chapters. The units of data analysis were sampled according to a non-probability convenience sampling method where all 38 relevant academic resources that responded to the search key-phrases including a combination of words “teletraffic, traffic, engineering, mobile, cellular, networks” were reviewed. This sampling method alienated potentially relevant data analysis units presented in languages other than English. Moreover, patent documents were not included in the analysis. The performance triangle as a basis for traffic engineering was leveraged into designing the categorization of the data units and a subsequent framework for their assessment as illustrated in Table 3. The analysis of the data units involved simple statistical calculation of relative frequencies and observations by comparison on the checklist in Table 3. To obtain trends, the analysis was done by arranging the analyzed works in a chronological order.

**Table 3.** Teletraffic engineering studies in mobile cellular networks.

Author & year	Mobile cellular network technology	Traffic characterization	Performance triangle parameter	Tools and methods used
---------------	------------------------------------	--------------------------	--------------------------------	------------------------

### 4 Results

The analysis revealed that there was very little (2.5%) work done in mathematical analysis of MCNs in 1980s with 1G analog MCNs. The studies peaked at 40% of the reviewed works in the 1990s. The numbers fell again in 2000s to 20%. Starting from 2010, the reviewed documents make 37.5%. In 1990s the analysis was on the performance of abstract models of MCNs and sometimes confining the analysis within a particular multiple access technology. In the 2000s, the technological focus of the analysis was in the revolutionary data-servicing 3G networks whereas starting from 2010, there is an observable moving focus from 3G, to 4G and beyond as years progress. As noted in Table 4, in the 1990s, teletraffic engineering was heavily based on modeling MCNs starting from the legacy Erlang models. In the 2000s, the developed models were mostly used in performance evaluation of the network services. More recently, literature surveyed shows a trend towards using teletraffic engineering for service scenario definition. It is clear from Table 4 that as the network technologies

evolved to provide higher speeds and capacities, the engineering challenge shifted from simple dimensioning to service optimization. An evolution in the analysis methods from single mathematical models, to a combination of models, to simulation can also be noted.

**Table 4.** Teletraffic engineering studies in mobile cellular networks.

Year	Technology	Traffic characteristics	Objective	Tools and methods	Notes
1992–2000 [16–28]	FDMA, CDMA, TDMA as well as generalized mobile cellular network	Predominantly voice calls; fresh, handed over, overflowed The spatial aspect of mobile traffic also features in many of these studies	Early 90 s - extending Erlang models in network performance evaluation. Mid 90 s - traffic characterization as well. End of the 90 s- comparison, among analytical tools, simulation and measurements. Some attempts to model service time distributions, contrary to the assumption of the exponential distribution	Erlang models, extended Erlang models, Simulation; with tools e.g. ICEPT tool	Employing macrocells over microcells as a solution to the capacity problem Also demand based network planning proposed
2001–2009 [29, 30]	3G networks	Both studies featured multimedia traffic mixtures	User perceived network performance	Erlang loss formula, the Processor Sharing model in the Ocelot network planning and optimization tool	Both studies were assessing the performance of 3G technologies
2011–2017 [31–35]	Generalized cellular networks, and specifically, 3G, 4G and beyond	General traffic, with emphasis on traffic mixture characterization	Performance analysis with novel models of traffic processes and models of network technology advances	Traditional models; other mathematical tools and methods	Mostly modeling and performance analysis of the new QoS mechanisms

## 5 Discussion

### 5.1 Trends

**Trends in the Evolution of MCNs.** The evolution of MCNs has happened in multiple aspects as a result of the ever evolving service demand scenario. Data transmission capabilities have evolved across years from being able to support only textual data to a point where high definition multimedia interactivity is now supported. Reviewed works show this trend in the ever changing traffic models that have evolved from simple Poisson processes to Interrupted Poisson Processes or multi-state Markov Modulated

Poisson Processes. Moreover, traffic mixtures are now predominant in TE of MCNs. The introduction of sectorization has reduced interference but also reducing capacity hence introducing another performance trade-off in MCNs. Similarly, the evolution from macro-cells to micro-cells to pico- and femto-cells has dictated the change in the propagation environment which together with sectorization has dictated TE models with overflow traffic and increased proportion of handovers as evidenced in studies in 2010s. Transport methods have become more spectral efficient but interference limited. Consequently QoS functions have shifted from reservation centric to opportunistic service differentiation centric methods. The move from technology driven to user driven to service driven evolution of MCNs is evident in the fact that earlier studies mostly extended Erlang models to fit MCNs; in the mid 2000s, these models were used extensively to analyze performance of existing systems for user satisfaction. Studies in 2010s, show a trend towards applying TE as a tool to design new service scenarios as well as QoS management schemes.

**Trends in the Evolution of TE of MCNs.** TE was predicted to drastically change as the variables in the TE optimization problems increased [12]. Back then, however, most of the research concentrated on the modeling of the traffic demand, taking into account the influence that the spatial and temporal changes of user locations had on the distribution of traffic offered to the network. With GoS, emphasis has shifted from only network resources availability to also include the resource reliability as evidenced by the performance centric studies in the 2000s.

Moreover, the incorporation of data services over mobile networks saw the increased importance of admission control and scheduling mechanisms for assurance of adherence to SLAs. Internet centric TE was therefore adopted while leveraging the challenges posed by the air interface rather than mitigating them. Examining the studied documents shows traffic management mechanisms that are not only focused on throughput but also fairness in user service.

Furthermore, more realistic traffic arrival and service time models proved to be mathematically intractable. This gave rise to the use of computer simulations as an important traffic engineering tool. The most notable change in traffic models is the inclusion of handover, and in hierarchical designs of overflow traffic.

There have been interesting developments in the mathematical methods employed in Operations Research. Although only a few studies have attempted this route, there is a noted trend in employing such tools as genetic algorithms, fuzzy logic, neural networks, heuristics, control theory, and game theory into developing more accurate and more parsimonious models, as well as realistic simulations and emulations of traffic engineering problems.

**The Relationship Between TE and the Evolution of MCNs.** The two concepts show cycles of one influencing the other in turns. Figure 5 is a summary of this complex relationship where advances in each field influence the maturity of the other field.

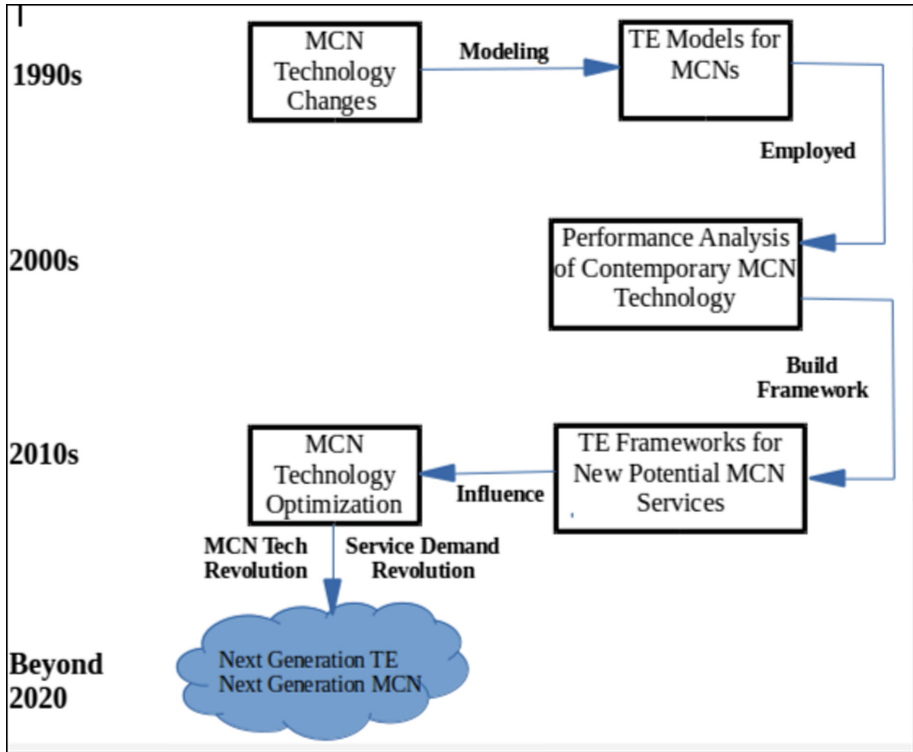


Fig. 5. The relationship between MCN evolution and changes in TE paradigms

## 5.2 Opportunities

So far, most authors have used mere modifications of prior traffic models in their studies. With the seminal work by Leland and Taquq that highlighted the multifractal nature of packet traffic, researchers began venturing into fitting common long tailed distributions into empirical packet data. Overall traffic profile would hence be a combination of different traffic classes. Currently, enough data has been gathered over several implementations of mobile cellular networks to allow for the derivation of parsimonious traffic models. There is even a chance for TE to dictate how next generation applications should behave to fit the next generation networks for the desired performance.

With the current move towards the Internet of things (IoT), it is expected that traffic characteristics will be very much influenced by the service profile rather than the user profile. Information about the network is available wherever the device may be. This drive should as a consequence render traffic measurements and monitoring much easier by employing crowd-sourcing. There is therefore a big challenge and hence an opportunity to engineer mobile cellular networks that make it easy to share user perceived network conditions without compromising the users' privacy and security.



## 6 Conclusion and Recommendations

This study was set out to investigate the complex relationship between the paradigm shifts in TE with respect to the evolution of MCNs across their now five generations. At the inception of cellular networks, TE was a simple extension of the then well established Erlang analytical models. The subsequent revolution of cellular networks saw traffic engineering failing to catch up with the design challenges posed by the ever changing service scene in MCNs. However, we are now at a point where advances in both technology, mathematical tools and communications have helped to ease knowledge dissemination and quickly fill the gaps between disciplines. There is now an opportunity, for a revolution in TE tools and methods that could be developed and standardized to optimize the current MCNs as well as predict the next usage scenarios.

**Acknowledgments.** We would sincerely like to thank the independently formed review team at CoICT that tirelessly reviewed this work over and over. We are also sincerely grateful to colleagues with whom we have shared ideas and worked together towards strengthening each others' academic growth.

## References

1. Akimaru, H., Kawashima, K.: *Teletraffic: Theory and Applications*, 2nd edn. Springer, Heidelberg (1999). <https://doi.org/10.1007/978-1-4471-0871-9>
2. Stuckman, P.: *Traffic engineering concepts for cellular packet radio networks with quality of service support*. Ph.D. dissertation (2003)
3. Iversen, V.B.: *Teletraffic Engineering and Network Planning*, Technical University of Denmark (2015). [http://orbit.dtu.dk/files/118473571/Teletraffic\\_34342\\_V\\_B\\_Iversen\\_2015.pdf](http://orbit.dtu.dk/files/118473571/Teletraffic_34342_V_B_Iversen_2015.pdf). Accessed Aug 2018
4. Zukerman, M.: *Introduction to Queuing Theory and Stochastic Teletraffic Models*, EE Department, City University of Hong Kong (2018)
5. Siripongwutikorn, P., Banerjee, S., Tipper, D.: *Traffic Engineering in the Internet: A Survey of Load Balanced Routing* (2002)
6. Grillo, D., Skoog, R.A., Chia, S., Leung, K.K.: *Teletraffic Engineering for mobile personal communications in ITU-T work – the need for matching practice and theory* (1998). <https://doi.org/10.1109/98.736476>
7. Sauter, M.: *From GSM to LTE-Advanced Pro and 5G: An Introduction to Mobile Networks and Mobile Broadband*, 3rd edn. Wiley, New Jersey (2017)
8. Du, K., Swamy, M.N.S.: *Wireless Communication Systems: From RF Subsystems to 4G Enabling Technologies*. Cambridge University Press, Cambridge (2010)
9. Shruti: A sneak peek into future generations, 7G: a survey. *Int. J. Adv. Res. Comput. Sci. (IJARCS)* 9(1) (2018). <https://doi.org/10.26483/ijarcs.v9i1.5357>. Accessed 8 Oct 2018
10. *Different Generations of Mobile Technologies*. <http://www.3g4g.co.uk/>
11. *Introduction to the E.750 series of Recommendations on Traffic Engineering Aspects of Networks Supporting Personal Communications Services, Series E: Overall Network Operation, Telephone Service, Service Operation and Human Factors: Quality of Service, Network Management and Traffic Engineering – Traffic Engineering – Mobile Network Traffic Engineering, - T* (2002)

12. Tekinay, S., Sohraby, K.: Teletraffic: modeling, engineering, and management for persona/communications and wireless networks. *IEEE Commun. Mag.* **35**(2) (1997). <https://doi.org/10.1109/mcom.1997.565661>. Accessed 31 Aug 1997
13. Koucheryavy, Y., Giambene, G., Staehle, D., Barcelo-Arroyo, F., Braun, T., Siris, V. (eds.): Traffic and QoS Management in Wireless Multimedia Networks: COST 290 Final Report. Springer, New York (2009). <https://doi.org/10.1007/978-0-387-85573-8>
14. Iversen, V.B., Epifania, E.: Teletraffic engineering of multi-band W-CDMA systems. In: Gaïti, D., Pujolle, G., Al-Naamany, A., Bourdouceu, H., Khriji, L. (eds.) *Network Control and Engineering for QoS, Security and Mobility II*. IFIP International Federation for Information Processing. Springer, Heidelberg (2003). [https://doi.org/10.1007/978-0-387-35703-4\\_7](https://doi.org/10.1007/978-0-387-35703-4_7)
15. Stasiak, M., Glabowski, M., Wisniewski, A., Zwierzykowski, P.: *Modeling and Dimensioning of Mobile Networks: from GSM to LTE*. Wiley, Hoboken (2011)
16. Steele, R., Nofal, M.: Teletraffic performance of microcellular personal communication networks. *IEEE Proc. Commun. Speech Vis.* **139**(4), 448 (1992). <https://doi.org/10.1049/ip-i-2.1992.0061>
17. Everitt, D.E.: Traffic engineering of the radio interface for cellular mobile networks. *Proc. IEEE* **82**(9) (1994) <https://doi.org/10.1109/5.317083>
18. Lagrange, X., Godlewski, P.: Teletraffic analysis of a hierarchical cellular network. In: 1995 IEEE 45th Vehicular Technology Conference. Countdown to the Wireless Twenty-First Century (1995). <https://doi.org/10.1109/vetec.1995.504995>
19. Jabbari, B.: Teletraffic aspects of evolving and next-generation wireless communication networks. *IEEE Pers. Commun.* **3**(6), 4–9 (1996). <https://doi.org/10.1109/98.556473>
20. Zonoozi, M.M., Dassanayake, P., Faulkner, M.: Teletraffic modeling of cellular mobile networks. In: *IEEE Proceedings of Vehicular Technology Conference - VTC* (1996). <https://doi.org/10.1109/vetec.1996.501517>
21. Fitzpatrick, P., Lee, C.S., Warfield, B.: Teletraffic performance of mobile radio networks with hierarchical cells and overflow. *IEEE J. Sel. Areas Commun.* **15**(8), 1549–1557 (1997). <https://doi.org/10.1109/49.634793>
22. Orlik, P.V., Rappaport, S.S.: A model for teletraffic performance and channel holding time characterization in wireless cellular communication with general session and dwell time distributions. *IEEE J. Sel. Areas Commun.* **16**(5), 788–803 (1998). <https://doi.org/10.1109/49.700913>
23. Tutschku, K.: Demand-based radio network planning of cellular mobile communication systems. In: *Proceedings of IEEE INFOCOM '98, the Conference on Computer Communications. Seventeenth Annual Joint Conference of the IEEE Computer and Communications Societies. Gateway to the 21st Century* (Cat. No. 98CH36169) (1998). <https://doi.org/10.1109/infcom.1998.662915>
24. Tran-Gia, P., Leibnitz, K., Tutschku, K.: Teletraffic issues in mobile communication network planning. Presented at the 11th ITC Specialist Seminar on Multimedia and Nomadic Communications, Yokohama, Japan, 27–29 October 1998 (1998). <https://doi.org/10.1023/a:1019114122207>
25. Tutschku, K., Tran-Gia, P.: Spatial traffic estimation and characterization for mobile communication network design. *IEEE J. Sel. Areas Commun.* **16**(5), 804–811 (1998). <https://doi.org/10.1109/49.700914>
26. Evans, J.S., Everitt, D.: On the teletraffic capacity of CDMA cellular networks. *IEEE Trans. Veh. Technol.* **48**(1), 153–165 (1999). <https://doi.org/10.1109/25.740079>
27. Fang, Y., Chlamtac, I.: Teletraffic analysis and mobility modeling of PCS networks. *IEEE Trans. Commun.* **47**(7), 1062–1072 (1999). <https://doi.org/10.1109/26.774856>

28. Rocha, M.N., Mateus, G.R., da Silva, S.L.: QoS and simulation models in mobile communication networks. In: Proceedings of the 3rd ACM International Workshop on Modeling, Analysis and Simulation of Wireless and Mobile Systems - MSWIM 2000 (2000). <https://doi.org/10.1145/346855.346873>
29. Borst, S., Clarkson, K., Graybeal, J., Viswanathan, H., Whiting, P.: User-level QoS and traffic engineering for 3G wireless 1xEV-DO systems. *Bell Labs Tech. J.* **8**(2), 2003 (2003). <https://doi.org/10.1002/bltj.10062>
30. San Jose, E.R., Velez, F.J.: Tele-traffic engineering for enhanced UMTS multi-rate application. In: 5th European Personal Mobile Communication Conference, Conference Publication No. 492, Glasgow, UK (2003). <https://doi.org/10.1049/cp:20030281>
31. Maguitte, O.M., Sunhaloo, M.S., Oodit, B., Armoogum, V.: A study of voice traffic blocking in a model cellular network. *International Journal of Wireless & Mobile Networks (IJWMN)* **3**(6) (2011). <https://doi.org/10.5121/ijwmn.2011.3608>
32. Weng, X., Cao, D., Niu, Z.: Energy-efficient cellular network planning under insufficient cell zooming. In: 2011 IEEE 73rd Vehicular Technology Conference (VTC Spring) (2011). <https://doi.org/10.1109/vetecs.2011.5956699>
33. Glabowski, M., Hanczewski, S., Stasiak, M.: Modelling of cellular networks with traffic overflow. *Mathematical Problems in Engineering*, Volume 2015, Article ID 286490, 15 pages, Hindawi Publishing Corporation (2015). <https://doi.org/10.1155/2015/286490>
34. ElSawy, H., Sultan-Salem, A., Alouini, M.-S., Win, M.Z.: Modeling and analysis of cellular networks using stochastic geometry: a tutorial. *IEEE Commun. Surv. Tutor.* **19**(1), 167–203 (2017). <https://doi.org/10.1109/comst.2016.2624939>
35. Wang, G., Feng, G., Qin, S., Wen, R.: Efficient traffic engineering for 5G core and backhaul networks. *J. Commun. Netw.* **19**(1), 80–92 (2017). <https://doi.org/10.1109/jcn.2017.000010>
36. Wirth, P.E.: The role of teletraffic modeling in the new communications paradigms. *IEEE Commun. Mag.* **35**(8), 86–92 (1997). <https://doi.org/10.1109/35.606035>
37. Meraj ud in Mir, M., Kumar, S.: Evolution of mobile wireless technology from 0G to 5G. (IJCSIT). *Int. J. Comput. Sci. Inf. Technol.* **6**(3), 2545–2551 (2015). <http://ijcsit.com/docs/Volume%206/vol6issue03/ijcsit20150603123.pdf>
38. Basharin, G.P., Gaidamaka, Y.V., Samouylov, K.E.: Mathematical theory of teletraffic and its application to the analysis of multiservice communication of next generation networks. *Autom. Control. Comput. Sci.* **47**(2), 62–69 (2013). <https://doi.org/10.3103/s0146411613020028>
39. Khabsa, M., Giles, C.L.: The number of scholarly documents on the public Web. *PLoS ONE* **9**(5), e93949 (2014). <https://doi.org/10.1371/journal.pone.0093949>



# Exploring the Impacts of Intrinsic Variables on Security Compliance Efficiency Using DEA and MARS

Charlette Donalds<sup>1</sup> , Kweku-Muata Osei-Bryson<sup>2</sup>,  
and Sergey Samoilenko<sup>3</sup>

<sup>1</sup> University of the West Indies, Mona, Kingston, Jamaica  
charlette.donalds02@uwimona.edu.jm

<sup>2</sup> Virginia Commonwealth University, Richmond, VA, USA  
KMOsei@VCU.edu

<sup>3</sup> Averett University, Danville, VA, USA  
ssamoilenko@Averett.edu

**Abstract.** Given that appropriate human behavior is required to minimize the occurrence of cybersecurity breaches, the issue of *security compliance* is critical. Within this context organizations would be interested in the efficient achievement of *security compliance*. In this paper we explore the concept of *Security Compliance Efficiency*, and present a hybrid DEA+MARS methodology for identifying its antecedents. We also present resulting examples of relationships that describe the impacts of intrinsic variables on *Security Compliance Efficiency*.

**Keywords:** Security Compliance Efficiency ·  
Data Envelopment Analysis (DEA) ·  
Multivariate Adaptive Regression Splines (MARS)

## 1 Introduction

The current era is dominated by the use of information and communication technologies (ICTs) in the lives and activities of individuals, organizations and governments. However, increased adoption of ICTs is positively correlated with increased economic loss and technological threats and/or attacks. For instance, the average cost of cybercrimes to organizations increased by 23% in 2017 over 2016, reaching US \$11.7 million [1]. Too, the WannaCry ransomware attack in May 2017 affected more than 300,000 victims in 150 countries [2]. To cope with these technological or cybersecurity threats, security stakeholders have implemented technology-based protection solutions and conducted cybersecurity awareness activities for users. Users are recognized as key threats to achieving security because they often fail to adhere to the security best practices. According to researchers, users are often considered the “weakest link in the chain” of system security but are also considered the greatest assets to reduce potential security threats [3–5].

To influence users' *security compliance* behavior, the literature offers some antecedents. In general, studies report that increased security awareness initiatives positively influence users' compliance behavior [6–10] and specially, Bulgurcu, Cavusoglu and Benbasat [6] and Donalds [8] found support for the direct link between general security awareness (*GSAW*) and users' *security compliance* behaviour (*SECC*).

Self-efficacy (*SLEF*) is another factor cited to influence users' behavior generally. According to protection motivation theory, *SLEF* emphasizes an individual's ability or judgment of his or her ability to perform an action [11]. More specifically, the theory suggests that increasing individual's *SLEF* can improve their competence in coping with a task. In a computer training course *SLEF* was found to be a strong influence on individuals' performance in their use of the computers [12]. Additionally, Donalds and Osei-Bryson [13] offer empirical support for the influence of security self-efficacy on *SECC*.

While the constructs referenced above can be considered to be extrinsic to the individual and thus subject to be influenced by organizational efforts, others are more intrinsic. One such construct is general security orientation (*GSOR*). *GSOR* is intrinsic since according to Ng, Kankanhalli and Xu [14], an individual with a greater predisposition towards computer security should exhibit higher levels of *security compliance* behavior. *GSOR* has also been shown to be significantly correlated with *SECC* [13].

Another intrinsic construct, *Gender*, has also been shown to have a profound influence on an individual's perceptions, attitudes and performance [15]. Results from studies in the domain have also found gender to be significantly correlated with employees' *security compliance* intention and behaviour [9, 16–18].

More recent results from Donalds and Osei-Bryson [13] suggest an individual's dominant decision style (i.e. *Analytical*, *Behavioral*, *Conceptual*, *Directive*) and dominant orientation (i.e. *Idea* vs. *Action*), which are intrinsic to the individual, also impact *SECC*. Rowe and Boulgarides [19] note that cognitive theorists have long argued that an individual decision style is an important determinant of behavior. Too, others report that an individual's decisions seem to be a function of the individual's cognitive makeup [e.g. 20, 21].

Various studies, including Donalds and Osei-Bryson [13], have attempted to identify the antecedents of *security compliance* behavior. In general, prior studies have concentrated on the issues of efficacy and effectiveness of the relationships between the antecedents of and *security compliance* behavior, however, in this study we take it a step further. In this study we focus on the efficiency of the relationships between the antecedents of and *security compliance* behavior. In other words, previous studies have placed emphasis on “doing the right thing”, while the current study inquiries into whether “doing the right thing is done the right way”. This focus is of particular importance in the context of the settings characterized by limited resources.

Overall, prior security studies can be considered to be aimed at identifying the relationship described generically as:

$$\text{Compliance} = f(\text{Intrinsic Inputs}, \text{Discretionary Inputs}) \quad (1)$$

where *GSAW* and *SLEF* are the *Discretionary Inputs*, and *Gender*, *GSOR*, *Dominant Individual Decision Styles* (*DominantDS*) and *Dominant Orientation* are the *Intrinsic Inputs*.

In this paper we explore the concept of *Security Compliance Efficiency* and its relationships with intrinsic antecedents, where *Security Compliance Efficiency* is defined as:

$$\text{Security Compliance Efficiency} = f_{\text{Output}}(\text{Compliance})/f_{\text{Input}}(\text{Discretionary Inputs}) \quad (2)$$

such that its values fall in the [0, 1] interval with the top value indicating the highest level of relative efficiency. For illustrative purposes, using the Donalds and Osei-Bryson [13] causal model, presented in Fig. 1, we investigate the concept of *Security Compliance Efficiency*. We adopted this model as it identifies both intrinsic and discretionary inputs, elements salient to our work.

In the context of the causal model of Donalds and Osei-Bryson [13] we would have:

$$\text{Security Compliance Efficiency} = f_{\text{Output}}(\text{SECC}, \text{PWDC})/f_{\text{Input}}(\text{GSAW}, \text{SLEF}) \quad (3)$$

thus, a relatively efficient individual is one who has the same level of *compliance* as another individual though his/her *GSAW* and *SLEF* levels are lower, or has a higher level of *compliance* as another individual though their *GSAW* and *SLEF* levels are the same.

Organizations would be interested in knowing the impacts of non-discretionary variables (e.g. *Gender*, *GSOR*, *Dominant Individual Decision Styles & Dominant Orientation*) on *Security Compliance Efficiency* since this would help them to identify the situations in which they can invest less while achieving the same level of *compliance*. Further, this would be of particular importance to organizations with budget and other types of resource constraints, including small and medium enterprises (SMEs) and other types of enterprises in developing countries. For it is known that SMEs are essential to the poorest countries in the world where they serve as an important driver of economic growth that accounts for majority of all businesses [22]. Moreover, African SMEs are also important to the global economy because their presences and success create "...a growing middle class with disposable income, in tandem with market opportunities for new investors" [23].

## 2 Overview of Supporting Analytic Methods

In this study we use a two-stage Data Envelopment Analysis (DEA) based approach [e.g., 24] that involves utilizing the DEA methodology to generate the *Security Compliance Efficiency* scores, then use the Multivariate Adaptive Splines (MARS) statistical analysis method to explore the relationships between the intrinsic non-discretionary inputs (i.e. *Gender*, *GSOR*, *Dominant DominantDS*, and *Dominant Orientation*) and *Security Compliance Efficiency*.

### 2.1 Overview of Data Envelopment Analysis

DEA is a nonparametric method of measuring the efficiency of decision-making units [25]. Any collection of similar entities could comprise a set of decision-making units (DMUs) and can be subjected to DEA, as long as the chosen entities transform the same type of inputs into the same type of outputs. It has been previously applied to address a wide range of multi-objective and other types of decision making problems [26, 27].

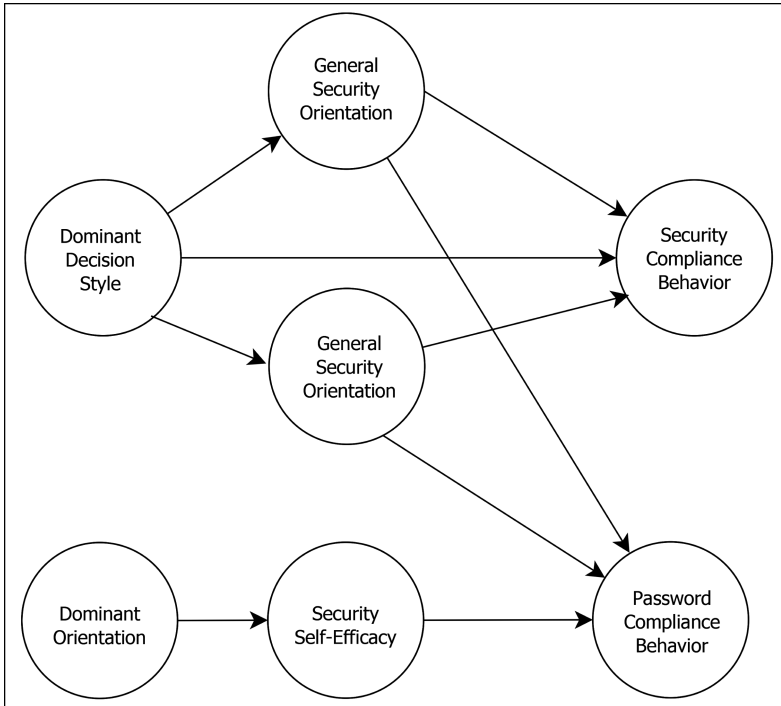


Fig. 1. Donalds and Osei-Bryson [13] causal model of security compliance.

The empirical foundation of DEA eliminates the need for some of the assumptions and limitations of traditional efficiency measurement approaches. As a result, DEA could be used in cases where the relationships between the multiple Inputs and multiple Outputs are complex or unknown. Consequently, a DEA model is better perceived as a collection of the Inputs that in some way or form are important to the Outputs of the transformation process under an investigation of a decision maker.

The original DEA model was introduced in 1978 by Charnes, Cooper and Rhodes and it is commonly called the CCR Model. This model allowed representing multiple inputs and outputs of each DMU as a single abstract “meta input” and a single “meta output.” Consequently, the efficiency of each DMU could be represented as a ratio of

the abstract input to the abstract output, and the resulting efficiency value could then be used for comparison with other DMUs in the set. By using the techniques of Linear Programming (LP), this comparison results in efficiency ranking of each DMU in the given set, where the highest ranking DMU is considered to be 100% *relatively efficient* and is assigned a perfect score of “1”. Because multiple DMUs could receive the same score, there could be multiple efficient DMUs in the given set. As a result, DEA envelops the data set with the boundary points represented by the *relatively efficient* DMUs – by connecting the boundary points an investigator could obtain a visual representation of the efficient frontier for a given set of DMUs.

The two most common orientations of DEA model are the Input-oriented and the Output-oriented. An *Input-Oriented Model* is concerned with the minimization of the use of inputs for achieving a given level of outputs when inputs are controllable. In the case of an Input-Oriented Model, no DMU would be considered efficient if it is possible to decrease any of its inputs without affecting any other inputs and without decreasing level of the outputs. An *Output-Oriented DEA model*, on the other hand, would be concerned with the maximization of the level of the outputs per given level of the inputs. Thus, it deals with the efficiency of the output production where outputs are controllable.

DEA also allows for accommodating different assumptions regarding *return to scale*. The original CCR model is the most suitable in the case when an investigator has a reason to believe that all DMUs function under the condition of *constant return to scale* (e.g., when the output/input ratio is linear). BCC model [28], on the other hand, is more flexible and allows for considering *variable returns to scale* (e.g., when the output/input ratio is non-linear). Consequently, a DMU that is relatively efficient based on CCR model must also be relatively efficient based on BCC model, but not the vice versa.

## 2.2 Overview of Multivariate Adaptive Regression Splines

Multivariate Adaptive Regression Splines (MARS) is a technique that may be used to discover, describe and evaluate causal links between factors. It has been previously applied to address a wide range of problems [e.g., 29, 30]. While ordinary regression equations attempt to model the relationship between outcome and predictor variables using a single function, the regression splines approach models the relationship between outcome and predictor variables as a piecewise polynomial function  $f(x)$  which can be obtained by dividing the range of each predictor variable into one or more intervals and representing  $f$  by a separate polynomial in each interval [31]. A regression spline function can be expressed as a linear combination of piecewise polynomial *basis functions* (BF) that are joined together smoothly at the knots, where a *knot* specifies the end of one region of data and the beginning of another. When using MARS for modeling the relationship between the predictor and dependent variables, it is not necessary to know the functional forms of the relationships, as MARS establishes them based on the data. MARS provides the analysis of variance (ANOVA) decomposition, which identifies the relative contributions of each of the predictor variables and the interactions between variables, and handles missing values.



MARS uses both simple and complex BFs. Simple BFs involve a single variable and come in pairs of the form  $(x - t)_+$  and  $(t - x)_+$  where  $t$  is the knot,  $(x - t)_+ = \frac{(x - t)}{2}$  if  $x > t$ , and 0 otherwise; and  $(t - x)_+ = \frac{(t - x)}{2}$  if  $x < t$ , and 0 otherwise [32]. Complex BFs have the form:  $h_k(\mathbf{x}) = \prod_{ij} f_{ij}(x_i)$  where  $x_1, \dots, x_q$  are the independent variables,  $f_{ij}$  is a spline BF for the  $i^{\text{th}}$  independent variable  $x_i$  at  $j^{\text{th}}$  knot. The function generated using the MARS approach can be described as follows:

$$Y = \beta_0 + \sum_{k=1}^K \beta_k h_k(\mathbf{x}) \quad (4)$$

where  $\beta_0$  is the coefficient of the constant BF,  $\beta_k$  ( $k = 1, K$ ) are the coefficients of the BFs,  $K$  is the number of basis functions (BF) in the model. The coefficient of each BF (i.e.  $\beta_k$ ) is estimated by minimizing the sum of square errors, which is similar to the estimation process of linear regression, but involving local data for the given region.

Generation of a MARS model involves 2 phases. In the *Forward Phase* BFs are added, allowing the model to become more flexible but also more complex, and terminating when a user specified maximum number of BFs is reached; in the *Backward Phase* BFs are deleted in order of least contribution to the model until an “Optimal” model is found, with the selection of the “Optimal” model being based on the Generalized Cross Validation (GCV) measure. The GCV measure plays a trade-off role between accuracy and simplicity in the generation of MARS models as that played by the Akaike Information Criterion (AIC), Bayes Information Criterion (BIC), and Shwartz Bayes Criterion (SBC) measures play in traditional regression.

### 3 Research Methodology

Our methodology is based on the two-stage DEA model framework but also includes steps to generate appropriate data for this framework, which are as follows:

**Step 1:** Select an appropriate causal model, and conduct preliminary identification of the discretionary variables and the intrinsic non-discretionary variables.

**Step 2:** Develop an appropriate data collection instrument.

**Step 3:** Do appropriate data collection, data understanding, and data cleaning.

**Step 4:** Do factor analysis and calculation of factor scores.

**Step 5:** Using the discretionary variables as the inputs and the dependent variables as the outputs, conduct DEA to generate the *Security Compliance Efficiency* scores.

**Step 6:** Do MARS-based statistical analysis to identify the characteristics of the relationships between the intrinsic non-discretionary variables and *Security Compliance Efficiency*.

## 4 Application of the Research Methodology

### Step 1 – Select causal model:

We selected Donalds and Osei-Bryson [13] causal model.

### Step 2 – Develop appropriate data collection instrument:

Our data collection instrument consisted of two parts: the Decision Styles items as well as the items that measured the antecedents of and *security compliance*. We adopted the standard Decision Styles Inventory (DSI) measures as proposed by Rowe and Mason [33]. We also adopted the items that measured the antecedents of and *security compliance* as proposed by Donalds and Osei-Bryson [13].

### Step 3 – Do appropriate data collection, data understanding, and data cleaning:

Our data was collected via a web-based survey which was pretested by some IS security experts, faculty members and graduate students. The final instrument was used to collect data from Jamaican employees across multiple industries and faculty members, undergraduate and graduate students from an institution of higher learning. The survey link was sent to faculty members and some Jamaican employees using direct referrals and was advertised in some undergraduate as well as graduate classes. Further, the researchers requested that participants forward the link to other potential participants. As a result, a precise sample frame is difficult to establish. Albeit, the survey was sent/advertised to approximately 510 individuals. We received 248 responses, yielding a response rate of 48.6%. Respondents were from varying industries including education, banking and financial services and telecommunication/IT services. 32.26% of the respondents were males while 67.47% were females.

### Step 4 – Do factor analysis and calculation of factor scores:

From the exploratory factor analysis of the *security compliance* items, five factors (i.e., *password compliance behavior (PWDC)*, *security compliance behavior*, *general security awareness*, *general security orientation* and *security self-efficacy*) emerged to explain the maximum portion of the variance in the original variables. These are consistent with the factors identified in the Donalds and Osei-Bryson [13] model.

### Step 5 – Do DEA:

We generated 2 DEA models both with an input-orientation with the different scales (i.e. Constant Returns to Scale (CRS) and Variable Returns to Scale (VRS)). The factors that can be considered to be discretionary variables (i.e. *GSAW*, *SLEF*) were used as the input variables for the DEA models. Two factors (i.e. *SECC*, *PWDC*) are associated with *security compliance*, thus we used these factors as the output variables for the DEA models.

### Step 6 – MARS-based statistical analysis:

#### 6.1 CRS Model: Results and Discussion

In this model *Security Orientation (GSOR)*, *Gender*, and *DominantOrientation* (i.e. 'Idea' vs 'Action') all impact *Security Compliance Efficiency*, often in complex ways (see Tables 1, 2 and 3). An examination of the 2<sup>nd</sup> and 4<sup>th</sup> rows of Table 3 suggests that when *GSOR* > 3.00 then *Action-oriented Males* display greater *Security Compliance Efficiency* than *Idea-oriented Males*. Similarly an examination of the 3<sup>rd</sup> and 4<sup>th</sup> rows of

Table 3 suggests that when  $GSOR > 3.00$  then *Idea-oriented Females* display greater *Security Compliance Efficiency* than *Idea-oriented Males*. The reader may recall that given our definition of *Security Compliance Efficiency* then the implication of being less efficient is that *GSAW* and *SLEF* scores would need to be higher to achieve the same level of *security compliance* as the more efficient individual. Thus for such less efficient individuals the organization would need to invest more resources to improve the values of *GSAW* and *SLEF*.

**Table 1.** Regression equation for CRS.

RHS of Regression Equation
0.774893 + 0.04090968*Max(0, $GSOR - 1.33$ )*( 1 if <i>DominantOrientation</i> is "Action") - 0.117547*(1 if <i>DominantOrientation</i> is "Action") *(1 if <i>Gender</i> is "F") + 0.180019* Max(0, $GSOR-3.00$ ) - 0.260166* Max(0, $GSOR-2.33$ ) + 0.046970* Max(0, $GSOR-2.33$ ) *( 1 if <i>Gender</i> is "F")

**Table 2.** Detailed breakdown of regression equation for CRS.

Dominant Orientation	Gender	GSOR	RHS of regression equation	
<i>Action</i>	F	<1.33	0.774893	
		(1.33, 2.33]	0.774893 +0.04090968 * ( $GSOR - 1.33$ )	
		(2.33, 3.00]	0.774893 +0.04090968 * ( $GSOR - 1.33$ ) -0.117547 -0.260166 * ( $GSOR - 2.33$ ) +0.046970 * ( $GSOR - 2.33$ )	
		>3.00	0.774893 +0.04090968 * ( $GSOR - 1.33$ ) -0.117547 -0.260166 * ( $GSOR - 2.33$ ) +0.046970 * ( $GSOR - 2.33$ ) +0.180019 * ( $GSOR - 3.00$ )	
		M	<1.33	0.774893
			(1.33, 2.33]	0.774893 + 0.04090968 * ( $GSOR - 1.33$ )
	(2.33, 3.00]		0.774893 +0.04090968 * ( $GSOR - 1.33$ ) -0.260166 * ( $GSOR - 2.33$ )	
	>3.00		0.774893 +0.04090968 * ( $GSOR - 1.33$ ) +0.180019 * ( $GSOR - 3.00$ ) -0.260166 * ( $GSOR - 2.33$ )	

(continued)

**Table 2.** (continued)

Dominant Orientation	Gender	GSOR	RHS of regression equation
<i>Idea</i>	F	<1.33	0.774893
		(1.33, 2.33]	0.774893
		(2.33, 3.00]	0.774893 -0.260166 * (GSOR - 2.33) +0.046970 * (GSOR - 2.33)
		>3.00	0.774893 +0.180019 * (GSOR - 3.00) -0.260166 * (GSOR - 2.33) +0.046970 * (GSOR - 2.33)
	M	<1.33	0.774893
		(1.33, 2.33]	0.774893
		(2.33, 3.00]	0.774893 -0.260166 * (GSOR - 2.33)
		>3.00	0.774893 +0.180019 * (GSOR - 3.00) -0.260166 * (GSOR - 2.33)

**Table 3.** Regression equation for CRS – comparison of impacts.

Dominant Orientation	Gender	GSOR	RHS of regression equation
<i>Action</i>	F	>3.00	0.774893 + 0.04090968 * (GSOR - 1.33) -0.117547 +0.180019 * (GSOR - 3.00) - 0.260166 * (GSOR - 2.33) +0.046970 * (GSOR - 2.33)
	M	>3.00	0.774893 + 0.04090968 * (GSOR - 1.33) +0.180019 * (GSOR - 3.00) - 0.260166 * (GSOR - 2.33)
<i>Idea</i>	F	>3.00	0.774893 +0.180019 * (GSOR - 3.00) - 0.260166 * (GSOR - 2.33) +0.046970 * (GSOR - 2.33)
	M	>3.00	0.774893 +0.180019 * (GSOR - 3.00) - 0.260166 * (GSOR - 2.33)

#### 4.1 VRS Model: Results and Discussion

In this model only *Security Orientation (GSOR)*, *Gender*, and *DominantDecisionStyle* (i.e. 'A', 'B', 'C', 'D') impact *Security Compliance Efficiency*, but in complex ways also (see Tables 4, 5 and 6). An examination of the 1<sup>st</sup> and 3<sup>rd</sup> rows of Table 6 suggests that when *GSOR* > 3.00 then individual with *Conceptual* decision style display less *Security Compliance Efficiency* than individuals with the other decision styles (i.e. *Analytical*, *Behavioral* and *Directive*).

**Table 4.** Regression equation for VRS.

RHS of Regression Equation
0.92517 - 0.13683*Max(0, GSOR-1.33) + 0.11648*Max(0, GSOR-3.00) - 0.096062*(1 if DominantDS is "C") *Max(0, GSOR -1.33)

**Table 5.** Detailed breakdown of regression equation for VRS.

Dominant Decision Style	GSOR	RHS of regression equation
<i>C: Conceptual</i>	<1.33	0.92517
	(1.33, 3.00]	0.92517 -0.13683 * (GSOR - 1.33) -0.096062 * (GSOR - 1.33)
	>3.00	0.92517 -0.13683 * (GSOR - 1.33) -0.096062 * (GSOR - 1.33) +0.11648 * (GSOR - 3.00)
<i>A: Analytic, or B: Behavioral, or D: Directive</i>	<1.33	0.92517
	(1.33, 3.00]	0.92517 -0.13683 * (GSOR - 1.33)
	>3.00	0.92517 -0.13683 * (GSOR - 1.33) +0.11648 * (GSOR - 3.00)

**Table 6.** Regression equation for VRS – comparison of impacts.

Dominant Decision Style	GSOR	RHS of regression equation
<i>C: Conceptual</i>	>3.00	0.92517 -0.13683 * (GSOR - 1.33) -0.096062 * (GSOR - 1.33) +0.11648 * (GSOR - 3.00)
<i>A: Analytic, or B: Behavioral, or D: Directive</i>	>3.00	0.92517 -0.13683 * (GSOR - 1.33) +0.11648 * (GSOR - 3.00)

## 5 Conclusion

In this paper we have explored the concept of *Security Compliance Efficiency*, and presented a hybrid DEA+MARS methodology for identifying its antecedents. Our search of the research literature did not provide evidence of previous research where the concept of *Security Compliance Efficiency*, as defined in this paper, was previously addressed. Yet given that cybersecurity challenges are common to both ‘developed’ countries and to ‘developing’ countries that are increasingly becoming ICT-oriented,

the issue of *Security Compliance Efficiency* is one that needs to be adequately addressed. This paper addresses that gap in the cybersecurity literature that has so far not addressed the *Security Compliance Efficiency* issue. In doing so we have made use of the well-established DEA methodology for generating relative efficiency scores. Rather than using traditional regression analysis for doing statistical analysis we used MARS as it allows us to not only identify if a given variable has a statistically significant impact but also conditions under which it has different types of impacts. It should also be noted that application of our hybrid two-stage DEA+MARS method involved both an input-oriented constant-returns-to-scale (CRS) DEA model, and an input-oriented variable-returns-to-scale (VRS) DEA model.

For illustrative purposes we used the causal model of Donalds and Osei-Bryson [13], but this methodology may be appropriately applied to any other causal model that has dimensions of *security compliance* as its dependent variable(s).

As noted earlier in the paper, organizations would be interested in knowing the impacts of non-discretionary variables on *Security Compliance Efficiency* since this would help them to identify the situations in which they can invest less while achieving the same level of compliance. We identified various non-trivial relationships (e.g. *Idea-oriented Females* display greater *Security Compliance Efficiency* than *Idea-oriented Males*).

## References

1. Accenture: 2017 Cost of Cyber Crime Study, p. 54. Ponemon Institute LLC & Accenture (2017)
2. McAfee Labs: McAfee labs threat report, September 2017 (2017)
3. Sasse, M.A., Flechais, I. (eds.): Usable Security: Why Do We Need It? How Do We Get It?. O'Reilly, Sebastopol (2005)
4. Warkentin, M., Willison, R.: Behavioral and policy issues in information systems security: the insider threat. *Eur. J. Inf. Syst.* **18**(2), 101–105 (2009)
5. Boss, S.R., Kirsch, L.J., Angermeier, I., Shingler, R.A., Boss, R.W.: If someone is watching, I'll do what I'm asked: mandatoriness, control, and information security. *Eur. J. Inf. Syst.* **18**, 151–164 (2009)
6. Bulgurcu, B., Cavusoglu, H., Benbasat, I.: Information security policy compliance: an empirical study of rationality-based beliefs and information security awareness. *MIS Q.* **34**(3), 523–548 (2010)
7. D'Arcy, J., Hovav, A., Galletta, D.: User awareness of security countermeasures and its impact on information systems misuse: a deterrence approach. *Inf. Syst. Res.* **20**(1), 79–98 (2009)
8. Donalds, C.: Cybersecurity policy compliance: an empirical study of Jamaican government agencies. In: SIG GlobDev Pre-ECIS Workshop, Munster, Germany (2015)
9. Herath, T., Rao, H.R.: Protection motivation and deterrence: a framework for security policy compliance in organisations. *Eur. J. Inf. Syst.* **18**(2), 106–125 (2009)
10. Stanton, J.M., Stam, K.R., Mastrangelo, P., Jolton, J.: Analysis of end user security behaviors. *Comput. Secur.* **24**(2), 124–133 (2005)
11. Bandura, A.: Self-efficacy: toward a unifying theory of behaviour change. *Psychol. Rev.* **84**(2), 191–215 (1977)
12. Compeau, D.R., Higgins, C.A.: Computer self-efficacy: development of a measure and initial test. *MIS Q.* **19**(2), 189–211 (1995)

13. Donalds, C., Osei-Bryson, K.-M.: Exploring the impacts of individual styles on security compliance behavior: a preliminary analysis. In: SIG ICT in Global Development, 10th Annual Pre-ICIS Workshop, Seoul, Korea (2017)
14. Ng, B.-Y., Kankanhalli, A., Xu, Y.C.: Studying users' computer security behavior: a health belief perspective. *Decis. Support Syst.* **46**(4), 815–825 (2009)
15. Nosek, B.A., Banaji, M.R., Greenwald, A.G.: Harvesting implicit group attitudes and beliefs from a demonstration web site. *Group Dyn.: Theory, Res., Pract.* **6**(1), 101–115 (2002)
16. Ifinedo, P.: Understanding information systems security policy compliance: an integration of the theory of planned behavior and the protection motivation theory. *Comput. Secur.* **31**(1), 83–95 (2012)
17. Vance, A., Siponen, M., Pahnla, S.: Motivating IS security compliance: insights from habit and protection motivation theory. *Inf. Manag.* **49**(3–4), 190–198 (2012)
18. Anwar, M., He, W., Ash, I., Yuan, X., Li, L., Xu, L.: Gender difference and employees' cybersecurity behaviors. *Comput. Hum. Behav.* **69**, 437–443 (2017)
19. Rowe, A.J., Boulgarides, J.D.: Decision styles—a perspective. *Leadersh. Organ. Dev. J.* **4**(4), 3–9 (1983)
20. Henderson, J.C., Nutt, P.C.: The influence of decision style on decision making behavior. *Manag. Sci.* **26**(4), 371–386 (1980)
21. Niu, H.-J.: Cyber peers' influence for adolescent consumer in decision-making styles and online purchasing behavior. *J. Appl. Psychol.* **43**(6), 1228–1237 (2013)
22. International Monetary Fund: Regional economic outlook: Sub-Saharan Africa. *World Economic and Financial Surveys*, p. 123 (2015)
23. World Economic Forum. <https://www.weforum.org/agenda/2015/08/why-smes-are-key-to-growth-in-africa/>. Accessed 29 July 2018
24. Banker, R.D., Natarajan, R.: Evaluating contextual variables affecting productivity. *Oper. Res.* **56**(1), 48–58 (2008)
25. Samoilenko, S.: Overview on data envelopment analysis. In: Osei-Bryson, K.-M., Ngwenyama, O. (eds.) *Advances in Research Methods for Information Systems Research*. ISIS, vol. 34, pp. 139–150. Springer, Boston (2014). [https://doi.org/10.1007/978-1-4614-9463-8\\_11](https://doi.org/10.1007/978-1-4614-9463-8_11)
26. Ayabakan, S., Bardhan, I.R., Zheng, Z.: A data envelopment analysis approach to estimate IT-enabled production capability. *MIS Q.* **41**(1), 189–205 (2017)
27. Samoilenko, S., Osei-Bryson, K.M.: Using data envelopment analysis (DEA) for monitoring efficiency-based performance of productivity-driven organizations: design and implementation of a decision support system. *Omega* **41**(1), 131–142 (2013)
28. Banker, R.D., Charnes, A., Cooper, W.W.: Some models for estimating technical and scale inefficiencies in data envelopment analysis. *Manag. Sci.* **30**(9), 1078–1092 (1984)
29. Behera, A.K., Verbert, J., Lauwers, B., Dufflou, J.R.: Tool path compensation strategies for single point incremental sheet forming using multivariate adaptive regression splines. *Comput.-Aided Des.* **45**(3), 575–590 (2013)
30. Osei-Bryson, K.M.: A hybrid decision support framework for generating & selecting causal explanatory regression splines models for information systems research. *Inf. Syst. Front.* **17**(4), 845–856 (2015)
31. Hastie, T., Tibshirani, R., Friedman, J.: *The elements of statistical learning: data mining, inference, and prediction*. Springer, New York (2001). <https://doi.org/10.1007/978-0-387-21606-5>
32. Hastie, T., Tibshirani, R.: *Generalized Additive Model*. Chapman and Hall, London (1990)
33. Rowe, A.J., Mason, R.O.: *Managing with Style: A Guide to Understanding Assessing, and Improving Decision Making*. Jossey-Bass, San Francisco (1987)



# A Critical Review of Edge and Fog Computing for Smart Grid Applications

Gilbert M. Gilbert<sup>(✉)</sup>, Shililiandumi Naiman, Honest Kimaro,  
and Burchard Bagile

University of Dar es Salaam, Dar es Salaam, Tanzania  
gilly.map@gmail.com, smakere@gmail.com,  
honest\_c@yahoo.com, bbagile@yahoo.com

**Abstract.** Smart grid and cloud computing architectures have been perfectly suiting each other naturally. As a result, over the years cloud computing architectures have dominated the implementations of smart grid applications to address computing needs. However, due to continuing additions of heterogeneous (sensing and actuating) devices, emergence of Internet of Things (IoT), and massive amount of data collected across the grids for analytics, have contributed to the complexity of smart grids, making cloud computing architectures no longer suitable to provide smart grid services effectively. Edge and Fog computing approaches have relieved the cloud computing architectures of problems related to network congestion, latency and locality by shift of control, intelligence and trust to the edge of the network. In this paper, a systematic literature review is used to explore the research trend of the actual implementations of edge and fog computing for smart grid applications. A total of 70 papers were reviewed from the popular digital repositories. The study has revealed that, there is significant increase in the number of smart grid applications that have exploited the use edge and fog computing approaches. The study also shows that, considerable number of the smart grid applications are related to energy optimizations and intelligent coordination of smart grid resources. There are also challenges and issues that hinder smooth adoption of edge and fog computing for smart grid applications, which include security, interoperability and programming models.

**Keywords:** Smart grid · Applications · Edge computing

## 1 Introduction

Electric power systems are the most important infrastructures to drive the industrial economy of any state. These infrastructures are linked to many aspects human development and well-being. As the demands for more energy keep on increasing, so is the need of technologies for effective and intelligent management of power grids. Smart grid is a type of cyber-physical system (CPS) that enables the electric power grid to co-exist with information and communication technologies (ICT). As defined in [1] and [2], smart grid:



*“uses sensing, embedded processing and digital communications to enable the electricity grid to be observable (able to be measured and visualised), controllable (able to be manipulated and optimised), automated (able to adapt and self-heal), fully integrated (fully interoperable with existing systems and with the capacity to incorporate a diverse set of energy sources)”.*

This modernized infrastructure is considered as intelligent, secure, reliable, economic and friendly to environment. However, smart grid infrastructures are still very complex due to sheer number of different (heterogeneous) devices (sensors, smart meters, and actuators), huge geographical size and the use computationally intensive models for control, analysis, optimization and simulation [3]. Over the years, cloud computing infrastructures have been the dominant solutions to handle heavy computational tasks related to smart grid applications [4]. Cloud computing offers its services on-demand, which enables data, gathered across the grid to be processed in an efficient manner. Therefore, the architectures of smart grids and cloud computing are suiting each other perfectly as natural partners [5].

As the number of devices in smart grid continues to grow as well as the rise of Internet of Things (IoT), cloud computing can no longer satisfy all the computing requirements needed by smart grid applications. Cloud computing is susceptible to high latency and network congestions, and it is insensitive to locations or source of data and mobility. Therefore, some delay-sensitive applications are seriously affected and their outcome can escalate to wrong grid states. To enable de-centralized computing, as opposed to cloud computing, some computations need to be performed close to the source (edges) of the data to minimize data movement and unnecessary computations at the cloud [6]. Moreover, latency-sensitive and geo-based applications can benefit from this approach. Edge computing compliments the cloud computing by extending the services to the edges of the network, and hence improving quality of services and experience.

In edge computing, there is a transfer of a control from a central system to the extreme nodes. Moreover, some intelligence, trust and data are retained at the network peripherals [7]. There are variants of edge computing approaches including fog computing, dew computing and mobile edge computing. Some researchers do treat these approaches as different by arguing that edge computing approaches mean edge routers, base stations, and home gateway, while fog computing is inclusive of cloud, core, metro, edge, clients, and things [8]. Others postulate that, with edge computing control resides on the device itself (sensor or actuator), while in fog computing control is down to the level of local area network [9]. A number of researchers still agree that edge computing and fog computing can be used interchangeably as related field [7]. However, many studies in smart grid have addressed their research using fog computing. Despite the differences of these concepts in terms of implementation, there is a common consensus on modality of their operations, that, peripheral nodes are expected to respond to computing demands.

Several reviews and surveys have been published to address edge and fog computing concepts. These studies [10–13] have to a greater extent discussed about advantages, architectures, applications and research issues. To the best of the authors’ knowledge, there is yet to be found any publication that systematically review literatures on edge and fog computing implementations for smart grid applications. Studies by [6] and [14] provide promises on the suitability of these computing platforms to

smart grid applications. This paper uses systematic literature review to investigate research trend in the adoption of edge computing approaches for smart grid applications from existing literatures. This review provides a comprehensive picture of the status of smart grid applications implementations using edge computing platforms. The review aims at summarizing and obtaining the comprehension of edge and fog computing with respect to its usage, applications and challenges in smart grid by answering the following three research questions:

1. What are the current edge and computing requirements and usage for smart grid (electric power systems) applications?
2. Which smart grid applications currently are benefiting from edge computing implementation?
3. What are the potential challenges with edge computing for smart grid applications?

## 2 Methodology

After reviewing the literature on edge and fog computing, it was found that there are significant number of studies that have conducted literature review on this field. Most of these studies offer overview of edge and fog computing in terms of principles, architectures and applications. Therefore, the author chose to conduct a systematic literature review in an effort to attain an outline of the edge and fog computing for smart grid applications focusing on real and practical implementations. This review is conducted using the reference manual adapted from [15].

### 2.1 Data Search Strategy

In the context of this study, the types of publications considered were journal articles, books, book chapters, conference papers and book reviews. Studies relevant to edge and fog computing for smart grid applications were searched using a combination of agreed-upon keywords. The publications were searched based on popular digital repositories which include Google scholar, ScienceDirect, EBSCO, Education Resources Information Center (ERIC), Taylor & Francis, IngentaConnect, Emerald, Institute of Electrical and Electronics Engineers (IEEE) Xplore Digital Library, Computer Society Digital Library (CSDL), Association for Computing Machinery (ACM) Digital Library, Springer Link and Wiley Online Library.

The list of keywords used to define the search string are: edge, fog, mobile, computing, architecture, smart grid, electric power system, application, challenge, integration, orchestration, coordination and issue. To generate the final search term, the two Boolean operators AND and OR were employed to connect the keywords together. A quotation mark is also used for exact text. As a result, the ultimate search strings are:

“Edge computing” AND (“smart grid” OR electric “power system\*” OR “smartgrid”) AND (application\* OR service\*) AND (integration OR orchestration OR coordination OR interoperability OR integration) AND (challenge\* OR issue\*)

“Fog computing” AND ((“smart grid” OR electric “power system\*” OR “smartgrid”) AND (application\* OR service\*)) AND (integration OR orchestration OR coordination OR interoperability OR integration) AND (challenge\* OR issue\*)

This research query was used retrieve publications from IEEE, ScienceDirect, Springer and Arxiv. ACM library does not support a query with Booleans, therefore its search queries were: +(*“edge computing”*) + (*“smart grid” “challenge” “application”*) and +(*“fog computing”*) + (*“smart grid” “challenge” “application”*).

In choosing the publications, the search strings were applied in each of the selected databases in the advanced search option. Irrelevant papers were omitted after filtering the results. Then, inclusion and exclusion criteria were considered to narrow down the results by studying abstracts of the papers. To confirm their inclusion, the remaining papers were read in full-text.

**2.2 Study Selection Procedure**

After publications retrieval, unrelated papers were removed by applying a set of inclusion and exclusion criteria as shown in Table 1.

**Table 1.** A set of inclusion and exclusion criteria

Inclusion criteria	Exclusion criteria
<ol style="list-style-type: none"> <li>1. Papers that explicitly discuss edge and fog computing and their varieties in smart grid applications</li> <li>2. Papers that mention and analyze an architectures for the edge and fog computing in smart grid applications</li> <li>3. Papers that detail how edge and fog computing are advantageous to an application or a domain, in this case smart grid applications</li> <li>4. Papers that are focused on presenting present challenges with edge and fog computing and smart grid application integration</li> <li>5. Papers that are discussing edge and fog with Internet of Things (IoT) in smart grid applications</li> <li>6. Papers that are accessible and retrievable</li> <li>7. Papers that are from 2015 since edge (and fog) computing is a relatively new paradigm</li> </ol>	<ol style="list-style-type: none"> <li>1. Papers that do not have edge and fog computing for smart grid applications as a primary study</li> <li>2. Papers that are mainly discussing cloud computing or Internet of Things (IoT) issues</li> <li>3. Papers that are inaccessible</li> </ol>

**2.3 Data Extraction and Analysis**

Papers information were recorded in an Excel form that was created as instructed in the guideline by [15]. The information was used to separate primary studies and align the papers according to research questions. The collected information includes papers’

titles, source, and accessibility. The other fields were used for filtering, that is, if titles, abstracts and full-texts meet criteria. A note filter was also included to store comment of why the paper has been retained or removed. The papers that met the specified criteria as Yes were then recorded to a new sheet for addressing the research questions.

The search process was conducted between September and October 2018, with initial total of 830 of articles published between 2004 and 2019. However, in this paper, the search considered only papers published from 2015 to 2019 for analysis. This is due to maturity of these computing technologies started in the early 2015. Articles that were opinion articles, conceptual articles, or technical notes were not considered. Other articles were removed as a result of titles, keywords and abstracts analysis. The paper filtering process is shown in Table 2.

**Table 2.** Publications filtering process

Digital repository	Initial results before filtering	Title and keyword selected	Abstracts selected	Full text selected
ACM	308	144	36	6
IEEE	94	62	41	28
Science direct	181	51	36	10
Springer	188	65	22	15
Wiley Online	44	26	5	4
Arxiv	15	7	7	7
Results	830	355	147	70

### 3 Analysis and Discussion

#### 3.1 Analysis

Out of the 70 publications chosen for full-text reading, 62 papers were considered as primary studies. They were then mapped into three aforementioned research questions. Table 3 shows the results of the final literature review.

**Table 3.** Mapping of research questions to publications

Research question	Publications
1	[6, 16–52]
2	[19, 24, 26, 30, 34, 36, 38, 46, 48, 53–64]
3	[13, 21, 23, 27, 35, 41, 42, 55, 65–69]

As shown in Table 4, edge and fog computing technologies have been increasingly attracting the attention of power system researchers and practitioners. There is significant increase of publications year after starting from 2015. However, it should be

noted that, 2019 articles that were considered are those that were scheduled to be published in 2019 when this study was conducted.

**Table 4.** Publications trend between 2015 and 2019

Digital repositories	Year				
	2015	2016	2017	2018	2019
ACM, IEEE, Science Direct, Springer, Wiley Online, Arxiv	11	49	148	262	52

### 3.2 Discussion

#### Research Question One

Various researchers [3, 14, 16, 21, 70] have proposed features of edge computing that fit to the requirements of smart grid applications implementation. The following are the features: Support for real-time, that is, reducing latency and responsive time [38, 47–51], Support for Scalability [68], Decentralization [6, 16–18, 51, 52, 68], Consistency [19], Heterogeneity [20–22], Intelligent coordination [23–27], Optimal design/Resource utilization [28–36], Privacy and Security [16, 17, 37, 39–42], Data Mining and Storage [43–45], Virtualization [46], Energy Efficiency [51, 71].

With regard to supporting real-time applications, Islam and Hashem [38] suggested a hierarchical infrastructure for big data management for customer's real-time services. Zhang et al. [47] demonstrated application of power internet of thing by taking advantage of reducing dependence on the cloud center.

In the context of scalability, Bakken et al. [68] proposed an architecture that consisted of three layers in terms of ICT platform services, power services, and power applications to reduce stress in power grids. They then reviewed algorithms for enhancing edge services in power grid.

As far as decentralization is concerned, Yan and Su [52] introduced an implantable data storage-and-processing solution for reducing the workload in centralized-based information processing architectures. In their work, researchers Eisele et al. [18] presented a component-based decentralized software platform for resiliency by allowing applications to discover each other.

Intelligent coordination of resources and applications is one of the features of edge computing that has been greatly exploited by researchers to develop smart grid applications. A research work by Wang et al. [27] devised a software based scheme to coordinate tasks for scheduling and collaboration. Moreover, Al-jarood et al. [25], put forward a service-oriented middleware to facilitate effective integration and utilization of computing resources.

Many studies for smart grid applications have well delved in optimal design and resource utilization. Zahoor et al. [28] modelled cloud-fog a hierarchical structure with algorithms for resource management. Another work by Fatima et al. [32] provide a resource allocation model to optimize resources in residential buildings. Similar works can also be found in [34, 72].

Edge and fog computing approaches provide a platform for local computing that can address geo-restriction regulations, local security and privacy effectively compared to cloud computing. Han and Xiao [40] demonstrated the possibility of overcoming big data security challenges in smart grid by proposing a Map-Reduce style algorithm to detect non-technical fraud loss. In their work, Lyu et al. [42] used Gaussian mechanism to preserve privacy during smart meter data aggregation.

Data mining and storage in edge and fog computing help to reduce the burden of accessing large data sets from the central repository. Qureshi et al. [43] designed a strategy based in Map-Reduce to store in-place, partition-based and multi-homing block replica data blocks to edge nodes. Jaradat et al. [45] discussed techniques used for management of big data in smart grids.

Virtualization technologies are vital in both cloud and fog computing approaches by providing abstract platforms for multiple operating systems and applications to be able to run on the same hardware at the same time. A research work by Meloni et al. [46] proposed and validated a Cloud-IoT-based architectural solution for processing measurement data by exploiting virtualization technologies.

When it comes to energy management in edge and fog computing, Aujla and Kumar [71] proposed an energy management scheme for sustainability of cloud data centers in the edge cloud environment using Software Defined Network (SDN). Similarly, a study by Minh et al. [51] proposed a novel service placement mechanism for balancing energy consumption of computing entities.

### **Research Question Two**

From the literature, varieties of smart grid applications are improved by edge and fog computing. The applications are: Advance metering [52, 63, 73], Electricity market analysis ([26]), Dynamic analysis and control/state estimation [46], Load and reactive power balance [30, 53, 54, 64], Power system protection/Monitoring [19, 54, 55], Distributed generation/automation ([36, 58, 59]), Data Management [38, 59], Energy Management [24, 34, 48, 60–63].

### **Research Question Three**

What are the potential challenges and research issues with the adoption edge computing for smart grid applications?

From the literatures, there still exist a number of potential challenges in the use of edge computing for smart grid applications. The following are the identified challenges and research issues that need the attention of the scholars and stakeholders.

Programming model [27, 68]: The heterogeneity of devices and platforms in edge computing causes difficulties for programmers to develop applications that are cross-cutting. In addition, research effort is needed on how to manage many applications and movement of edge servers, cloud and nodes.

Formal Specification [16]: In complex system and software engineering, formal systems are used to model the interactivity of different components. In smart grid applications, a lot of effort has been on the practical aspects, therefore, attention is lacking on formalism [74, 75].

Security [21, 41, 55, 65]: Despite the promise of edge computing approaches to minimize security issues, there are still some challenges. As data are processed at the edge of the network, attackers could exploit the weak security systems of edge devices.

Attackers could also temper with smart gateways. Yu et al. [13] and Abbas et al. [12] have expanded the dimensions of seriousness of security issues in edge and mobile computing. Research is needed to balance real-time requirements and delay due security processing at edge nodes and gateways.

Integration and interoperability [14, 25, 66]: Edge and fog computing systems are mostly heterogeneous. There are always challenges in management of applications running in different platforms. Computational offloading could be difficult to orchestrate due to heterogeneous processor architectures [12]. Research direction on this aspect efficient computational offloading model for real time scenario [67].

Data aggregation [35, 42, 65]: In smart grid, data aggregation is an important process in power analytics for prediction power consumption, network planning and power pricing. The major challenge in data aggregation is privacy and security of measurements. Since aggregation can be done regional-wise, employed techniques can also be an issue due to data integration and consistency. Research is needed on speedy aggregation techniques and workload distribution among nodes.

Edge devices placement planning [67]: Placement of edge nodes and devices should carefully planned to meet computational needs. This is to ensure consistency of connectivity as well as load balancing. Since presence or absence of edge device may influence resource management schemes, research is needed on the policy to ensure efficient distributed workload system.

## 4 Conclusion

This paper presents a literature review on edge and fog computing and their adoption in smart grid applications. Out of 830 papers, 70 met the specified criteria, and were critically reviewed. From the study, it could be revealed that, currently smart grid applications are being developed to exploit edge-computing technologies. Compared to previous studies that concentrated on the concepts and principles of edge and fog computing generally, this study have shown an increase in the adoption of edge and fog computing approaches in real, practical and field implementation of smart grid applications year after year. However, despite the promises and opportunities of edge computing presented in this paper, there are still some clear challenges related to security, interoperability and common platform of programming models. Moreover, most of the reviewed articles are from developed countries in Europe, American and Asia, which suggest how far they are in smart grid implementations. Future research directions, therefore, need to address the state of smart grid implementations in developing world [76]. Researches should go deeper into determining the cost-effectiveness of computing technologies, accessibility, data management as well as security and privacy as decisions to smart grid move are made. A study could also be widened to include other academic databases to ascertain the practicability of edge computing in smart grid.

## References

1. Ekanayake, J., Liyanage, K., Wu, J., Yokoyama, A., Jenkins, N.: *Smart Grid: Technology and Applications*. Wiley, Hoboken (2012)
2. DECC Department of Energy and Climate Change: *Smarter Grids: The Opportunity*. 30 (2009)
3. Green, R.C., Wang, L., Alam, M.: Applications and trends of high performance computing for electric power systems: Focusing on smart grid. *IEEE Trans. Smart Grid*. **4**, 922–931 (2013)
4. Naveen, P., Ing, W.K., Danquah, M.K., Sidhu, A.S., Abu-Siada, A.: Cloud computing for energy management in smart grid - an application survey. In: *IOP Conference Series: Materials Science and Engineering*, p. 121 (2016)
5. Birman, K., Ganesh, L., van Renesse, R.: Running smart grid control software on cloud computing architectures. In: *Computational Needs for the Next Generation Electric Grid*, pp. 1–33 (2011)
6. Boccadoro, P.: *Smart Grids empowerment with Edge Computing: An Overview* (2018)
7. Garcia Lopez, P., et al.: Edge-centric computing. *ACM SIGCOMM Comput. Commun. Rev.* **45**, 37–42 (2015)
8. Chiang, M., Ha, S., Chih-Lin, I., Rizzo, F., Zhang, T.: Clarifying fog computing and networking: 10 questions and answers. *IEEE Commun. Mag.* **55**, 18–20 (2017)
9. Klonoff, D.C.: Fog computing and edge computing architectures for processing data from diabetes devices connected to the medical internet of things. *J. Diabetes Sci. Technol.* **11**, 647–652 (2017)
10. Thien, A.T., Colomo-Placios, R.: A systematic literature review of fog computing. *Nokobit* **2016**(24), 28–30 (2016)
11. Mouradian, C., Naboulsi, D., Yangui, S., Glietho, R.H., Morrow, M.J., Polakos, P.A.: A comprehensive survey on fog computing: state-of-the-art and research challenges. *IEEE Commun. Surv. Tutor.* **20**, 416–464 (2018)
12. Abbas, N., Zhang, Y., Taherkordi, A., Skeie, T.: Mobile edge computing: a survey. *IEEE Internet Things J.* **5**, 450–465 (2018)
13. Yu, W.: A survey on the edge computing for the internet of things. *IEEE Access.* **6**, 6900–6919 (2017)
14. Muzakkir Hussain, M., Alam, M.S., Sufyan Beg, M.M.: Feasibility of fog computing in smart grid architectures. In: Krishna, C.R., Dutta, M., Kumar, R. (eds.) *Proceedings of 2nd International Conference on Communication, Computing and Networking*. LNNS, vol. 46, pp. 999–1010. Springer, Singapore (2019). [https://doi.org/10.1007/978-981-13-1217-5\\_98](https://doi.org/10.1007/978-981-13-1217-5_98)
15. Kitchenham, B., Charters, S.: *Guidelines for performing systematic literature reviews in software engineering*, version 2.3 (2007)
16. Okay, F.Y., Ozdemir, S.: A fog computing based smart grid model. In: *2016 International Symposium on Networks, Computers and Communications, ISNCC 2016*, pp. 1–6 (2016)
17. Dubey, A., Karsai, G., Pradhan, S.: Resilience at the edge in cyber-physical systems. In: *2017 2nd International Conference on Fog and Mobile Edge Computing, FMEC 2017*, pp. 139–146. ACM, Austin (2017)
18. Eisele, S., Mardari, I., Dubey, A., Karsai, G.: RIAPS: resilient information architecture platform for decentralized smart systems. In: *Proceedings of 2017 IEEE 20th International Symposium on Real-Time Distributed Computing, ISORC 2017*, pp. 125–132. ACM, Santa Barbara (2017)



19. Yang, Z., Chen, N., Chen, Y., Zhou, N.: A novel PMU fog based early anomaly detection for an efficient wide area PMU network. In: 2018 IEEE 2nd International Conference on Fog and Edge Computing, IC FEC 2018 - In Conjunction with 18th IEEE/ACM International Symposium on Cluster, Cloud and Grid Computing, IEEE/ACM CCGrid 2018, pp. 1–10. ACM, New Delhi (2018)
20. Risteska Stojkoska, B.L., Trivodaliev, K.V.: A review of internet of things for smart home: challenges and solutions. *J. Clean. Prod.* **140**, 1454–1464 (2017)
21. Jiang, R., Lu, R., Choo, K.K.R.: Achieving high performance and privacy-preserving query over encrypted multidimensional big metering data. *Future Gener. Comput. Syst.* **78**, 392–401 (2018)
22. Xiao, J., Kou, P.: A hierarchical distributed fault diagnosis system for hydropower plant based on fog computing. In: Proceedings of the 2017 IEEE 2nd Information Technology, Networking, Electronic and Automation Control Conference, ITNEC 2017, pp. 1138–1142 (2018)
23. Tehreem, K., Javaid, N., Bano, H., Ansar, K., Waheed, M., Butt, H.: A cloud-fog based environment using beam search algorithm in smart grid. Presented at the 5 September 2019
24. Yaghmaee Moghaddam, M.H., Leon-Garcia, A.: A fog-based internet of energy architecture for transactive energy management systems. *IEEE Internet Things J.* **5**, 1055–1069 (2018)
25. Al-Jaroodi, J., Mohamed, N., Jawhar, I., Mahmoud, S.: CoTWARE: a cloud of things middleware. In: Proceedings of IEEE 37th International Conference on Distributed Computing Systems Workshops, ICDCSW 2017, pp. 214–219 (2017)
26. Shahryari, K., Anvari-Moghaddam, A.: Demand side management using the internet of energy based on fog and cloud computing. In: Proceedings of 2017 IEEE International Conference on Internet of Things, IEEE Green Computing and Communications, IEEE Cyber, Physical and Social Computing, IEEE Smart Data, iThings-GreenCom-CPSCoM-SmartData 2017, pp. 931–936 (2018)
27. Wang, P., Liu, S., Ye, F., Chen, X.: A fog-based architecture and programming model for IoT applications in the smart grid (2018)
28. Zahoor, S., Javaid, N., Khan, A., Ruqia, B., Muhammad, F.J., Zahid, M.: A cloud-fog-based smart grid model for efficient resource utilization. In: 2018 14th International Wireless Communications and Mobile Computing Conference, IWCMC 2018, pp. 1154–1160 (2018)
29. Mishra, J., Sheetani, J., Reddy, K.H.K., Roy, D.S.: A novel edge-supported cost-efficient resource management approach for smart grid system. *Adv. Intell. Syst. Comput.* **710**, 369–380 (2018)
30. Ismail, M., Javaid, N., Zakria, M., Zubair, M., Saeed, F., Zaheer, M.A.: Cloud-fog based smart grid paradigm for effective resource distribution. Presented at the 5 September 2019
31. Nazir, S., Shafiq, S., Iqbal, Z., Zeeshan, M., Tariq, S., Javaid, N.: Cuckoo optimization algorithm based job scheduling using cloud and fog computing in smart grid. Presented at the 5 September 2019
32. Fatima, A., Javaid, N., Waheed, M., Nazar, T., Shabbir, S., Sultana, T.: Efficient resource allocation model for residential buildings in smart grid using fog and cloud computing. In: Barolli, L., Xhafa, F., Javaid, N., Enokido, T. (eds.) IMIS 2018. AISC, vol. 773, pp. 289–298. Springer, Cham (2019). [https://doi.org/10.1007/978-3-319-93554-6\\_26](https://doi.org/10.1007/978-3-319-93554-6_26)
33. Mehmood, M., Javaid, N., Akram, J., Abbasi, S.H., Rahman, A., Saeed, F.: Efficient resource distribution in cloud and fog computing. In: Barolli, L., Kryvinska, N., Enokido, T., Takizawa, M. (eds.) NBiS 2018. LNDECT, vol. 22, pp. 209–221. Springer, Cham (2019). [https://doi.org/10.1007/978-3-319-98530-5\\_18](https://doi.org/10.1007/978-3-319-98530-5_18)

34. Ahmad, N., Javaid, N., Mehmood, M., Hayat, M., Ullah, A., Khan, H.A.: Fog-cloud based platform for utilization of resources using load balancing technique. In: Barolli, L., Kryvinska, N., Enokido, T., Takizawa, M. (eds.) *NBiS 2018. LNDECT*, vol. 22, pp. 554–567. Springer, Cham (2019). [https://doi.org/10.1007/978-3-319-98530-5\\_48](https://doi.org/10.1007/978-3-319-98530-5_48)
35. Carvalho, O., Garcia, M., Roloff, E., Carreño, E.D., Navaux, P.O.A.: IoT workload distribution impact between edge and cloud computing in a smart grid application. *Commun. Comput. Inf. Sci.* **796**, 203–217 (2018)
36. Ning, S., Ge, Q., Jiang, H.: Research on distributed computing method for coordinated cooperation of distributed energy and multi-devices. In: 2018 33rd Youth Academic Annual Conference of Chinese Association of Automation (YAC), pp. 905–910 (2018)
37. Alrawais, A., Alhothaily, A., Hu, C., Xing, X., Cheng, X.: An attribute-based encryption scheme to secure fog communications. *IEEE Access.* **5**, 9131–9138 (2017)
38. Islam, T., Hashem, M.M.A.: A big data management system for providing real time services using fog infrastructure. In: 2018 IEEE Symposium on Computer Applications and Industrial Electronics, ISCAIE 2018, pp. 85–89 (2018)
39. Beligianni, F., Alamaniotis, M., Fevgas, A., Tsompanopoulou, P., Bozaris, P., Tsoukalas, L. H.: An internet of things architecture for preserving privacy of energy consumption. In: *Mediterranean Conference on Power Generation, Transmission, Distribution and Energy Conversion, MedPower 2016*, p. 107 (7)–107 (7) (2016)
40. Han, W., Xiao, Y.: Big data security analytic for smart grid with fog nodes. In: Wang, G., Ray, I., Alcaraz Calero, Jose M., Thampi, Sabu M. (eds.) *SpaCCS 2016. LNCS*, vol. 10066, pp. 59–69. Springer, Cham (2016). [https://doi.org/10.1007/978-3-319-49148-6\\_6](https://doi.org/10.1007/978-3-319-49148-6_6)
41. Sani, A.S., Yuan, D., Jin, J., Gao, L., Yu, S., Dong, Z.Y.: Cyber security framework for Internet of Things-based Energy Internet. *Futur. Gener. Comput. Syst.* (2018)
42. Lyu, L., Nandakumar, K., Rubinstein, B., Jin, J., Bedo, J., Palaniswami, M.: PFFA: privacy preserving fog-enabled aggregation in smart grid. *IEEE Trans. Ind. Inform.* **14**, 3733–3744 (2018)
43. Qureshi, N.M.F., et al.: An aggregate MapReduce data block placement strategy for wireless IoT edge nodes in smart grid. *Wirel. Pers. Commun.* **1**, 1–12 (2018)
44. Barik, R.K., et al.: FogGrid : leveraging fog computing for enhanced smart grid network. In: 14TH IEEE India Council International Conference, INDICON 2017, pp. 1–6 (2017)
45. Jaradat, M., Jarrah, M., Bouselham, A., Jararweh, Y., Al-Ayyoub, M.: The internet of energy: Smart sensor networks and big data management for smart grid. *Proced. Comput. Sci.* **56**, 592–597 (2015)
46. Meloni, A., Pegoraro, P.A., Atzori, L., Benigni, A., Sulis, S.: Cloud-based IoT solution for state estimation in smart grids: exploiting virtualization and edge-intelligence technologies. *Comput. Netw.* **130**, 156–165 (2018)
47. Zhang, Y., Liang, K., Zhang, S., He, Y.: Applications of edge computing in PloT. In: *Proceedings of 2017 IEEE Conference on Energy Internet and Energy System Integration, EI2 2017*, pp. 1–4 (2018)
48. Chen, Y.D., Azhari, M.Z., Leu, J.S.: Design and implementation of a power consumption management system for smart home over fog-cloud computing. In: 2018 International Conference on Intelligent Green Building and Smart Grid, IGBSG 2018, pp. 1–5 (2018)
49. Hussain, M., Alam, M.S., Beg, M.M.S.: Fog assisted cloud models for smart grid architectures - comparison study and optimal deployment, pp. 1–27 (2018)
50. Kumar, S., Agarwal, S., Krishnamoorthy, A., Vijayarajan, V., Kannadasan, R.: Improving the response time in smart grid using fog computing. In: Kulkarni, A.J., Satapathy, S.C., Kang, T., Kashan, A.H. (eds.) *Proceedings of the 2nd International Conference on Data Engineering and Communication Technology. AISC*, vol. 828, pp. 563–571. Springer, Singapore (2019). [https://doi.org/10.1007/978-981-13-1610-4\\_57](https://doi.org/10.1007/978-981-13-1610-4_57)

51. Minh, Q.T., Nguyen, D.T., Van Le, A., Nguyen, H.D., Truong, A.: Toward service placement on fog computing landscape. In: Proceedings of 2017 4th NAFOSTED Conference on Information and Computer Science, NICS 2017, pp. 291–296 (2017)
52. Yan, Y., Su, W.: A fog computing solution for advanced metering infrastructure. In: Proceedings of the IEEE Power Engineering Society Transmission and Distribution Conference, pp. 1–4 (2016)
53. Rabie, A.H., Ali, S.H., Ali, H.A., Saleh, A.I.: A fog based load forecasting strategy for smart grids using big electrical data (2018). <http://dx.doi.org/10.1007/s10586-018-2848-x>
54. Jiang, Z., Shah, H., Rojas-Cessa, R., Grebel, H., Mohamed, A.: Experimental evaluation of power distribution to reactive loads in a network-controlled delivery grid. In: 2018 3rd International Conference on Fog and Mobile Edge Computing, FMEC 2018, pp. 199–204 (2018)
55. Cao, H., Liu, S., Wu, L., Guan, Z., Du, X.: Achieving differential privacy against non-intrusive load monitoring in smart grid: a fog computing approach. *Concurr. Comput. Pract. Exp.*, p. e4528 (2018)
56. Mousavi, M.J., Stoupis, J., Saarinen, K.: Event zone identification in electric utility systems using statistical machine learning. In: 2018 IEEE/PES Transmission and Distribution Conference and Exposition (T&D), pp. 1–9 (2018)
57. Khan, S., Paul, D., Momtahan, P., Aloqaily, M.: Artificial intelligence framework for smart city microgrids: state of the art, challenges, and opportunities. In: 2018 3rd International Conference on Fog and Mobile Edge Computing, FMEC 2018, pp. 283–288 (2018)
58. Tom, R.J., Sankaranarayanan, S.: IoT based SCADA integrated with fog for power distribution automation. In: Iberian Conference on Information Systems and Technologies, CISTI, pp. 1–4. ACM, Santa Clara (2017)
59. Kumar, N., Zeadally, S., Rodrigues, J.J.P.C.: Vehicular delay-tolerant networks for smart grid data management using mobile edge computing. *IEEE Commun. Mag.* **54**, 60–66 (2016)
60. Naeem, M., Javaid, N., Zahid, M., Abbas, A., Rasheed, S., Rehman, S.: Cloud and fog based smart grid environment for efficient energy management. In: Xhafa, F., Barolli, L., Greguš, M. (eds.) INCoS 2018. LNDECT, vol. 23, pp. 514–525. Springer, Cham (2019). [https://doi.org/10.1007/978-3-319-98557-2\\_48](https://doi.org/10.1007/978-3-319-98557-2_48)
61. KaleemUllah Khan, M., Javaid, N., Murtaza, S., Zahid, M., Ali Gilani, W., Junaid Ali, M.: Efficient energy management using fog computing. In: Barolli, L., Kryvinska, N., Enokido, T., Takizawa, M. (eds.) NBiS 2018. LNDECT, vol. 22, pp. 286–299. Springer, Cham (2019). [https://doi.org/10.1007/978-3-319-98530-5\\_24](https://doi.org/10.1007/978-3-319-98530-5_24)
62. Naqvi, S.A.A., Javaid, N., Butt, H., Kamal, M.B., Hamza, A., Kashif, M.: Metaheuristic optimization technique for load balancing in cloud-fog environment integrated with smart grid. In: Barolli, L., Kryvinska, N., Enokido, T., Takizawa, M. (eds.) NBiS 2018. LNDECT, vol. 22, pp. 700–711. Springer, Cham (2019). [https://doi.org/10.1007/978-3-319-98530-5\\_61](https://doi.org/10.1007/978-3-319-98530-5_61)
63. Matta, N., Rahim-Amoud, R., Merghem-Bouhahia, L., Jrad, A.: Putting sensor data to the service of the smart grid: from the substation to the AMI. *J. Netw. Syst. Manage.* **26**, 108–126 (2018)
64. Rasheed, S., Javaid, N., Rehman, S., Hassan, K., Zafar, F., Naeem, M.: A cloud-fog based smart grid model using max-min scheduling algorithm for efficient resource allocation. In: Barolli, L., Kryvinska, N., Enokido, T., Takizawa, M. (eds.) NBiS 2018. LNDECT, vol. 22, pp. 273–285. Springer, Cham (2019). [https://doi.org/10.1007/978-3-319-98530-5\\_23](https://doi.org/10.1007/978-3-319-98530-5_23)
65. Okay, F.Y., Ozdemir, S.: A secure data aggregation protocol for fog computing based smart grids. In: Proceedings of 2018 IEEE 12th International Conference on Compatibility, Power Electronics and Power Engineering, CPE-POWERENG 2018, pp. 1–6 (2018)

66. Aujla, G.S., Chaudhary, R., Kumar, N., Kumar, R., Rodrigues, J.J.P.C.: An ensemble scheme for QoS-aware traffic flow management in software defined networks. In: IEEE International Conference on Communications, pp. 1–7 (2018)
67. El-Sayed, H., et al.: Edge of things: the big picture on the integration of edge, IoT and the cloud in a distributed computing environment. *IEEE Access*. **6**, 1706–1717 (2017)
68. Bakken, D., et al.: Towards enhanced power grid management via more dynamic and flexible edge computations. In: 2017 IEEE Fog World Congress, FWC 2017, pp. 1–8 (2018)
69. Akram, W., Niazi, M.A.: A formal specification framework for smart grid components. *Complex Adapt. Syst. Model.* **6**, 5 (2018)
70. Hussain, M.M., Alam, M.S., Beg, M.M.S.: Fog computing in IoT aided smart grid transition- requirements, prospects, status quos and challenges (2018)
71. Aujla, G.S., Kumar, N.: MEnSuS: An efficient scheme for energy management with sustainability of cloud data centers in edge–cloud environment. *Futur. Gener. Comput. Syst.* **86**, 1279–1300 (2018)
72. Fatima, I., Javaid, N., Iqbal, M.N., Shafi, I., Anjum, A., Ullah Memon, U.: Integration of cloud and fog based environment for effective resource distribution in smart buildings. In: 2018 14th International Wireless Communications and Mobile Computing Conference, IWCMC 2018, pp. 60–64 (2018)
73. Nazmudeen, M.S.H., Wan, A.T., Buhari, S.M.: Improved throughput for power line communication (PLC) for smart meters using fog computing based data aggregation approach. In: Proceedings of IEEE 2nd International Smart Cities Conference: Improving the Citizens Quality of Life, ISC2 2016, pp. 1–4 (2016)
74. Hackenberg, G., Irlbeck, M., Koutsoumpas, V., Bytschkow, D.: Applying formal software engineering techniques to smart grids. In: Proceedings of 2012 1st International Workshop on Software Engineering Challenges for the Smart Grid, SE-SmartGrids 2012, pp. 50–56 (2012)
75. Rohjans, S., Lehnhoff, S., Schütte, S., Andrén, F., Strasser, T.: Requirements for smart grid simulation tools. In: IEEE International Symposium on Industrial Electronics, pp. 1730–1736 (2014)
76. Young, J.: Smart grid technology in the developing world. Honors Projects (2017)



# Information Security Culture Assessment of Small and Medium-Sized Enterprises in Tanzania

Zainab Ruhwanya<sup>(✉)</sup>  and Jacques Ophoff<sup>(✉)</sup> 

University of Cape Town, Cape Town, South Africa  
RHWZAI001@myuct.ac.za, jacques.ophoff@uct.ac.za

**Abstract.** This study explores the status of information security culture (ISC) of small and medium-sized enterprises (SMEs) in sub-Saharan Africa (SSA) using Tanzania as a case. To assess the ISC of SMEs, measurement criteria from organizational and environmental dimensions were compiled from the literature. A combination of quantitative and qualitative methods was employed to collect data. The ISC dimensions were assessed using surveys collected using both paper and online sources, from 39 SMEs in the roundtable and five focus group discussions. The findings indicated lack of information security policy, absence of security education, training and awareness (SETA) programs, lack of human resource, poor risk assessment, and management and lack of national information security culture initiatives. These findings show the immaturity of ISC in SMEs in Tanzania. The results and implications of these findings suggest further research and intervention is necessary to institutionalize ISC in the SME environment.

**Keywords:** Information security culture · Information security · Security · Culture · Small and medium-sized enterprises · Tanzania · Sub-Sahara Africa

## 1 Introduction

Fifty-eight percent (58%) of small and medium-sized enterprises (SMEs) experienced security attacks and data breaches in 2018 [1]. In today's ever-increasing information security threats landscape, cultivating information security culture (ISC) within an organization is critical. Not surprisingly, researchers are concerned with understanding, promoting, and assessing ISC in organizations. In response to this concern, several ISC theoretical frameworks have been proposed [2–6]. However, prior research has been focusing on assessment of ISC of large organizations. An SME is recognized as different from a large organization by its size, culture, and shortage of human and financial resources [7]. The few studies about the assessment of holistic ISC of SMEs are from the developed world [3], and little is known about SMEs from sub-Saharan Africa (SSA). SMEs are a significant and an essential part of SSA countries' economy, and information security is a critical success factor [8] for any enterprise. Thus, any security attack on SMEs harms the economy. For instance, for an SME to recover from

a security breach approximately US\$955,429 to US\$1,207,965 is required [9]. This high recovery cost threatens the existence of an SME especially those from the poorest parts of the world.

This study is motivated by limited empirical research on ISC of SMEs in sub-Saharan Africa, and the need to develop ISC strategies that are context specific for SSA. The study aims to explore the status quo of ISC of SMEs in SSA using Tanzania as the case. We posit that for ISC one size does not always fit all due to the contextual and operational differences of the parent nations and organizations [10, 11]. We pose the following question: *What is the current state of the information security culture of small and medium-sized enterprises in Tanzania?*

The rest of this paper answers this question by presenting ISC dimensions to explain the status of the ISC in Tanzania. The following section discusses the background literature and presents a list of ISC dimensions for assessment. Next, the research methodology is presented. The analysis of the data and a discussion of the results follow. Finally, we present the conclusions of the study.

## 2 Literature Review

### 2.1 Information Security Culture

Information security is defined as “the protection of information and its critical elements, including the systems and hardware that use, store, and transmit that information” [12]. Information security’s objective is to preserve the critical characteristics of information namely confidentiality, integrity, and availability (CIA) when information is in storage, processing, or transmission [12]. Information security involves people, technologies and processes, yet the majority of security experts and organizations tend to look at the security problems from the technology viewpoint and as the solution [13]. However, people are the weakest link in information security [13]. It is evident that a majority of security violations cases results from behavioral issues such as human errors, and employee negligence [13, 14]. Hence to manage people’s problems; there is a need for cultivation of ISC in the organizations [15].

Information security culture is referred to as the subset of the organizational culture [8]. Organizational culture is developed; is taught to new members, is learned on how to relate to the environment [16], is transferred from one generation another [17], and is necessary for problem-solving [16, 18], and it changes with time [16] to meet organizational visions [8]. Straub et al. [10] classified definitions of culture into three categories, as (i) shared value views (sense of what ought to be) example Hofstede’s [17] (ii) outcomes-oriented (problem-solving) views like Schein’s [16, 18] and (iii) as a way of being (unconscious view).

Many information security culture scholars except for [2, 19] are defining ISC based what it is composed of and not what it is to accomplish. We argue that it is essential to look at the ISC in a problem-solving viewpoint. A problem-solving view of culture looks at what ISC can accomplish in the organization [10]. The problem in the information security space is that an organization must survive from the external and internal threats. Hence information security culture must make it possible to cope with

organizational problems of external adaptation (control external security threats and data breaches) and internal integration (have consensus for the acceptable security behaviors) [16].

Hence, in a holistic way we define information security culture as “*a patterned way of security-based thinking shared within an organization; based on values, assumptions, and beliefs, which influences the behaviors and actions of the individuals so that, information security becomes a natural aspect in the daily activities in the organization. This ISC is developed, learned and changes with time with the aim to protect information assets and preserve confidentiality, integrity, and availability of information and information systems resources so as meet to the core organization vision*” [2, 19].

## 2.2 Information Security Culture Assessment

The review of the literature indicates that there are various frameworks for the ISC assessment of an organization [2–6, 20]. The frameworks present different dimensions including internal (organizational) and external (environmental) factors. Organizational dimension includes top management support [2–6], information security policy & procedures (ISP) [2–6], risk assessment & management [2], security education, training, & awareness (SETA) programs [2–6], technical and human resources [2–6]. Environmental dimension includes national security culture initiatives [3, 4], suppliers/vendors [3], and partner organizations. Despite differences among frameworks on the specific constructs and relationships, there are some convergences among them. Particularly on the importance of the constructs such as top management support, ISP, and SETA programs and national security culture initiatives [3], which has been reported to have a positive influence on information security culture of an organization [21].

Although [2, 4–6, 20] frameworks are valuable in assessing ISC of organizations, majority frameworks are for large organizations and not for SMEs. For instance, [2, 20] presents assessment frameworks and methodology that aims at pinpointing what areas in information security need attention for ISC to thrive in an organization. The frameworks emphasize an assessment based on the availability of a well-defined information security policy and the availability of information security officers in the organization. Besides, the frameworks are suitable for assessing a single organization, which has a well-defined ISC in place. Since in most cases SMEs lack formalized ISC [3] applying these assessment frameworks for SMEs may be impractical.

Additionally, although framework by [3] was developed for SMEs, it lacks some of the factors that are necessary for SMEs in the SSA. Information security culture exists in its parent culture [18], and the SSA region’s culture is different from that of Australia [17]. There is a need for assessment dimensions specific for SMEs in the SSA context, and method that can comprehensively assess ISC. Hence, organizational, and environmental dimensions consisting of factors for measuring ISC of SMEs in the SSA context are presented in Table 1.

Furthermore, most studies use a single assessment method. Assessment of ISC is complex, and it inherits its complication from the assessment of culture. One measurement method such as quantitative [2, 20] or qualitative [3] assessment is not enough to understand information security culture. Researchers propose that to understand the culture of an organization a combination of quantitative and qualitative

**Table 1.** Information security culture assessment dimensions

	Sub-dimension	Description
Organizational dimension	Top management support	Support for ISC from the SME's management (owners) through enterprise's vision and strategy necessary for the protection of the information resources. Allocation of resources for ISC issues as well as the trust between management and employees [21]
	ISP	Availability of formal or informal information security policy and procedures (ISP) that prescribes and states what is expected of employee's' behaviors for preserving information security of the SME [21–23]
	Risk assessment and management	Capabilities that an SME has in identifying, measuring, controlling and minimizing losses associated with security threats [2]
	SETA programs	Availability of resources to support SETA programs. Security training creates awareness of information security protections, technologies, requirements, risks, and threats [23, 24]
	Technical resources	Availability of security countermeasures, i.e., technical resources necessary for the protection of information systems, such as anti-malware, and firewalls [15]
	Human resources	Availability of either a part-time/full-time employee hired by the SME who qualifies to be an IT security expert such as an information security officer (ISO) [20, 25]
Environmental dimension	National ISC initiatives	Availability of government support on the promotion of national information security culture. Availability of strategic plans and guidance on information security culture to SMEs. Also, the availability of clear regulations on the protection of information and information systems resources [3, 26]
	International security standards	The use of international standards such as COBIT or BS7799 that affects or influences the information security culture of an SME [27–29]
	IT suppliers/vendors	These are security technology suppliers or vendor that might persuade an SME to invest in security technology mostly it is for the vendor's benefit, but also affects the ISC consciousness of an SME [3]
	Partners organizations	These can be any external organization that partners with an SME for business or as a supporting system. The partner organization might have their security policy that forces an SME to practice security conscious culture while communicating or doing business transactions with that partner



techniques must be utilized [16, 25]. It is proposed to conduct interviews with key personnel, observations, and questionnaires with the member of the groups. The succeeding section will explain the assessment method followed in detail.

### 3 Research Methodology

Considering the challenging nature of the assessment of ISC as a whole, a combination of measuring items and data collection methods are recommended [8]. Hence to assess the organizational and environmental dimensions of the ISC of SMEs a combination of quantitative (survey) and qualitative (roundtable discussions and focus groups) methods were employed.

#### 3.1 Instrument Development

To improve the validity and reliability of results, we synthesized instruments from a comprehensive review of validated and tested survey instruments in the literature. The organizational dimensions included management support questions from Knapp et al. [21] information security policy and procedures from [21, 23], methods for risk assessment and management [20], SETA [23], technical and human resources. For the qualitative data, open-ended questions were used to complement the survey data. The qualitative data was essential to gain a more in-depth understanding of the status of the ISC of SMEs in Tanzania.

The survey instruments had two sections: the first section captured the enterprise data, which collected SMEs specific information such as the type of industry, number of employees and organization operation years. The second section captured the primary research data, this covered organizational and environmental dimensions. All primary research items were of five-point scale response format, the value of five (5) “strongly agree” and one (1) “strongly disagree” to show a respondent’s level of agreement with the statements. Example survey questions: “*Our organization management takes security issues into account when planning organization strategies*”; “*Our government demonstrates strong commitment to encouraging information security culture.*”

Pre-test of the survey instrument was done in two phases; the first phase included three doctoral students who reviewed the resulting survey instruments to identify unclear phrasing and determine the survey response time. Questions that seemed difficult to understand for an SME were removed or re-structure. The second phase included five volunteers, two representatives from the Tanzanian chamber of commerce industry and agriculture (TCCIA) and three SMEs. Final modifications were made to the instruments for distribution.

#### 3.2 Case Study Organizations

In Tanzania, SMEs are considered a pillar of the Tanzanian economy contributing around 27% of the GDP [31]. Overall, SMEs account for about 3 million Tanzanian enterprises and employ approximately 93.3% of all Tanzanian workers [31]. SMEs

categorization is based on turnover, numbers of employees and capital investment. Notably, those engaging one to 100 people with the capital investment of a maximum of 800 million Tanzanian Shillings (TZS) (1 USD = 2285 TZS). Tanzania's SME national policy refers to SMEs as micro, small and medium enterprises [30]. The micro-enterprises fall under the informal sector with a capital investment up to TZS 5 million and recruits up to four employees. Small enterprises are formalized employing between 5 and 49 staff and medium enterprises employ between 50 and 99 staff. These SMEs include a wide range of ventures that cover non-farm economic activities manufacturing, mining, commerce, and services. The SMEs differs in their focus, technology innovations, and risk-taking attitudes.

### 3.3 Data Collection

Data was collected from the SMEs situated in the city of Dar es Salaam, a prominent commercial capital of Tanzania located on the coast of the Indian Ocean. According to the Tanzanian SME Development Policy [30] and the national baseline survey on SME [31], the majority of SMEs are situated in Dar es Salaam. Recruitment of the subjects of this study was done through the Tanzanian chamber of commerce industry and agriculture (TCCIA)<sup>1</sup>. TCCIA has chambers in 21 regions, and 90 district centers; with the central office in Dar es Salaam. TCCIA is a private sector association established in 1988 with support from the Tanzanian government to strengthen and promote the development of privately owned enterprises. TCCIA receive backing from international organizations and government to promote training and mobilization of the business community. All respondents in this study were obtained from the TCCIA SMEs members' database.

**Roundtable and Focus Group Discussions.** We organized one roundtable discussion in Dar es Salaam, Tanzania. Thirty-nine distinct SMEs took part in the study; representatives included SMEs owners, managers, and employees. This interactive setup of qualitative data collection is suitable for explorative studies that involve managerial people with a diverse organizational culture like SMEs. In addition, roundtable discussion stimulates the exchange of ideas and allows complex issues and factors to be discussed adequately. Apart from not only collecting data we also intended to create awareness of the need for ISC in the SME environment.

The roundtable discussion lasted 4 h; the meeting was divided into five small discussion focus groups where each group consisted of 6 to 10 participants. Informed consent was reviewed and obtained in writing before starting discussions. Participants completed a demographic questionnaire and the main survey questionnaire before beginning discussions. Data were collected in the form of digitally audio-recorded sessions. Data were transcribed verbatim and analyzed thematically with Atlas.Ti. Data collected from the focus group discussions is used to complement the survey data in this paper.

---

<sup>1</sup> <http://www.tccia.com/tccia/>.

**Survey.** Two survey modes, paper-based and web-based questionnaires were administered to the SMEs. The mixed-mode survey has been shown to be better in increasing the response rate from SMEs [32]. The paper-based questionnaires were distributed to 39 SMEs attendees of the roundtable discussion linked to this study, among those 26 responded to the survey. The online-based survey was distributed through TCCIA SMEs members e-mail list. One hundred and thirteen e-mails were sent, only fourteen SMEs responded to the survey.

The paper-based response rate was 68%, while online survey response rate was 12.4%. The online survey response rate was very low; nonetheless, studies [32, 33] have shown that web-based survey has a lower response rate compared to the paper-based survey. Furthermore, research [33] indicate that lower electronic-based response rate is to be expected especially when the respondents include top managers than the employees, which was the case in our study. In total forty responses were received from the SMEs. Data was analyzed with SPSS Statistics software package. Screening of data for outliers, missing responses, non-normal distribution [34] and erroneous data was done to the data. Six incomplete responses were removed and resulted in 34 SMEs responses for analysis.

## 4 Analysis and Discussion

This study presents 34 cases of SMEs from Tanzania; the majorities 18 of SMEs were small enterprises and 16 medium enterprises. Eighteen (18) of the respondents were SMEs owners, eight managers, and eight employees. Most SMEs (14) have been operating for 6–10 years, 10 SMEs operating for 11–20 years, 6 SMEs operating for more than 20 years and 5 SMEs operating from 3–5 years and 2 SMEs operating for less than three years. A wide range of SMEs industries was from agricultural services, finance banking, and insurance and Information and communication technologies. Fifteen (15) industries were represented with top being from Agriculture Services (7), Finance, banking and insurance (6), Information & communication technology (ICT) and Telecommunication (5), Retail & Wholesale merchandising (5), Manufacturing (3), Consulting services (3), Healthcare (3), Education (3), Legal (3), Tourism & Hotel (2), Transportation (2), Food Processing (2), Export (2), Oil & Gas (1) and Entertainment (1).

The next segments analyze the organizational and environmental dimensions to determine the status of ISC of SMEs in Tanzania. Due to the small sample size ( $n = 34$ ) data analysis is limited to descriptive analysis. The descriptive analysis included the means for measuring the central tendency and standard deviation (SD) for the average amount that a response deviated from the mean.

The overall mean is the interpretation of the mean values for a specific sub-dimension holding several statements. The responses were collected from a five-point Likert scale response format, for all items, the value of five (5 strongly agree) is the highest score, and one (1 strongly disagree) is the lowest score. Therefore, the mean score of 4.0 (agree) on a sub-dimension is used for indication of an acceptable level of information security culture. This cutoff point is similar to a 4.0 mean presented in the ISC assessment by Da Veiga & Martin [20]. Their study used a survey approach to

assess the ISC of an organization by identifying what components of an organization was to be enhanced or obstructed to improve the protection of the organization's information.

#### 4.1 Organizational Dimension

The mean score values of organizational factors (Table 2) as computed from responses of 34 SMEs show no sub-dimension with an overall mean of 4.0 or higher. Mean comparisons between small vs. medium enterprises were also computed as seen in Table 2. Results indicated a higher mean score for medium enterprises than small enterprises for all sub-dimensions.

**Table 2.** Organizational dimension means for SMEs in Tanzania

Organizational dimension	Small enterprises		Medium enterprises		Overall	
	Mean	SD	Mean	SD	Mean	SD
Technical resources	3.56	0.82	3.81	0.92	3.68	0.88
Top management support	3.37	0.99	3.67	0.71	3.5	0.87
SETA programs	2.94	0.90	3.33	0.66	3.12	0.81
ISP	2.97	0.99	3.27	0.81	3.11	0.91
Human resources	2.76	0.76	3.32	0.60	3.03	0.73
Risk assessment and management	2.81	1.06	3.28	0.73	3.03	0.94

**Technical Resources.** Majority of SMEs appears to invest more in security technology than any other sub-dimensions. A higher technical resource mean score indicates that SMEs see technology tools as the key to their security problems. This result is in line to other SSA studies that report SMEs to be more interested in security technology [35]. Interestingly, qualitative findings support this observation. Majority of focus group participants expressed that their first thinking on security protection is to install anti-malware and firewall and consider their enterprises are safe with these technologies. In addition, participants from sectors such as agriculture services, finance, ICT, and telecommunication reported to use and prefer cloud computing for their business. These SMEs believed that their data are safe in the cloud. *“Yes, of course, we have normal measures, for instance, all our documents are saved in the cloud. If a person quits, they can no longer access our organizational document because once we remove the person from the cloud, they can no longer access our information. Also, it is easy to track the projects trail, who saved and who deleted from the cloud, we have a lot of restrictions in place [SME\_R3a]”*

*... the good thing is it is sitting somewhere in the cloud, so it does not matter, even if the person loses the laptop. [SME\_R2a].*

**Top Management Support.** Top management support is the most significant factor in influencing the cultivation of ISC in the organization [21]. However, in this study, the results showed an incredibly low mean value of 3.5 compared to the technology

investment. This poor top management support for ISC reflected on the investment of other sub-dimensions such as information security policy, the absence of SETA programs, lack of human resource investment and inadequate risk assessment and management.

The findings from the focus group indicated a lack of facts about ISC as the main obstacles in top management support of ISC. SMEs owners and managers are aware of information security but lack the know-how on the cultivation of ISC and the importance of strategizing about ISC to their organizations. The size of the enterprises influenced how SMEs saw the importance of ISC in their organization. Participants reported their size and lack of financial resources as the hindrance factors. *“You know how to handle information security differs. For example, for my business, I do not know the importance of information security. Those who are in the large organization they might know because they have a lot to lose. For SMEs like us, it is hard to deal with security; it is expensive.”*

**ISP.** Results from the focus group showed a strong perception that the size of the organization determined the formality of SME’s information security policy and procedure. Verbal ISP reminders seemed to be the approach preferred by most SMEs. *“Our information policy is implemented verbally; people know what not to do. Moreover, we have antivirus and firewall our policy is implemented there” [SME\_R1a].*

**Risk Assessment and Management.** In this construct, 67.6% (n = 23) of SMEs reported that risk assessment was too complex for their organizations. Participants reported a lack of measures for assessing and managing security incidents and a lack of pre-predefined procedures in case of security incidents. Moreover, majority of the participants reported that their organizations conduct fewer or no assessments of their systems.

**Human Resources.** SMEs management biggest concern was the complexity of hiring a full time IS security expert due to lack of finances and lack of trust.... *Let us say we are using one system. I do not want to hire an IT specialist because, one, it is not cost effective. And another thing, I think I am not utilizing him fully. Even if I employ the person, on the salary that I am paying he is [probably] working for one or two hours for the rest of the day. [This way] I am not utilizing the person properly. This is what we always feel as employers. Ooh, now if I outsource, [I think about] my information, someone else can look at it and hack. So that is something that comes up, that we do not outsource..., we also don’t want to employ an IT personnel. So that is where the problem arises[SME\_R2a].*

## 4.2 Environmental Dimension

Like the organizational dimension, the environmental dimension (Table 3) results indicated a higher mean score for medium enterprises than small enterprises. The mean values of the variables ranged from 2.85 to 3.49. SMEs responses show that their ISC is more influenced by vendors (3.38) and partner organization (3.49) than the national ISC initiatives (2.91). Overall, the environmental factors in Table 3 show that SMEs are unsure of the existence of environmental support for the ISC of SMEs in Tanzania.

**Table 3.** Environmental dimension means for SMEs in Tanzania

Environmental dimension	Small enterprises		Medium enterprises		Overall	
	Mean	SD	Mean	SD	Mean	SD
Partner organization	3.38	0.22	3.61	0.25	3.49	0.97
Vendor pressure	3.11	0.29	3.66	0.24	3.38	1.13
National ISC initiatives	2.72	0.16	3.11	0.15	2.91	0.68
International security standards	2.33	0.26	3.37	0.19	2.85	1.06

**Partner Organization and Vendor Pressure.** From the environmental dimension, we see that SMEs' partner organizations and vendors mean score were higher than the rest of the sub-dimensions. This shows that SMEs are more likely to be persuaded to invest in security technologies by vendors and their business partners. IT vendor and partners influence were reflected in SME's choice of cloud computing, many report cloud computing as the best and secure way to store data. "...cloud computing is the thing. We host remotely; we choose the partners who are serious with IT security [SME\_R4a]." However, literature shows that cloud computing does not always guarantee security [37] because the security of data in the cloud is to a higher extent user's (subscriber's) responsibility and not only service provider's.

**National Information Security Culture Initiatives.** There was a consensus among participants of the focus group that in Tanzania there are poor national initiatives for the cultivation of ISC in SMEs environment. "*Lack of information security culture in our organizations is not about the country's national culture, but it is [just] lack of information security culture in the country*" [SME\_R1a].

Most SMEs were unaware of the national information security related laws, regulations, national acceptable standards, or even international security standards. Tanzania for instance is a member of the International Organization for Standardization (ISO) through Tanzania Bureau of Standards (TBS). However majority of SMEs are unaware of recommended information security strategies or framework to follow. When reporting on the influence of international security standards, only two SMEs (medium enterprises) dealing with information and communication technology business indicated to be aware of and use international information security standards such as ISO 27001.

Scholars argue that national initiatives for ISC can be a positive contributor to motivating SMEs to engage in security protection actions [3]. As it has been for IT adoption [36], external support, such as government and private sectors initiatives can directly stimulate information security practices of SMEs. In Tanzania, SMEs are expected to receive institutional support from different government and parastatal organizations. The Tanzania SME policy [30], mentions information technology-based institutions such as the Tanzania Commission for Science and Technology (COSTECH) and Tanzania Communications Regulatory Authority (TCRA). However, SMEs reports a lack of institutional support especially on issues related to Information security culture. SMEs in Tanzania requires external support such as government institution to push for the cultivation of ISC in SMEs environment as it is done in other countries [26].

## 5 Conclusion

The findings of this exploratory study show an unfavorable status of the ISC of the participating SMEs in Tanzania. The results and implications of these findings suggest further research and intervention is necessary to institutionalize ISC in the SME environment. This study proposes the development of frameworks for the institutionalization of ISC of the SME in SSA environment using design science research. We also call for the national level ISC initiatives to motivate SMEs to nurture ISC. Furthermore, there is a need for theoretical based national level SETA-programs interventions to SMEs owners, managers, and employees. The main limitation of this study was the small sample size on a quantitative part of the study; future research may benefit from a larger sample size by including SMEs from other regions of SSA for a cross-country comparison to identify country-specific factors.

## References

1. Verizon Business. 2018 Data breach investigations report, Trends, pp. 1–62 (2018)
2. Da Veiga, A., Eloff, J.H.: A framework and assessment instrument for information security culture. *Comput. Secur.* **29**(2), 196–207 (2010)
3. Dojkovski, S., Lichtenstein, S., Warren, M.: Institutionalising information security culture in Australian SMEs : framework and key issues. In: *International Symposium on Human Aspects of Information Security and Assurance*, pp. 10–24 (2007)
4. Tolah, A., Furnell, S.M., Papadaki, M.: A comprehensive framework for cultivating and assessing information security culture. In: *The Eleventh International Symposium on Human Aspects of Information Security and Assurance (HAISA)*, pp. 52–64 (2017)
5. Van Niekerk, J., Von Solms, R.: Understanding information security culture: a conceptual framework. *Proc. ISSA* **2006**(May), 1–10 (2006)
6. Alnatheer, M., Nelson, K.: Proposed framework for understanding information security culture and practices in the Saudi context. In: *7th Australian Information Security Management Conference* (2009)
7. Thong, J.Y.L., Yap, C.S.: Information technology adoption by small business: an empirical study. In: Kautz, K., Pries-Heje, J. (eds.) *Diffusion and Adoption of Information Technology*. ITIFIP, pp. 160–175. Springer, Boston, MA (1996). [https://doi.org/10.1007/978-0-387-34982-4\\_12](https://doi.org/10.1007/978-0-387-34982-4_12)
8. Schlienger, T., Teufel, S.: Information security culture – from analysis to change. *S. Afr. Comput. J.* **31**, 46–52 (2003)
9. Ponemon Institute LLC: 2017 State of Cybersecurity in Small & Medium-Sized Businesses (SMB) Sponsored by Keeper Security (2017)
10. Straub, D., Loch, K., Evaristo, R., Karahanna, E., Srite, M.: Toward a theory-based measurement of culture. *J. Glob. Inf. Manag.* **10**(1), 13–23 (2002)
11. Karjalainen, M., Siponen, M.T., Petri, P., Suprateek, S.: One size does not fit all: different cultures require different information systems security interventions. In: *IFIP 8.11/11.13 Dewald Roode Information Security Research Workshop* (2013)
12. Whitman, M.E., Mattord, H.J.: *Principles of Information Security*, 4th edn, p. 617. Course Technol, Boston (2012)

13. Mitnick, K.D., Simon, W.L.: *The Art of Deception: Controlling the Human Element of Security*. Wiley, Hoboken (2011)
14. Herath, T., Rao, H.R.: Encouraging information security behaviors in organizations: role of penalties, pressures and perceived effectiveness. *Decis. Support Syst.* **47**(2), 154–165 (2009)
15. Thomson, K.-L., Von Solms, R., Louw, L.: Cultivating an organizational information security culture. *Comput. Fraud Secur.* **2006**(10), 7–11 (2006)
16. Schein, E.H.: Coming to a new awareness of organizational culture. *Sloan Manage. Rev.* **2**, 3–16 (1984)
17. Hofstede, G.: Cultural dimensions in management and planning. *Asia Pacific J. Manag.* **1**(2), 81–99 (1984)
18. Schein, E.H.: *Organizational Culture and Leadership*, 3rd edn. Jossey-Bass, Hoboken (2004)
19. Alhogail, A.: Information Security Culture: A Definition and A Literature Review. *IEEE* (2014)
20. Martins, N., Da Veiga, A.: Information security culture: a comparative analysis of four assessments. In: *European Conference on Information Management and Evaluation* no. September, pp. 49–58 (2014)
21. Knapp, K.J., Marshall, T.E., Kelly, R.R., Nelson, F.F., Rainer, R.K., Ford, F.N.: Information security: management's effect on culture and policy. *Inf. Manag. Comput. Secur.* **14**(1), 24–36 (2006)
22. Kinnunen, H., Siponen, M.: Developing organization-specific information security policies. *PACIS* **2018**, 1–13 (2018)
23. Chen, Y.A.N., Ramamurthy, K.R.A.M., Wen, K.: Impacts of comprehensive information security programs on information security culture. *J. Comput. Inf. Syst.* **55**(3), 11 (2015)
24. Siponen, M.T.: Five Dimensions of Information Security Awareness. *Comput. Soc.*, no. June, pp. 24–29 (2001)
25. Schlienger, T., Teufel, S.: Analyzing information security culture: increased trust by an appropriate information security culture. In: *Proceedings of International Conference on Database and Expert Systems Applications DEXA*, January 2003, pp. 405–409 (2003)
26. Enisa: Information security and privacy standards for SMEs. European Union Agency For Network And Information Security, no. December. 2015
27. Sipior, J.C., Ward, B.T.: A framework for information security management based on guiding standards: a united states perspective. *Issues Inf. Sci. Inf. Technol.* **5**, 51–60 (2008)
28. Von Solms, B.: Information security—the third wave? *Comput. Secur.* **19**, 615–620 (2000)
29. Siponen, M.: Information security standards focus on the existence of process, not its content. *Commun. ACM* **49**(8), 97 (2006). Technical Opinion
30. URT: Small and Medium Enterprise Development Policy. *J. SMEs policies*, vol. II, no. April, pp. 12–20 (2003)
31. Ministry of Industry and Trade. National Baseline Survey Report for Micro, Small and Medium Enterprises in Tanzania. Ministry of Trade and Financial Sector Deepening Trust, vol. 53, no. 9 (2012)
32. Meckel, M., Walters, D., Baugh, P.: Mixed-mode surveys using mail and web questionnaires. *Electron. J. Bus. Res. Methods* **3**(1), 69–80 (2005)
33. Fan, W., Yan, Z.: Factors affecting response rates of the web survey: a systematic review. *Comput. Human Behav.* **26**(2), 132–139 (2010)
34. Heiman, G.W.: *Basic Statistics for the Behavioral Sciences*. Cengage Learning, Boston (2013)



35. Bougaardt, G., Kyobe, M.: Investigating the factors inhibiting SMEs from recognizing and measuring losses from cyber crime in South Africa. *Electron. J. Inf. Syst. Eval.* **14**(2), 167–178 (2011)
36. Ghobakhloo, M., Hong, T.S., Sabouri, M.S., Zulkifli, N.: Strategies for successful information technology adoption in small and medium-sized enterprises. *Information* **3**(1), 36–67 (2012)
37. Chen, D., Zhao, H.: Data Security and Privacy Protection Issues in Cloud Computing. In: 2012 International Conference on Computer Science and Electronics Engineering, no. March 2012, pp. 647–651 (2012)



# **Correction to: A Framework for Understanding the Empowerment Effects of Telecentres on Rural Communities in Developing Countries**

Sellina Khumbo Kapondera , Roberta Bernardi ,  
and Niki Panteli 

**Correction to:**  
**Chapter “A Framework for Understanding the Empowerment  
Effects of Telecentres on Rural Communities in Developing  
Countries” in: P. Nielsen and H. C. Kimaro (Eds.):**  
*Information and Communication Technologies  
for Development, IFIP AICT 551,*  
[https://doi.org/10.1007/978-3-030-18400-1\\_9](https://doi.org/10.1007/978-3-030-18400-1_9)

In the originally published version of this chapter, the name of the second author Roberta Bernardi was incorrect. The name of the author has been corrected.

---

The updated version of this chapter can be found at  
[https://doi.org/10.1007/978-3-030-18400-1\\_9](https://doi.org/10.1007/978-3-030-18400-1_9)

© IFIP International Federation for Information Processing 2020  
Published by Springer Nature Switzerland AG 2020  
P. Nielsen and H. C. Kimaro (Eds.): ICT4D 2019, IFIP AICT 551, p. C1, 2020.  
[https://doi.org/10.1007/978-3-030-18400-1\\_64](https://doi.org/10.1007/978-3-030-18400-1_64)

## Author Index

- Abdelnour-Nocera, José II-229  
Abubakar, Naima Hafiz I-414  
Achieng, Mourine I-568  
Addo, Atta I-402  
Adu-Gyamfi, Eric I-331  
Agagliate, Thierry I-168  
Ahsan, Hasib II-267  
Akkermans, Hans II-26, II-386  
Alphonse, Roselyne I-436  
Amara, Amara I-168  
Andegelile, Yona I-712  
Andrade, Antonio Diaz II-215  
Andrew, Rogers I-436  
Apiola, Mikko I-76, I-366, I-508, II-294  
Ayebazibwe, Immaculate I-63
- Baart, André II-386  
Bagile, Burchard I-763  
Bailey, Arlene I-27  
Bankole, Felix I-633  
Baryashaba, Amos II-316  
Bass, Julian M. I-355, II-3  
Bernardi, Roberta I-104  
Binamungu, Leonard Peter II-316  
Bitebo, Ally I-712  
Bon, Anna II-26, II-386  
Bonina, Carla I-319  
Booi, Samkelo Lutho I-152  
Braa, Jørn I-260, I-272, I-390  
Brown, Suzana I-687  
Browne, Oliver I-27  
Budoya, Christian M. II-374
- Chaudhuri, Bidisha I-3  
Chawurura, Trymore I-15  
Chhetri, Amrit I-619  
Chigona, Wallace I-152, II-135, II-151  
Christensen, Lars Rune II-267  
Chrysantina, Aprisa I-448  
Chugulu, Godfrey I-712  
Clayton, Anthony I-27  
Clemmensen, Torkil II-229  
Constant, Sendrine I-168  
Cosmas, Joseph II-361
- Das, Badal Kumar II-267  
Dasuki, Salihu Ibrahim I-414  
Dasuki, Salihu I-181  
Dayoub, Moammar I-508  
de Boer, Victor II-386  
Donalds, Charlette I-751  
Duncombe, Richard I-195, I-231
- Eaton, Ben I-319  
Eskelund, Karsten I-51  
Ezeomah, Bookie I-231
- Gaiani, Silvia I-366  
Gee, Matt I-27  
Gilbert, Gilbert M. I-763  
Godara, Balwant I-168  
Gomera, William Clifford I-649  
Gomez-Morantes, Juan Erasmo I-195  
Gordijn, Jaap II-386  
Gupta, Sharmistha Swasti II-280
- Haakana, Jani II-294  
Hamad, Omar F. I-736  
Hatakka, Mathias I-520, II-60  
Hederman, Lucy II-39  
Heeks, Richard I-51, I-195, II-14  
Helminen, Jaakko I-366, I-508, II-294  
Henry-Lee, Aldrie I-27  
Herselman, Marlien I-556  
Hertzum, Morten II-229  
Hlabano, Mbongeni I-284  
Hussain, Faheem I-675, I-687
- Ibwe, Kwame I-724  
Ifinedo, Princely II-303  
Iliya, Abdulrashid I-343  
Inuwa, Ibrahim II-122  
Isagah, Tupokigwe I-544  
Iversen, Mari I-619
- Jimenez, Andrea II-180  
Johnson-Coke, Yhanore I-27  
Joia, Luiz Antonio II-203

- Joshi, Tanmay II-280  
 Justo, Godfrey II-349
- Kaasbøll, Jens J. I-63, I-116, I-619, II-398  
 Kabanda, Salah I-140  
 Kah, Muhammadou M. O. I-181, I-343, II-122  
 Kalinga, Ellen I-532, II-433  
 Kanjo, Chipso I-619, II-398  
 Kapinga, Alsen Florian I-486, I-649  
 Kapondera, Sellina Khumbo I-104  
 Karim, Azmina I-675  
 Kendall, Linus I-3  
 Kikoba, Bigten R. I-532  
 Kimaro, Honest C. I-63, I-272, I-579, I-763, II-349, II-361, II-398  
 Kirongo, Balozzi Bekuta I-366  
 Kissaka, Mussa M. I-736, II-374  
 Kizito, Michael I-39  
 Kondowe, Calisto II-135  
 Koskinen, Kari I-319  
 Kreps, David II-3  
 Kuhl, Alexander II-203  
 Kumalija, Claud I-272  
 Kumar, Nihaalini I-168  
 Kundaali, Herald I-712  
 Kunene, Khaya I-152  
 Kunyenje, Gregory II-151
- Leach, Richard I-27  
 Lewis, Dave II-39  
 Li, Magnus II-241  
 Li, Yan II-95  
 Lissah, Jane I-701  
 Longe, Olumide II-303  
 Lozano-Paredes, Luis H. I-425  
 Lungo, Juma I-532
- Madon, Shirin I-660  
 Makamba, Peter II-110  
 Maki, Norah II-361  
 Makindara, Jeremia I-436  
 Makuru, Patricia II-433  
 Malik, Fareesa I-248  
 Maliwichi, Priscilla I-152  
 Manhibi, Ronald I-15  
 Markus, M. Lynne I-460  
 Mashaka, Bakari II-192  
 Masiero, Silvia I-295  
 Masoumifar, Ali M. I-687
- Matewa, Chido II-110  
 Matsinhe, Fernanda I-140  
 Mawere, Munyaradzi II-168, II-421  
 Mazana, Mzomwe Yahya II-409  
 Maziku, Hellen II-361  
 Mbage, Said H. I-436  
 Mbelwa, Jimmy T. I-579  
 Mbembati, Hadija I-712  
 Mbise, Mercy I-701  
 Mbwilo, Betty II-349  
 McBride, Neil II-192  
 Mengesha, Nigusie II-303  
 Mesui, 'Anau II-215  
 Misaki, Ezra I-366, I-508, I-593, II-294  
 Mkocho, Khadija I-736  
 Mkude, Catherine G. II-326  
 Mohallel, Amr A. I-355  
 Montero, Calkin Suero II-409  
 Mramba, Nasibu Rajabu I-76  
 Msiska, Brown I-116  
 Mtebe, Joel S. II-374  
 Mugisha, Samuel II-316  
 Mukherjee, Arunima I-127, I-472  
 Mukoya, Festus I-127  
 Musimenta, Angella II-316  
 Mussa, Bernard I-579  
 Mwalemba, Gwamaka II-337  
 Mwapwele, Samwel Dick I-378  
 Myllynpää, Ville I-508, II-294
- Nah, Sze San II-386  
 Naiman, Shililiandumi I-763  
 Nan, Wenxiu (Vince) I-460  
 Nicholson, Brian I-51, I-207  
 Nielsen, Petter I-116, I-207, I-218, I-331  
 Nyende, Hawa I-89
- Ononiwu, Chidi G. I-343, II-122  
 Ophoff, Jacques I-776  
 Osei-Bryson, Kweku-Muata I-751  
 Ospina, Angelica V. II-14  
 Otine, Charles II-361  
 Owoseni, Adebowale I-606  
 Oyelere, Solomon Sunday I-76, I-649, II-409  
 Oyerinde, 'Yinka I-633
- Pandey, Priyanka II-83  
 Panteli, Niki I-104

- Poppe, Olav I-260  
 Protas, Catherine I-724
- Quaye, Ago K. M. I-343, II-122
- Rangaswamy, Nimmi II-280  
 Rashid, Mamunur II-267  
 Ravishankar, M. N. I-295  
 Reilly, Katherine M. A. I-425  
 Renaud, Karen II-253  
 Renken, Jaco I-307  
 Roberts, Tony II-180  
 Roodt, Sumarie I-378  
 Ruhode, Ephias I-568  
 Ruhwanya, Zainab I-776  
 Rumanyika, Joel I-76
- Sæbø, Johan Ivar I-260, I-331, I-448  
 Sæbo, Johan I-207  
 Sæbø, Øystein II-60  
 Sahay, Sundeep I-207, I-472, I-496  
 Samoilenko, Sergey I-751  
 Sanner, Terje Aksel I-218  
 Saugene, Zeferino I-331  
 Schoemaker, Emrys I-660  
 Seedat, Yazeed I-378  
 Senyoni, Wilfred F. I-272, I-390  
 Shiang, Cheah Wai II-386  
 Shuaibu, Aishatu I-181  
 Simba, Fatuma II-433  
 Singh, Dineshkumar II-229  
 Singh, Veerendra Veer II-229  
 Sitompul, Taufiq I-390
- Smith, Ronel I-556  
 Strand, Cecilia I-520  
 Suero Montero, Calkin I-486  
 Suhonen, Jarkko I-649  
 Sutinen, Erkki I-366, I-508, II-294
- Tedre, Matti I-76  
 Thapa, Devinder II-49, II-60  
 Thomas, Manoj A. II-95  
 Tolani, Adedamola I-606  
 Turpin, Marita I-556  
 Twinomurinzi, Hossana I-606
- Van Belle, Jean-Paul I-284  
 van Biljon, Judy II-253  
 van Dijk, Janneke I-15, II-110  
 van Stam, Gertjan I-15, II-72, II-110, II-168,  
 II-421  
 Vhoko, Peter II-110  
 Vila-Pozo, Marta Maria I-496
- Wahaj, Zujaja I-248  
 Waizenegger, Lena II-215  
 Wakunuma, Kutoma II-192  
 Wall, P.J. II-14, II-39  
 Westerlund, Tomi I-508, II-294  
 Wimmer, Maria A. I-544, II-326
- Yudianto, I-390
- Zheng, Yingqin II-49, II-83