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Jim Spohrer
Christine Leitner *Editors*

Advances in the Human Side of Service Engineering

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11th International Conference on Applied Human Factors and Ergonomics and the Affiliated Conferences

Proceedings of the AHFE 2020 Virtual Conference on the Human Side of Service Engineering, July 16–20, 2020, USA

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Preface

If there is any one element to the engineering of service systems that is unique, it is the extent to which the suitability of the system for human use, human service, and for providing an excellent human experience has been and must always be considered. The International Conference on the Human Side of Service Engineering (HSSE 2020) was organized within the framework of the International Conference on Applied Human Factors and Ergonomics (AHFE) as an Affiliated Conference. This conference included over 60 presentations during the 3-day event in sessions which focused on the study of people as the key variable in service systems, with service innovation as the primary goal to invent, adapt, and engineer better skills, technologies, organizations, information resources, and value propositions to address the needs, wants, and aspirations of diverse people in service systems. Newly included topics for HSSE relate to determinants of trust: standards, experience, public policy, privacy, and ethics. All of these are types of shared information resources that influence trust between actors and will be impacted by advances in Artificial Intelligence (AI).

The book is divided into seven major sections as follows:

Section 1	Digital Services for Product Innovation
Section 2	Research Approaches to Service Innovation: Organizational Perspectives
Section 3	Service Design Techniques: Healthcare Applications
Section 4	Emerging Research Innovations in AI, User Experience and Design
Section 5	Challenges and Opportunities for Designing Smart Service with AI
Section 6	Service Science and Knowledge Science
Section 7	Empowerment of Citizens, Public Sector Employees and Other Stakeholders in the Digital Age

A major area of expansion in this conference is in AI, Big Data, and Knowledge Science in Human-Side of Service Engineering. Also, new was the exploration of a computable scholarly record, including meta science and engineering reproducibility in the era of AI.

We are deeply indebted to all Session Chairs for their contributions to HSSE 2020. We hope that you find this volume useful and interesting, and invite all to join us for next year's meeting. Our sincere thanks and appreciation goes to the Board members listed below for their contribution to the high scientific standard maintained in developing this book.

M. Warg, Germany
C. Zagel, Germany
A. Zimmermann, Germany

July 2020

Jim Spohrer
Christine Leitner

Contents

Digital Services for Product Innovation

Identifying Trendsetters in Online Social Networks – A Machine Learning Approach

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Abstract. Especially in the fashion business consumers nowadays ask continuously for new styles and products, which forces companies to generate new ideas and innovative products faster than ever. Besides, consumers interact with each other on social media platforms and exchange their problems, needs, preferences, and ideas. With 95 Mio. daily postings on Instagram, it becomes obvious that such a platform is a huge data source containing important and valuable information regarding product requirements, customer tastes and needs, and upcoming trends. This paper presents a model to identify trendsetters based on their social media profiles and interactions on Instagram by using multiple machine learning classifiers. The model is trained with data of 665 user accounts, considering 59 features. Maximum Entropy Model performs the best with a F1-score of 66.67%.

Keywords: Online social networks · Trendsetter · Machine learning

1 Introduction

The development of fashion trends has changed in terms of diffusion time and fashion trend actors during the last years. The fashion industry is undergoing a transition from the traditional bi-seasonal fashion collections towards so-called *fast fashion* with constantly changing, new intermediate collections [1] [2]. This leads to shorter product life cycles with a decreasing timespan between a new design release and consumption [2], which forces companies to generate new ideas and innovative products faster than ever. Besides, the increasing usage of online social networks (OSNs) and the resulting high connectivity across borders increase the power of consumers regarding trend creation [3]. Internet users are transforming from bare consumers to active creators of internet content [4] as social media platforms support the exchange of this user-generated content, enable the social interaction between the users [5] and therefore play a key role in information diffusion these days [6]. It has also been shown that the online buzz mirrors the real world and tracking the information online helps to identify trends, even before the "offline" world becomes aware of them [7]. Therefore, content published in OSNs can be used for trend detection [8], to identify popular topics early or even serve as an inspiration source for new product development [9].

There are 3.5 billion active social media users worldwide, which is 45% of the total global population [10]. Instagram, which is one of the most relevant OSNs related to

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fashion today [11], has one billion monthly active users, 95 million daily postings and 4.2 billion likes per day [10]. Compared to the informational Twitter, the visual-based platform Instagram is often used for self-expression [12] and inspiration [10] as it mostly spawns aesthetically pleasing and creative content. This shows its high potential as a data source for detecting upcoming trends and new ideas.

The question which arises is how to find and exploit the relevant data which contains information about new product ideas and innovative consumer perspectives out of this huge data source?

There have been many studies investigating trends and influential actors in OSNs, which can be divided into three main research strings according to the components of information diffusion in OSNs [6]. The first pillar focuses on analyzing the *process of information diffusion* resp. trends. Therefore, elaborate statistical methods are applied for various purposes, e.g., to forecast the final size of an information cascade, such as retweets [13], or to predict the future evolution of the popularity of hashtags. For the latter, Ma et al. tested different classification methods and find that Maximum Entropy performs the best and that considering content and context features is beneficial for prediction accuracy [14].

The second stream concentrates on the investigation of attributes and the content of *influential messages* [11, 15]. Jaakonmäki et al. investigate the most influential content features of an Instagram post on the engagement of followers and use LASSO, a regression algorithm, for this [15].

The third string deals with identifying *relevant user or user groups* regarding new trends, such as opinion leaders, and often focus on the position in the network or the personal traits of such actors [11, 17, 18]. For this, different approaches have been tested, mainly using means of social network analysis [17] or a combination of these with text mining and statistical analyses [18]. These studies dealing with trends and opinion leader identification have often based on Twitter data. Instagram, however, has been neglected by academic research for a long time [16]. Hence, research focuses mainly on analyzing the shared content and structure of the network. As Instagram is a photo-sharing application, a big portion of current research analyzes the posted images, e.g., to identify objects or faces on shared pictures [19] or investigate the hashtags [20] and comments below a picture [21]. Few studies, however, focus on the classification of user accounts. Ciampaglia et al. tried to predict whether a fashion model becomes popular based on Instagram data by using classification algorithms [22]. To the best of our knowledge, studies which concentrate on classifying Instagram accounts in a fashion-related area do not exist.

Hence, this paper presents a machine learning approach, which aims to recognize trendsetter accounts on Instagram. Firstly, we create a concept for labeling a training data set which bases on Rogers Innovation Diffusion Model. Then, we derive the features based on literature to finally train and compare several classifiers regarding their performance. For our research, we use publicly available data of Instagram accounts. After introducing the theoretical framework, the structure of the paper follows the different steps of a machine learning process, closing with the presentation of results and conclusion.

2 Theoretical Framework

Despite reducing product life cycles and very fast shelf turnover rates, the diffusion of products still follows a specific process, the fashion life cycle curve [2]. It comprises the phases introduction, growth, maturity, and decline and resembles Rogers' diffusion curve. Rogers Diffusion Model, which originally focuses on innovations, shows the adoption process related to different adopter types. According to Rogers, an innovation is any idea, practice or object that is perceived as new by an individual or another adopter [23]. By this definition, a new product or fashion trend can be considered an innovation. Therefore, Rogers' model can be applied in the context of fashion and new product ideas. He differentiates in his model five types of adopters - innovators, early adopters, early majority, late majority, and laggards - according to their innovativeness, which describes the degree to which a user adopts innovations relatively earlier than other members of a social system [24]. Innovators are the first 2.5% of consumers who adopt a new idea or innovation. They have a high impact on the introduction of innovation to a larger audience and therefore play a gatekeeping role in the flow of new ideas into a system [24]. Early adopters are the next 13.5% of consumers in this process. They are well integrated into a digital or real-world network [2], serve as role models for later adopter groups [23] and play an important role regarding trendsetting as they have the ability to influence others' behavior and attitudes [24]. Both, innovators and early adopters come up with new ideas or recognize the potential of innovation. They pass it on to their social system and play a decisive role in whether it will be accepted as a trend [23]. These two groups are summarized as *trendsetters*.

3 Methodology

3.1 Data Collection

Due to its high relevance regarding fashion, the OSN Instagram was chosen as a data source. There are three ways of accessing the necessary data. First, data is scraped through an API. Data like posts and comments are parsed by instaloader. Therefore, publicly available scripts are used, which can be found on GitHub[1]. Profile information, however, is extracted using the HTML-site of the respective accounts. We collect all available data of a fashion-related sub-community with a specific topic focus on sneakers. For this, we apply a content-based snowball sampling technique starting with the initial hashtag *#sneakers* and then proceed with the following lists of initial users. To ensure high sneaker relevance of sampling and to avoid bots and highly commercial accounts in our database, we consider the content of biography and the last 12 postings within the collection process. As an example, we exclude accounts that have words like for example "reseller" or "store" in their biography as this indicates their commercial purpose. The collected data set contains data of 724 user accounts within the timespan from May 2011 to August 2019, including all postings since account creation, which counts 459,243 postings and around 1.3 million comments with related context data.

[1] https://github.com/ping/instagram_private_api, https://instaloader.github.io/.

3.2 Data Labeling

The aim of our labeling concept is to minimize subjective bias. Our concept uses past product trends to classify users according to Rogers into trendsetters and non-trendsetters. A new successfully released Sneaker Model is defined as product innovation resp. product trend. We consider 40 successfully released sneakers of different brands in 2017/18 and extract all relevant postings with the related user data from the initial data set. According to Rogers, we label users who are in the group of the first 16% postings for at least one of the listed Sneaker Models as trendsetters (n = 263). Users who talked about the product later in time are labeled as non-trendsetters (n = 402). In total, our labeled data set consists of 665 user accounts.

3.3 Feature Extraction

For these 665 user accounts, we extract the features which we identify as potentially important according to existing literature treating with detecting influential user groups. We derive four categories of features based on literature review, which are *network-related* features like pagerank, *user-related* features like external links in biography, *context-related* features like minimum time to comment, and *content-related* features like number of posted images. For their calculation, we use statistical and social network analysis as well as text mining. As the features differ in their value space and type, e.g., numeric values, like the average number of posted images, and Boolean values, like the presents of external link in the biography, we normalize the data. To ensure that the features are in the same vector space, the vectorization of features is based on feature value's quantile.

3.4 Classification

We compare the performance of seven different machine learning algorithms (cf. Table 1) as they are often used for binary classification problems. As our labeled data set is imbalanced, containing much fewer trendsetters than non-trendsetters, we resample the training set applying undersampling (US) and oversampling (OS). For that, there are various approaches, e.g., random over- and undersampling or cluster-based sampling methods [25]. We use random undersampling and oversampling as well as SMOTE[2] for oversampling [26]. The reason for this is their broad acceptance and available implementations to combine them with different classifiers. After resampling, all classifiers are trained on an equal number of training samples per class. We use a train-split approach, setting the train data x = 80% and the test data y = 20% randomly. To increase the performance of classifiers, we perform a grid search to obtain the best parameter settings. We evaluate and compare the performance of selected classifiers by using the measures precision, recall, and F1-score. The latter considers both, recall and precision. Recall is calculated as the ratio of all correctly classified trendsetters (true positives) to all true trendsetters in the data set (true positives + false negatives), whereas precision is the number of correctly classified

[2] Synthetic Minority Oversampling Technique.

trendsetters divided by the number of correctly and incorrectly classified trendsetters (true positive + false positives). False positives are trendsetters which the model incorrectly labels as trendsetters [27]. For further evaluation of the model and to ensure that we face no overfitting or underfitting, we apply k-fold cross-validation, choosing k = 5. We also investigate the relevant features of each classifier, applying a linear SVC[3] algorithm to compare the performance with and without feature selection beforehand. The general idea of feature selection is to remove features that do not influence or even decrease performance. The analysis is done in Python with the scikit-learn[4] library as well as the imbalanced-learn[5] library for resampling.

4 Results

Table 1 shows the best result for each of the classifiers. In our experiments, the Maximum Entropy Model performs best with a F1-score of 66.67% using SMOTE oversampling and applying feature selection (FS) beforehand. At the same time, 5-fold cross-validation verifies that neither overfitting nor underfitting problems exist. Overall, the predictive power across all classifiers increases with prior resampling excluding support vector machine (SVM). The three boosting algorithms perform worst.

Table 1. Classifier performance

Classifier	Data Set	Train/Split			5-Folds
		Precision	Recall	F1-Scr.	F1-Scr.
Maximum Entropy Model (+FS)	OS SMOTE	55.88%	82.61%	66.67%	64.25%
Naive Bayes (+FS)	US	56.25%	78.26%	65.45%	63.51%
Random Forest	OS SMOTE	54.41%	80.43%	64.91%	63.75%
SVM (+FS)	Imbalanced	54.55%	78.26%	64.29%	50.64%
AdaBoost	OS SMOTE	56.14%	69.57%	62.14%	57.48%
GradientBoost	OS SMOTE	54.10%	71.74%	61.68%	62.12%
HistGradientBoost	OS SMOTE	55.56%	65.22%	60.00%	62.24%

Currently, the best performing model recognizes over 80% of trendsetters. However, the probability that the model classifies a non-trendsetter as trendsetter is high (precision = 55.88%). Nevertheless, for the purpose to detect early signals of trends or upcoming needs and preferences of consumers, it is more important to detect a high portion of trendsetters (high recall value) rather than not considering data of non-trendsetters (high precision value).

[3] Linear Support Vector Classification .

[4] scikit-learn: http://scikit-learn.org/.

[5] imbalanced-learn: http://contrib.scikit-learn.org/imbalanced-learn/stable/index.html#.

5 Discussion and Future Research

In a next step, we want to continue to optimize the model by considering further features for training our classifier to achieve better results than our current 66.7% F1-score. Besides, some limitations of analyses need to be mentioned. The training of algorithms and development of the model is done for a specific topic-community within the fashion area. As various communities may differ in their behavior and interaction, trendsetters of other fields or even with another fashion focus may behave in another way. Due to this, we want to validate the model once applied to another fashion community; the second test will be conducted using a community with a topic focus on sustainability and environment in order to check the transferability of the model to other areas. Furthermore, we want to analyze the postings published by trendsetters regarding upcoming trends and innovative consumer perspectives and discuss the results with designers and experts in the field of product innovation to investigate the potential of our classification model in practice.

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Consume Less, Create More – Digital Services in the Context of Sustainability

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Abstract. In 2019 the Coburg University of Applied Sciences offered the course "consume less, create more" to an interdisciplinary group of master students. The course offered a theoretical part including topics like sustainability, maker culture and upcycling as well as a practical part. The practical part was carried out through different project teams using old materials and unused objects from the student's households to create usable products for the students themselves.

The course took place at the maker space of Coburg University, offering classic tools and machines like laser cutters and 3d printers. The challenge was to find different criteria for sustainable DIY projects, produce at least one prototype and to create a tutorial. The main question to be answered is what conclusions can be derived for Digital Services concerning Sustainability from the course. The main methods are discussions with the students accompanied by individual interviews carried out by the authors. Also, observation is used to analyze how Digital Services are used during the creation of the different items. The findings are suggestions for various areas and ideas for Digital Services that concern Sustainability and target an interdisciplinary audience with higher education.

Keywords: Sustainability · DIY · Upcycling · Consumption · Mass consumption

1 The Master Course "Consume Less, Create More"

The master course "consume less, create more" took place in November 2019 at the Coburg University of Applied Sciences in the interdisciplinary study program "ZukunftsDesign"[1]. Aim of the course was to sensitize the students to the problem of sustainability and to encourage them to use upcycling and do-it-yourself approaches to create a more sustainable lifestyle. A more specific goal was also to create a usable subject for everyday life from old materials using modern technologies like laser cutting or 3D printing. It was requested to create a tutorial for the respective subject.

[1] ZukunftsDesign is German and can be translated as "designing the future".

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The duration of the course was set to be three working days. The teaching staff had scientific backgrounds in Design, Media & Communication Sciences and Business Administration. There was also support from technicians and staff of Coburg University.

In terms of content the first day of the course was reserved for a theoretical input about the topics Sustainability, DIY[2] and Maker Culture as well as the organizational part like creating teams. In the Sustainability part the students debated about different definitions of the term "Sustainability", analyzed a text of the sociologist Hartmut Rosa, concerning the difference between buying something and consuming something, and had a summarizing discussion. The section concerning Maker Culture was composed of a historical overview and present examples. Finally, on the first day of the course a challenge for all students was introduced: creating a usable subject from old materials using modern technologies and tools. The subject also should fulfil sustainability criteria which the students developed themselves. Also, a Tutorial should be created which would enable other people to reproduce the creation of such a subject.

For the second and third day of the course, the students could use the whole Maker Space of Coburg University which is called "Creapolis" and is a project funded by German State to transfer knowledge and new techniques into society. Noteworthy devices available there are CO2 Laser Cutter, 3D Printer, Textile Plotter and a Wood Workshop with various tools itself.

2 Discussing Sustainability

Given the prognosis on global consumption of natural resources, Sustainability has become a significant concern in almost all sectors of human life. Before working with the term and create a goal derived from it, a proper definition in the context of the master course is necessary.

The German term "Nachhaltigkeit" is different in its etymology from the English Term "Sustainability". While the German term implicates that something endures for a long time, the English Term Sustainability already is composed of the words sustain and ability. Therefore, the meaning of sustaining a system can be derived. In Germany, the term "Nachhaltigkeit" is first mentioned in a guidebook to reforestation. The name of this publication is "Sylvicultura oeconomica" by the author Hans Carl von Carlowitz. The term itself spread soon to other parts of society [1]. For a contemporary understanding of the concept of Sustainability, the definition by the United Nations World Commission on Environment and Development shall be used. The report states "sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own need" [2]. This quotation is a condensed description of the full spectrum the topic of Sustainability concerns. Sustainability itself also is composed of three pillars in common understanding. Which is Ecology/Environment, Society and Economy. While there is an understanding of all three parts as equally important elements there is also a priority

[2] Do-it-yourself.

model. This states that Environment is most important since there is no Society without Environment, and there is no Economy without Society.

In discussion with the students, three main findings can be stated. First, there is no common understanding of Sustainability. The teaching staff expected that sooner or later in the discussion Sustainability will be defined by the students as setting parameters in a way that a system could sustain itself. No such approach happened. Second, the definition of Sustainability is determined by private and professional background of the person. And at last Sustainability as the term already made ambivalent impressions on the students based on the way it is used in society and media.

The fact that every student had its approach and there was no minimal consensus in the definition of the term showed that Sustainability itself is a very popular concept but not universally defined. After approaching a more scientific definition of Sustainability, every student was able to name a scenario in which the term is used but does not fit. The concept of "greenwashing" which is making something look eco-friendly or sustainable, was discussed. It was mentioned that the term is not only misused for marketing purposes in various cases but also politics.

Concerning Digital Services, it was mentioned that there are internet platforms and apps available which can help to figure out to which degree a product or service is sustainable. Also, the overall importance of networking as the consumer was pointed out. Social Media and various platforms can help to create communities which aim to be more sustainable.

3 Methodical Approach

Discussions during the course provided a base for different argument concerning Digital Services in the context of Sustainability. Through the format of the course close-meshed support for the students through the teaching staff resp. authors were necessary. Therefore, immediate feedback on the topic as well as observation of the process was possible. Also, after finishing the course interviews with participating students were a crucial source of further information.

This information was combined with scientific concepts about consumption and Sustainability to derive conclusions for the use of Digital Services in the context of Sustainability.

4 The Act of Buying and the Act of Consumption

The sociologist Hartmut Rosa wrote the text "Über die Verwechslung von Kauf und Konsum"[3] for the compilation "Die Verantwortung des Konsumenten: Über das Verhältnis von Markt, Moral und Konsum"[4]. This text should serve as a discussion

[3] About the confusion of the act of buying and the act of consuming.

[4] The duty of the consumer: about the relationship of the market, moral and consumption.

basis for the students of the master course “consume less, create more”. Rosa defined four basic mechanics besides acceleration which are triggered by digitalization and modern society, therefore also by Digital Services [3].

The Dematerialization of consumption describes the ability to consume something without a physical representation. Books, Movies, Songs, Pictures and much more are available in the digital representation. Physical media has been replaced by the internet and access to it. The devices used to show such content are interchangeable. There is no longer a physical representation like in books or CDs necessary.

The Decommodification of consumption describes how content can no longer be used for a commercial purpose. Crucial world literature like Goethe’s Faust is freely available on the internet. Songs and movies, specialized information, blueprints and various other content can be accessed for free on the internet.

The Re-Materialization of consumption describes how certain fields of the market expand in contemporary society. In social sciences, a “Body Turn” is stated which means that services around the optimization of the human body expand. This concerns mainly offers in the field of beauty and health.

The Re-Commodification of consumption is a trend also triggered by Digital Services. For the example of media content, we no longer buy certain movies or books, we often buy access rights. The focus is more about having options. These also translates to physical products. An example is the purchase of convenient products which are not meant to consumed by the buyer but bought to be at stock in case of an unexpected visit.

Based upon these four dynamics Rosa discusses the more and more common confusion of the act of buying and the act of consumption. Rosa defines the act of buying as purchasing a good or an access right etc. The act of consumption is defined as actual usage of a product. The most common example is that it is not identical to buy a book and to read a book. According to Rosa, it is more and more common in industrial societies to get satisfaction and reputation by buying something rather than consuming something in terms of reading a book or use a certain item [3].

The thoughts of Hartmut Rosa delivered a base for reflecting own consumption behaviour amongst the students and teaching staff. A broad discussion about the effects of mass consumption on the planet and sustainable solutions was initiated in which students at first agreed with Rosas ideas.

In the context of Sustainability and Digital Services, ambivalent notions were made. Students agreed that Digital Services can be a solution to create more sustainable approaches but also are a huge impact on the planet itself. More specific, processing power in server farms is needed to make Digital Services possible at all. On the other hand, Digital Services can help to improve sustainable behaviour. The most important part identified by the students is the spreading of knowledge and information. This task can be carried out by platforms, online services and Apps for example. Furthermore, Digital Services like a CO2 Calculator App enables consumers to reflect their own behaviour in terms of Sustainability. In summary can be stated that Digital Services are tending to accelerate all dynamics (spreading information, seeking information, seeking cooperation partners, reflecting on own behaviour, spread sustainable ideas) of sustainable development.

5 Sustainability as a Creative and Individualized Process

The main part of the course "consume less, create more" was the task to create a usable item through upcycling. Therefore, three teams were built and named after different heroes of sustainability. The heroes were defined as scientists, entrepreneurs or activists that had an impact on society. While two of three groups focussed on physical items, one group created a concept which combines the qualities of a retail store and a recycling facility.

During the brainstorming phase of creating the individual project approaches the students had to think about how to reuse the material. Therefore, online research was crucial support. There are Apps available that concern DIY and Upcycling, which can help to create a general overview of the possibilities. But it can be stated that there was no Service available that covered the exact needs in this phase, which are figuring out what to produce out of certain materials in combination.

In the production phase, Digital Services seemed to be more seamlessly integrated into the workflow of the students. For example, one group made four large shopping bags (one for each team member) from a skateboard, old curtains and a shower curtain. They labelled the project "Upskate" as a reminiscence to Upcycling. To create the bag handle the CO2 laser was used to cut it out from the skateboard and to engrave it. In these process Software and online services like a graphic icon, hosts were fluently integrated. However, in the actual process of creation, which was creating the cutting pattern and the sowing no assistance through Digital Services was used.

To sum it up, Digital Resources were used mainly to inspire and to get details like icons. For the whole process, the students relied on their own skills in Design and Craftmanship.

6 Potentials of Digital Services in the Context of DIY, Upcycling and Sustainability

In conversations with the students and separate interviews, various approaches were created on how Digital Services could support a more Sustainable Lifestyle.

The main need for assistance was identified in the benchmarking of the Level of Sustainability. Benchmarks could be used for the Lifestyle, like CO2 Calculators that already exist. They could also be used to make DIY projects more sustainable. These concerns the materials a product is made of as well as its durability.

The offering of blueprints for DIY projects and Upcycling projects is also already realized in services like www.buildsomething.org. An improvement would be a search engine in which you select the available materials and you get suggestions on what to build out of it.

It should be noticed that a lot of already existing Digital Services can be used as a tool to achieve more Sustainability. There are YouTubers which focus on the topic, Facebook Groups, Instagram a Twitter Hashtags and countless online platforms. Also, to mention "ecosia", a search engine like google which invests in reforesting from its revenue. Another aspect is platforms to start sustainable projects, like change.org or Kickstarter.

All in all, in the perception of the students there is still a huge potential for approaches of more quality. The most successful DIY platforms are not focusing on sustainability [5]. Not everything labelled as sustainable fulfils strict criteria. To establish and proof true Sustainability through Digital Services is still an approach with enormous unused potential.

7 Summary

Creating upcycled products in groups of interdisciplinary students was used to reflect on Sustainability in the context of Digital Services. Modern technologies like CO2 lasers and 3D printers can empower consumers to produce their own goods and open new possibilities to repurposing materials.

To work on sustainable concepts a proper definition of Sustainability is crucial. Sustainability covers three areas: Environment, Society and Economy. Also, Sustainability is ambivalent in definition and meaning to individuals depending on their private and professional background.

Digital Services are ambivalent when it comes to Sustainability. On the one hand, online applications consume power and resources through server farms. On the other hand, they are an accelerator for sustainable communities, spreading information and benchmarking the level of sustainability on DIY-builds, products and services.

Already existing services are used to create sustainable approaches and communities and spread information. Services, especially for sustainable purposes, are getting more important since society is getting more aware of the importance of Sustainability.

Great potential lies in the quality, customization and individualization of Digital Services. Since Sustainability is crucial in all areas to continue and improve our society, the improvement of Digital Services in the context of Sustainability will be an improvement on Sustainability overall.

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“Innovation? Yes, I Can”–Individually Perceived Creative Self-efficacy as an Effect of Vividness Targeting Creativity Methods

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Abstract. The purpose of the paper is to explore the individual perceived creative self-efficacy as an effect of creativity methods, which target vividness, within the context of teaching innovation processes in higher education as well as in business context tested in the field. The three creativity methods which are investigated, are concepts and prototypes developed based on key ideas of design, tailored to the experimental design. Our approach is founded on a practice-based school of innovating. Three User case studies are conducted amongst interdisciplinary Master students, who are mostly employed at small and medium-sized enterprises (SMEs). The gained experiences and results from the case studies are reviewed by a questionnaire and report experience, e.g. the perceived creativity scored according to the Torrance Test of Creative Thinking (TTCT), Vividness and Creative Self-Efficacy.

Keywords: Human factors · Innovation · Design methods · Creativity

1 Introduction

In this paper we explore how several creativity methods, which target vividness, effect individual perceived creative self-efficacy within the context of teaching innovation processes in higher education as well as in business context. The three creativity methods which are investigated, are supported concepts and prototypes developed based on key ideas of design, tailored to the experimental design tested in the field. Those treatments are intended to reduce inhibitions to innovate, increase the creativity of the participants, and therefore their creative self efficacy.

2 Theoretic Background

2.1 Creative Self-efficacy

Creative Self-Efficacy is “a construct tapping employees’ belief that they can be creative in their work roles” [1] and describes the relationship to creative performance.

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2.2 Creativity

According to Groeben [2] today, Creativity is mostly understood as a “special quality of problem solving, which, … is basically available to all individuals … as a development opportunity”. Accordingly, one focus of research is on environmental variables that may be beneficial or detrimental to the development of Creativity. This results in four major sub-areas of creativity psychology. Theory modelling: product (criteria), process, person and environment [2]. In our paper, we look at the interaction of person and process.

2.3 Self-efficacy

Self-efficacy [3] refers to “self-related cognition (self-concept) for assessing one’s own ability to implement measures to cause consequences” [4]. In the context of motivation theories, self-efficacy is described as “generalised conviction or specific expectation in the best possible way” [4]. In the context of motivation theories, self-efficacy is seen as “generalised conviction or specific expectation in the best areas or situations to promote desired results with one’s own behaviour” as an essential prerequisite for the motivation to act [4]. Four factors effect Self-Efficacy: Performance Accomplishment, Vicarious Learning, Verbal Encouragement and Emotional States. Self-Efficacy engenders a special behavior and performance. We focus on Performance Accomplishment and Emotional States. “I can” as a prerequisite for “I do”.

2.4 Vividness

The “vividness effect” has been studied in social psychology regarding the clarity of information and its effect. According to the “classic” definition of [5], information can be de-scribed as “vivid” if it is

(a) emotionally stimulating,
(b) concrete and challenging (imagery-provoking),
(c) and is close in sensory, temporal or spatial terms.

What is striking about the concept of vividness and the associated research is that

1) there is mainly laboratory research on the subject and very little field research,
2) the operationalization of vividness proves to be complicated time and again, as already problematized by Taylor and Thompson [6]. What information is Vivid and what requirements result from this for the design of Vivid information? According to a common hypothesis, pictures are more vivid than text, but some studies based on this hypothesis have not been able to prove a vividness effect.

On the one hand, there is a need to clarify the basic concept of vividness for a theoretical framework in which the vividness of information could be investigated, and a need for further field research on where this work should start. In the context of the research work, appropriate treatments need to be developed and tested in the field.

2.5 Method

The definition of a method used within the paper describes "[a] well-specified repeatable procedure for doing something: an ordered sequence of goal-directed operations" [3] on a general domain level, providing "a recipe for action based on a specific purpose and specific values".

3 Design/Methodology/Approach

Our approach is founded on a practice-based school of innovating. The concept of the methods are based on the concept of vividness and also on key ideas from design, particularly design research, and target creative self efficacy.

User case studies are conducted amongst interdisciplinary Master students, who are mostly employed at small and medium-sized enterprises (SMEs). The experimental groups applied the methods to an ideation phase during a creativity process for solving a task and compare the experiences and self-perceived outcomes with the method to regular courses. The gained experiences and results from the case studies are reviewed by a questionnaire, e.g. the perceived creativity scored according to the Torrance Test of Creative Thinking (TTCT) [7] and Vividness and Creative Self-Efficacy is questioned here. Moreover the participants of the mastercourse "consume less– create more" wrote reports on their experience, which we analysed.

3.1 Creativity Methods

Association Memory. Afirst attempt was realized within the concept "Association Memory" [8], in which a multi-phase creative process with convergent and divergent phases as well as text-, image- and object-based elements was operationalized in a playful way. The 20 participants were asked by questionnaire afterwards about their experiences regarding their perceived creativity scored according to the Torrance Test of Creative Thinking (TTCT).

Storytelling Class. After a 15-minutes lecture on storytelling, the 24 participants created their own stories telling important aspects of their current project in 3 steps within teams of 3–5 students. The stories were presented to the whole class in roleplay or storyboard. We observed the students during the process and asked for their experience with the method.

Master Course "Consume Less, Create More". We began with lectures and discussions on Maker Culture and sustainability, where the criteria for the further process were set. The main part took place in the makerspace of our university. 11 students had the task to create a usable item through upcycling and using tools technologies of the makerspace.

4 Findings

4.1 Findings Association Memory

As described before [8], the analysis questionnaire responses revealed that the participants benefited from using the method during their creative process regardless of their former experience with creativity methods in general. Some students considered the creative potential to be more valuable, others were more focusing on the fun aspect of the game and of the prototyping– regardless of their semester being high or low [8]. The clear objective was also largely positively regarded besides the open-ended outcome and “the head starting to associate” [8]. Unconventional and free thinking was granted by the method, to the participants’ statements. The perceived Innovative Capability with the method “Association Memory” per self-assessment ranged from low through medium to high, but tended to be high “[8]. One of the reasons indicated most frequently for a lower perceived capability are doubts, that the generated ideas can be utilized in the following steps of the design process, which was not an integrated part of the game. The students described the Variety of their output with the method “Association Memory” as predominantly good, only 2 of them considered the Variety to be low. But a greater number of students were confused by the question or by the term “Variety”. Two mentioned, it was difficult for them to write down many associations, most highlighted the variety of associative chains, which they had with the method.

The Fun aspect was significantly highly rated by nearly all the students, only one of 23 participants didn’t enjoy the workshop according to our questioning. One person especially liked the prototyping, one was appealed by the variety and originality of the ideas generated by the whole group [8]. 8 of the participants said, it was “most creative” part of their studies, even they had no confidence in their creative performance at all before.

4.2 Findings Storytelling Class

The students said, they had surprising insights in their topic with the methods, they had a lot of fun and surprisingly less inhibitions to draw and roleplay. One student used the method successfully afterwards to empathize with the users of their process.

4.3 Findings Master Course “Consume Less, Create More”

We began with lectures and diskussions on Maker Culture and sustainability, where the criteria for the further process were set. The main part took place in the makerspace of our university. 11 students had the task to create a usable item through upcycling and using tools technologies of the makerspace. In their experience reports the students wrote, the workshop, which was very practical, was fun and they were very confident about their projects and learning skills in using tools and technologies to make their products.

5 Conclusions

This paper reveals that several creativity methods which are based on high level of vividness, increase the creativity during innovation processes and also increase a higher level of self perceived creative efficacy. A coach or teacher can gain knowledge and inspiration for applying creativity methods within the innovation process targeting creative self efficacy. Especially for people with less experience in creative processes might lose their inhibitions to get involved in innovative processes with unconventional methods. Moreover the paper offers in its findings possible criteria and requirements for digital services which support co-creation integrating customers.

Originality/value

There is a lot of research about creativity itself on the one hand and there is a multitudinous variety of creativity methods in practical usage. First results with new methods in reliance on those tested in the field are examined to criteria of creativity, experience and creative self-efficacy.

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Service Innovation for Cyborgs – Human Augmentation as a Self-experiment

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Abstract. Bodyhacking, Human Augmentation, Human Enhancement and Transhumanism. These terms describe a relatively new trend describing the development of humans towards cyborgs. While some people regard this as a threat for mankind others see it as a huge potential. This paper provides an overview of the most common developments and closes with the experiences of a self-experiment describing the practicability of NFC implants.

Keywords: Human augmentation · Human enhancement · Cyborgs · Transhumanism

1 Introduction

The self-determined development of physical and mental performance can be achieved through different mechanisms and technologies. In addition to medical drugs (such as doping, drugs), technical solutions are used in this context, which define the transformation of humans into "cyborgs" [1]. This created new paradigms such as those of human augmentation, human enhancement, transhumanism or body hacking. Technical solutions can be realized in different ways and be worn outside the body such as "wearables" or "exoskeletons". But also implants and combinations of implants and externally worn devices are being researched. A concrete delimitation of which solutions can already be regarded as human enhancement is therefore often difficult. The more innovative and exceptional the solutions are, the greater the role played by the ethical aspects of these areas of research [2]. At its heart is the question of whether humans should be able to intervene through technology into the natural life cycle in order to wipe out diseases, to extend their lives to potential immortality and thereby defy nature. Using selected examples, this article provides an overview of the current state of research and practice from the point of view of the discipline of future and trend research and innovation management. It is intended to serve as a guide for discussion and interpretation of case studies for other disciplines. Thus, each of the technical developments outlined, depending on the intended application, can be used both positively (for example, to heal suffering) and negatively (for example, in warfare). In addition to a general overview of current developments in the field of human augmentation as well as feasible innovative service solutions, the article provides an insight into the findings of a five-year self-experiment.

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2 Human Enhancement Through Computer Technology

2.1 Wearables

"Wearables" are complex devices that are equipped with sensors and are worn on the body as jewelry, bracelets or textiles [3]. In addition to everyday applications, for example as a multifunctional and functionally enhanced watch, these are also often used for medical purposes. Mainly the option of simple and relatively inexpensive heart rate measurement is used [4].

In addition to these wearables, which can now be found almost every day, a scene has recently been established in which somewhat more unusual wearable technologies are being developed to improve physical performance. One example is the "Ouijiband" [5]. It is a bracelet with an integrated gyroscope that compensates for the potential tremor of the human body and enables artists, for example, to draw perfectly round circles. It is also considered to be used in the context of operations and thus to enable very fine and detailed cuts.

Another, quite extraordinary wearable is realized in the "Kinesiowear" project [6]. It is an artificial muscle attached to the back that supports the wearer in general activities and lets them feel when other wearers are nearby. It is also possible to transmit information such as directional data using haptic feedback (in conjunction with a smartphone as a navigation system).

The "Eidos" system [7] takes a completely different approach, a futuristic-looking mask with which the wearer can focus and intensify selected sensory stimuli. This makes it possible to easily understand a specific person and thus an isolated sound even in crowded rooms using a directional microphone. The prototype is supplemented by another element worn over the eyes. Images are recorded via an integrated camera and returned to the user as effects. Movement patterns comparable to long exposures become visible.

A system has been developed at Monash University in Australia for several years, which should enable blind people to see using the combination of wearable and implant [8]. A small, high-resolution camera is integrated into glasses, the information of which is further processed, and corresponding features extracted. The resulting signal is transmitted via a wireless transmitter to implants that have been inserted into the primary visual cortex of the brain and thus stimulate neurons. The result is flashes of light in the user's visual field that the brain learns to interpret as images.

2.2 Exoskeletons

So-called. "Exoskeletons", also known as "robot suits", are mechanical orthoses that stabilize the limbs and possibly the torso of a person and (traditionally) replace or support unusual or impaired body parts in medical applications [9]. Although the specific physical implementation can be designed differently depending on the application, there is broad agreement in the literature that these are body-borne structures [10]. In addition to medicine, the military is a driving force behind the (further) development of technology. Originally developed for war operations, it enables healthy people to effortlessly move loads of 100 kg and more even on rough terrain [11].

However, current scientific publications show that exoskeletons are increasingly being used in industry in addition to medicine and the military [9]. In addition to the general relief of the body apparatus, they also serve to promote ergonomic aspects.

Even open source projects such as the “Open Prosthetics” project [12] or cost-effective developments such as the “Titan Arm” [13] currently focus exclusively on medical or industrial applications. It is still unclear when the first exoskeletons will be developed and used purely for private applications.

2.3 Subcutaneous/In-Vivo-Implants

Another technology is currently in private use: “Subcutaneous Implants”. If the implants based on RFID or NFC technology [14] were originally developed for marking and identifying farm animals and pets [15], they come from the body hacking scene for a number of years also for a variety of other purposes. The technology enables the wireless transmission of information stored on a small chip. In addition to specific readers, smartphones are used. Many the devices currently available are now compatible. In the form of an implant, the NFC chips (so-called tags) are usually integrated in an element about the size of a grain of rice made of biocompatible glass and are placed under the skin, primarily in the hand area, for example using an injection needle. The power supply is via induction, which eliminates the need to integrate a battery.

In addition to a globally unique and non-modifiable identification number (the so-called Unique ID), the tags usually have additional storage space that can be described as desired. In addition, more modern versions now even offer embedded sensors, for example to be able to measure body temperature wirelessly.

The range of applications is very diverse [16]. In addition to storing personal information such as passwords, access controls can also be implemented, or payment processes triggered. Even simple actions such as unlocking a smartphone or automatically opening websites can be easily implemented. Although there were already 50,000 to 100,000 people with NFC implants worldwide in 2018 [17], there are hardly any scientific studies on this topic. Nowadays, many applications are based on the underlying radio technology. However, the benefits that can be achieved in practice have so far been limited due to the proprietary systems or security concerns of individual service providers (e.g. credit card providers), not least because of the lack of appropriate infrastructure [18].

NFC implants are criticized by data protection experts [19]. Although the reading range is limited to a maximum of ten centimeters, the horror scenario of the “transparent person” is created [20].

The latest developments not only use simple NFC chips as the only medium. Miniaturized microcontroller boards have recently become available that not only store and read information but can also actively process them [21]. The “The North Sense” project [22] takes a completely different path. This implant is inserted in the sternum and gives the wearer an additional sense of orientation. You can feel where north is by vibration. Magnetic radiation is translated directly into haptic feedback. While physically healthy people certainly ask themselves the question of benefits, things look different for blind people, for example. An "integrated" compass could perhaps contribute to a more independent life in the future.

Ultimately, however, such implants are mostly only of interest to a specific group of people and not to the general public. However, this could change if traditional implants such as dental prostheses are to be provided with additional functions in the future.

3 Human Enhancement Through Bio and Chemistry Technology

3.1 Brain Enhancers

Optimizing the performance of the human brain was also recognized as a possible starting point for biohacking. So-called "nootropics" or "smart drugs" do not have the primary goal of reaching intoxication, as is usually the case with common drugs. Rather, the cognitive functions should be strengthened [23]. This often happens by taking medication that was originally developed to treat diseases [24]. The so-called "neuroenhancement" has become very common. Already in a study from 2008 it was found that around 20% of the 1400 persons questioned had taken means to improve their ability to concentrate [25].

In recent years, many media reports have shown that students and other groups of people with appropriate performance requirements now use means such as Ritalin instead of coffee or energy drinks to meet their needs [23, 26]. It is a widespread phenomenon that has led to a rapid increase in black market prescription drug sales. But the market for legal fabrics is also flourishing.

3.2 Thought and Knowledge Injections

Current research at the University of California goes a whole step further. The scientists at the Department of Integrative Biology and Physiology have managed to transfer memories by injection from one sea snail to another [27]. Research into how thoughts arise and are stored is still in its infancy. The researchers trained marine gastropods (genus: Aplysia California) with power surges, which caused them to develop a defense response over time. With the untrained snails, it was found that they only retract into their housing after about 50 s when they knocked on their house - with trained snails, this was the case after only one second.

As a result, ribonucleic acid was removed from the trained snails and the untrained snails were vaccinated with them. It was shown that the reactions were also transferred with the biomolecule. Science is still a long way from being able to transfer concrete thoughts to humans - but what would be the implications of such research? Imagine the consequences of such a development: will universities soon become superfluous if there is a dose of knowledge to buy in the pharmacy? And what impact would such a development have on the differences between rich and poor?

4 A 5-Year NFC-Implant Self-experiment

In order to gain a deeper understanding of the technology and services that can be realized through body modifications a self-experiment started in the beginning of 2016. Therefore, an NFC X2 tag was implanted under the skin between thumb and forefinger of the author. This tag is a small glass container containing a Mifare NTAG216 chip that offers a unique ID (UID) as well as 888 Bytes of memory. It is compatible to most modern smartphones and various other devices. They are usually inserted under the skin with a cannula. In 2018 the number of bodyhackers with NFC implants was estimated between 2,000 and 3,000 users in Germany, in 2016 even less.

While, from a technology perspective, many devices leverage the potentials of NFC and are compatible with the implant, an application as a substitute for credit cards, employee IDs or for ticketing systems in most times was not possible. We contacted many service providers, such as banks, public transports agencies or employers in order to ask, if the implant could be integrated into their systems to replace their typical devices. Unfortunately, none of the 22 companies allowed the usage of external devices which usually was justified with security reasons. In several cases the request was declined without any reason. But not only everyday use cases were hard to realize using the tag. An easy application is, e.g., using the tag as a wireless transfer device for electronic business cards as it can store respective data on the internal memory. This data can be read with NFC-enabled mobile phones and is automatically interpreted correctly. In the first couple of years this was only possible with Android phones, as Apple restricted the usage of NTC to Apple Pay and even deactivated the technology completely outside of America. Even though most smartphones today can read and interpret the information, users are not fully aware of the functionality and its abilities. The invisibility of the implant also restricts a proactive application.

In contrast, and as a use case that was useful and easy to realize standard door locks were replaced with electronic NFC-locks. They usually function with key tags but can be programmed to any tag of the same base technology. Interestingly, this led to a psychological experience rather than to technological one. It took more than a year before the feeling of forgetting the key in the apartment disappeared.

It remains to be seen until these new technologies are widely accepted and the service providers will approve corresponding use cases.

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Influence of Survey Link Locational Placement on the User Rating

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Abstract. User surveys utilizing standardized questionnaires are a common tool for determining the user experience of a website and forms an important basis for the user-oriented optimization of the offer. The sample recruitment is often done passively, such as through link banners placed in various positions on the website. However, the question arises whether the location of the survey link on the website has an impact on the user rating of the website. The present article examines this question using a comprehensive website evaluation with two identical surveys that were placed in two different locations on a web page (homepage and order confirmation page). A total of 524 persons participated in the study. The results show statistically significant differences in user ratings. Participants who joined via the order confirmation page were significantly more positive compared to those who came to the survey from the homepage.

Keywords: User-testing · Survey · Questionnaires · User experience

1 Introduction

User surveys using standardized questionnaires are an important usability tool to measure the quality or value of an interactive system, such as a website. These questionnaires are also used for benchmark analyses to compare different versions, for example, after a redesign or with the products of competitors [14]. Numerous standardized questionnaires are suitable for this purpose, for instance, AttrakDiff [6], UEQ [8], VISAWI [10], meCUE [9], SUS [2], SUMI [7] and many more. Due to their simple structure, they can easily be used for online evaluations. The call to participate in the study is often passive, for example, via a link integrated on the website [16].

It is known that data quality can be influenced by various sources of error in the data collection. One source of error is the sampling itself, which can lead to loss of quality and measurement errors. These sampling errors reduce the representativity of the data and reduce the accuracy of the sampling to the population [1]. One question that has received little attention in previous research is whether the locational placement of the survey link at various points in the navigation flow has an impact on the user's usability rating of the website. There are indications that it makes sense to determine the user survey immediately after use since the memory is more important than the current experience [11]. Moreover, users should have worked with the product for a certain period before being interviewed, because otherwise there is a risk of

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falsifying the results due to a lack of experience with the product [12]. This article also joins the findings of [5], which have already identified 12 possible sources of error for falsified survey data (e.g. deficiencies in the procedure, misinterpretation), which can sometimes lead to immense economic consequential damage due to wrong decisions. However, the literature provides hardly any concrete indications of where it makes sense to place a survey link. If the link placement influences the user rating, then a valid comparison is difficult both with benchmarks with competitors and with before-and-after comparisons of one's product. Thus, the results of this investigation provide relevant decision-making foundations for usability research and especially for practice.

2 Method

To examine whether the locational placement of the survey link has an impact on the user ratings, two identical questionnaires were created and placed in two different locations in the online shop of one of the leading manufacturers in Germany when it comes to furnishing and equipping social facilities. The company equips crèches, kindergartens, after-school care centers, schools, homes and facilities for people in need of care or disabled. The clientele mainly includes female educators and therapists.

The first link was included on the homepage and the second on the order confirmation page. To exclude the influence of the design, the banner links were designed identically and were both integrated directly under the navigation. In both cases, participation was voluntary and not paid. The data from the two questionnaires were collected separately and were permanently online at the same time.

2.1 Gathering the User Experience

The User Experience Questionnaire (UEQ)[1] was used to record user ratings. The UEQ is a validated and established questionnaire for measuring the entire user experience. It measures pragmatic (usability) and hedonic quality features (user experience) as well as the attractiveness of interactive products. The UEQ has the form of a seven-level semantic differential with a total of 26 randomized items, which in turn are divided between the scales of *Attractiveness*, *Perspicuity*, *Efficiency*, *Dependability*, *Stimulation*, and *Novelty* [14].

2.2 Sample and Methodology

The questionnaires were structured as follows: First sociodemographic (age, gender) aspects were collected. This was followed by an assessment of the user experience of the website based on the UEQ. None of the questions were handled as a mandatory field.

A total of N = 393 (89.8% female, 6.6% male, 3.6% N/A) participated via the order confirmation page link and N = 131 (79.4% female, 12.2% male, 8.4% N/A) via the

1 https://www.ueq-online.org/.

homepage link.[2] The age distribution of the two groups is largely balanced (M = 46.41 years (SD = 9.8), M = 40.54 years (SD = 7.3)).

2.3 Data Analysis

The data were evaluated using the two UEQ Excel tools: The *Data-Analysis-Tool* (incl. Competitor benchmark) and the *Compare-Products-Tool* (for comparing two data sets using a T-Test). First, the data were cleaned and evaluated separately using the *Data-Analysis-Tool*. To assess the validity the mean values of the correlations of the items per scale and the Cronbach alpha coefficients [4] were considered. Overall, the alpha values are between $\alpha = 0.68$ and $\alpha = 0.96$ and can therefore be assessed as good [13]. Next, competitor benchmarks were carried out. Finally, the results of the two surveys were compared by using the *Compare-Products-Tool*.

Evaluation of the User Experience. The UEQ scales ranging between −3 (extremely bad) and +3 (extremely good). According to the UEQ developers, values between −0.8 and 0.8 correspond to a neutral evaluation, values >0.8 to a positive evaluation and values >−0.8 to a negative evaluation [8].

Competitor Benchmark. The competitor benchmark allows conclusions about the relative quality of the evaluated product compared to other products. The measured scale means are set in relation to existing values from a benchmark data set. The UEQ data set contains data from 9905 persons from 246 studies concerning different products (business software, web pages, webshops, social networks). For the interpretation of the results, the developers identified 5 rating categories from “poor” to “excellent” for each scale [15].

Survey Comparison. After the individual evaluations, the two data sets were transferred to the *Compare-Products-Tool* for comparison. The tool provides a diagram of the scale averages of both measurements and compares the results. The error bars are shown with 95% confidence intervals of the scale mean values. If the confidence intervals of the measurements do not overlap, the difference at the 5% level is significant. But even with an overlap, the differences can be significant. The tool also offers a T-Test assuming unequal variances with an alpha level of 0.05 [15].

3 Results

3.1 Order Confirmation Page Link Results

Persons who participated via the order confirmation page rated the website very positively across all UEQ scales (Table 1). *Perspicuity* was rated best, closely followed by *Attractiveness*. Worst rated, but still positive was *Novelty*. According to the individual analysis, the competitor benchmark analysis also turned out very positive. The scales of

[2] Only questionnaires that were filled out completely and classified as “serious” in the subsequent data cleansing were counted.

Attractiveness, *Perspicuity* and *Dependability* are among the 10% of the best results and are therefore rated as excellent according to the UEQ analysis tool. *Dependability* was rated good and *Efficiency* and *Novelty* were rated above average (Fig. 1).

3.2 Homepage Link Results

Persons who participated via the homepage link rated *Attractiveness*, *Perspicuity*, *Dependability*, and *Stimulation* positively. However, *Dependability* has been just in the positive range. *Efficiency* and *Novelty* were rated neutral (Table 1). Just like the individual analysis, the competitor benchmark analysis has been significantly worse than the ratings by the participants who attended via the homepage link. Merely *Stimulation* was rated just above average. All other UEQ scales were rated below average (Fig. 1).

Table 1. Scale means of the data sets.

UEQ Scale	Mean Order Confirmation Page	M Homepage
Attractiveness	1.931 ⇧	1.117 ⇧
Perspicuity	1.980 ⇧	1.032 ⇧
Efficiency	1.399 ⇧	0.635 ⇨
Dependability	1.543 ⇧	0.828 ⇧
Stimulation	1.678 ⇧	1.007 ⇧
Novelty	1.037 ⇧	0.380 ⇨

Note: The arrows indicate the rating of the respective scale: ⇧ *= positive,* ⇨ *= neutral,* ⇩ *= negative.*

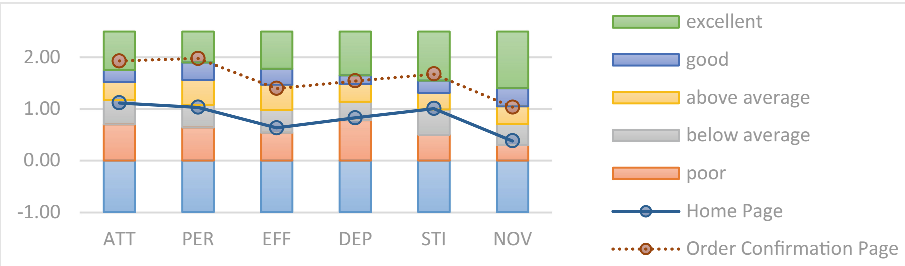

Fig. 1. Evaluation results of the data sets in the competitor benchmark.

3.3 Benchmark Results

A clear difference in user ratings can already be seen from the individual analyzes and competitor comparisons. The comparative analysis of the data sets confirmed this result. There was no overlap in the confidence intervals on any of the UEQ scales, i.e. the difference is significant for all UEQ scales at the 5% level. The significant differences were confirmed by a T-Test ($\alpha = 0.05$) as well as by a Mann-Whitney-U-Test (Table 2) with $p \leq 0.001$. With an exception for *Novelty* ($r < 0.3$) the effect sizes are in the middle range [3].

Table 2. Mann-Whitney-U-Test above scale means

UEQ Scale	Z	p	N	r
Attractiveness	−7.362	≤ 0.001	524	0.322
Perspicuity	−8.182	≤ 0.001	524	0.357
Efficiency	−7.173	≤ 0.001	524	0.313
Dependability	−7.471	≤ 0.001	524	0.326
Stimulation	−6.913	≤ 0.001	524	0.302
Novelty	−5.917	≤ 0.001	524	0.258

4 Implications and Future Work

In this study, we investigated the influence of the locational placement of survey links on user ratings. For this purpose, two links to two identical questionnaires were placed at the same time in different places in an online shop. In comparison, there were statistically significant differences in the average effect size regarding the user ratings between the two data sets. Persons who took part in the survey via the homepage link rated the shop significantly worse on all UEQ scales than people who took part via the order confirmation page. Thus, the question of whether the placement has an impact on the user ratings can basically be answered by “yes”. Nevertheless, the results should be interpreted with caution, since two extremes were considered in the present study. The statistically significant differences in the rating may also be due to the user groups. Persons who participated via the order confirmation page are guaranteed to have gone through the entire ordering process. Moreover, they are customers who have just bought something, which may result in their overall satisfaction with the usability of the website being more positive, i.e. they have not left the shop for lack of usability, for example. In the comparison group (homepage link), on the other hand, it is unclear whether they were “real” customers or spontaneous visitors. Therefore, it is unclear how often and how long they have been dealing with the website before the evaluation. They were ranging from spontaneous first-time users up to power users. It is also unclear whether these users clicked on the survey link immediately after entering the shop. Therefore, further studies with other passive recruitment methods and further link positionings are planned. For example, it would be interesting to include the survey link additionally as an intercept during the usage process e.g. pop up after a certain amount of time or a certain number of clicks. Moreover, further factors should be quantified as control variables using interaction metrics in subsequent studies.

The question of which of the results is the “right” one cannot be answered with this study. Nevertheless, it could be shown that the placement of the survey link can have a not inconsiderable influence on the user rating. This is particularly problematic when benchmarking one’s product with the products of competitors since it is not clear where their data was collected. Accordingly, the results can be incorrectly interpreted as particularly positive or negative. If the results are particularly positive, e.g. suggests that there is no need for optimization.

Overall, the topic should be of great importance with the increasing number of user studies. For example, the question arises whether what is measured is what is to be measured and if the results are reproducible. With the positioning of the survey link in the usability analysis of websites, a first interesting partial aspect was selected and the groundwork for further research into the problem is laid.

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Why Do You Listen to This? Experiencing Black Metal

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Abstract. This paper takes a look at why people enjoy listening to dreadful and frightening music. The experience of listening to Black Metal is reconstructed with Immanuel Kant's notion of the Sublime and in contrast to classical music. The paper states that the feeling of Sublimity afforded by Black Metal differs from that of classical music by the first's lack of the feeling of security. It concludes that Black Metal thus allows us profound experiences of the world not to found elsewhere in art.

Keywords: Human factors · Philosophy · Aesthetics · Music · Black Metal · Classical music

1 Introduction

> "Man sieht leicht, daß es auf dem, was ich aus dieser Vorstellung [des Gegenstandes] in mir selbst mache, … ankomme, um zu sagen, er sei s c h ö n…" [1, §2; Emphasis in the Original]

> "One can easily see that this matters what I do with this representation [of the object] in myself…" in order to say that it is beautiful.

As this quote by Immanuel Kant shows, the thought, that the beholder has to necessarily be involved as a Co-creator if it comes to Art, is not a new one. For it is the beholder's Judgment that deems something as beautiful, dreadful, boring etc. And it is of course possible that the same object could be deemed all of these things simultaneously by different or even the same beholder – hence the saying that beauty lies in the eye of the beholder. With that, this paper could come to a premature and disappointing end. People have different tastes, so they like different Art, different music, but in the end, they all enjoy beauty, albeit in different forms.

This, however, isn't the case. While Art and Music can be beautiful, and Black Metal too can be hauntingly beautiful (listen e.g. to ColdWorld or Midnight Odyssey), there is also Art that is decidedly not beautiful and even doesn't want to be beautiful. One such example would be Bernd Alois Zimmermann's *Requiem für einen jungen Dichter* [*Requiem for a young poet*]. This piece of Music starts with grim, determined destruction and ends in despair, with the few glimmers of hope, that are deceptively

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strewn in there, relentlessly mocked. It is depressing Music that methodically deconstructs and destroys everything that holds together a civilization.

Similarly, there is Black Metal that can hardly be described with any references to traditional beauty. It can be aggressive, hateful, monotonous, desperate, claustrophobic, grim suicidal. This is the kind of Black Metal this paper will take a look at. In this paper this kind of Black Metal will be given the non-autonymous designation bleak Black Metal.

Since Black Metal and Music in general is leisure activity, it poses the question: just why are people putting themselves through that, even enjoying it? This question becomes even more puzzling because as Kant pointed out above, it requires the collaboration of the perceiver to actually work, to actually unfold these effects. Why are people voluntarily collaborating in their free time to actively darken their mood?

This paper poses that beauty is indeed the wrong category to which Black Metal should be linked. Instead, it hypothesizes that the Sublime is a far more fitting framework for Black Metal.

To test this hypothesis, this paper will briefly present Kant's concept of the Sublime, as well as some criticism, before describing how the listener is involved in producing this Sublime.

2 The Sublime According to Kant

Kant sharply distinguishes Beauty and Sublimity. He poses, that Beauty lies within nature whereas sublimity lies in us [1, § 23][1]. This means, that the feeling of sublimity tells us a lot more about us, that about the perceived object. Kant states that something is deemed sublime, if it is potentially dangerous, but the Deemer has to currently be safe at the time of Deeming [1, §28]. Thus, nature can never in itself be sublime, for it is either beautiful or dreadful [1, §23]. Connected to this possible, though not imminent destruction, is a sense of magnitude. Kant states, that this is sublime which is absolutely big, meaning that it is big in comparison to anything and everything else. Additionally, he states that:

> "Erhaben ist, was auch nur denken zu können ein Vermögen des Gemütsbeweist, das jeden Maßstab der Sinne übertrifft". [1, §25; Emphasis in the original]

> That is sublime, for which the mere possibility of being able to think it, is proof of an ability of the mind, which exceeds every measure of the senses.

This in turn gives Man a sense of independence, despite the grandeur of nature, since the collaboration of our reason and our imagination can produce notions that exceed anything ontically existing in nature. But this also means, that whereas beauty arises when reason and imagination work in conjunction, sublimity arises when reason

[1] Kant thinks that beauty can teach us something about nature, especially in regards to its functionality and the laws governing it [1, §28]. While this is mirrored in the approach that some physicists have toward mathematically developing models about the universe, this has not been without criticism. See e.g. [2].

and imagination fight each other [1, §27]. Finally, he says that in order to perceive the sublime, one needs an inclination to do so. This inclination is gained by education [1, §29].

3 The Experience of Listening to Black Metal

As stated above, this paper doesn't look at Black Metal as a whole, since it is far too diverse and vast a field to be discussed in just a few pages. Instead, this paper will look specifically onto bleak Black Metal. With this designation I mean Black Metal which is particularly claustrophobic, vicious, uncompromisingly black, repulsive, depressing, malicious. Bands, which write this kind of Black Metal are e.g. Mayhem, Mgła, Deathspell Omega, Shining, Misþyrming, Tod huetet uebel, Akhlys or Батюшка.

Joel Kruger asserts that one reason why people listen to Music is, that music allows them to entrain [3]. Entrainment amongst others means to adjust one's movements according to outside influences, such as the walking pace of a companion or music. However, watching concerts of especially Батюшка, Mayhem or Shining, one can quickly see that the different audiences are hardly moving at all, and even the musicians themselves are only moving as much in order to play their respective instruments. In the case of Deathspell Omega, they even elect to not perform concerts at all because they deem most of their music to not be suitable for performing live [4]. This means that enticement to entrain motorically, to perform motions specific to that particular kind of music can be ruled out as a reason or goal to listen to bleak Black Metal. Here we can see an interesting similarity between bleak Black Metal and Classical Music. Since to move in a specific way is overwhelmingly not the reason why one listens to Classical Music, even if the piece one listens to originally was dance music, like Mozart's minuets, Beethoven écossaises or Franz Schubert's Ländler[2].

However, moving to music is obviously not its sole purpose. Meditational music, for instance, is not meant to be moving to, but rather to be still and contemplate oneself and at times life as a whole. In contrast, bleak Black Metal facilitates contemplating the abyss. Bleak Black Metal is the abyss in its purest form. Joel Krueger points out that music affords new kinds of emotional nuances [3]. Thus, one reason, why people listen to bleak Black Metal could be, that it affords contemplating the abyss in a way no other genre of music can.

Above, I summarized Kant's notion of the Sublime. Here we slowly arch back to that. The abyss, bleak Black Metal is able to conjure up, may be the Sublime in it musically most directly dreadful form. This is not to say that the abyssally Sublime could not be found in other music as well. Clearly, this is possible. The 1st movement of Beethoven's 5th symphony is awe-imposing sublime. It's like witnessing a disastrous thunderstorm from within the roaring midst of it, being pushed and shoved by the violent winds and tenderly being rocked by the loveliest late-summerly warm wisps. Since it is the abyss we are interested in here, we also need to mention Beethoven's

[2] I will add here, that there exists music, which on first glance appears to be dance music, but was never intended to be danced to, like Chopin's waltzes.

piano sonata No. 14, the famed Moonlight Sonata, *quasi una fantasia*. Franz Liszt said, the second movement to be a flower between to chasms [5, S. 71]. While the first movement is a mournful walk, the third movement is a wild ride through a tempestuous night.

Though each of these pieces is Sublime in their own right – and plenty more pieces could be named like Bach's toccata and fugue in d-minor, Edvard Grieg's *I dovregubbens hall*, Bedřich Smetana's *Vltava*, Richard Wagner's *Der Ring des Nibelungen* etc. – they differ in one important matter from bleak Black Metal: the listener is safe. As mentioned above, this is for Kant a prerequisite in order to be able to produce the Sublime. Now, one can argue, that each of these pieces deal with and are grounded on the human condition and so the dreadful and abysmal the conjure is ultimately inescapable for us humans. However, this notion is reached through reason. The Sublime in these pieces is produced not so much by our senses, but by our reason. And as Kant says, because our reason can produce notions like the Sublime that exceed our senses' capabilities by far, this in turn gives us a sense of autonomy [1, §27] and invulnerability, because this realm of reason ultimately eludes nature's direct influence. In contrast, bleak Black Metal is far more direct due to its viciousness and its harsh sound. The abyss, the Sublime isn't produced by divination or by reasoning, it arises directly from the music. Furthermore, especially when listening to e.g. Akhlys, one gets the feeling, that human reason is fleeting at best, and helpless at worst. And Deathspell Omega even go a step further when they in their theological-philosophical essays that are their lyrics conclude, that thinking about God, we have to conclude that, if he exists, he must be hateful[3]. Thus, the Sublime produced by bleak Black Metal lacks the notion of human autonomy that accompanies the Sublime in classical music. Hence, the awe and dread it shows, is far more gripping, because the realm of reason, that classical music allows for, is flatly and unceremoniously denied by bleak Black Metal.

The Sublime thus appears even vaster and more terrifying than Kant envisioned since it robs one of one's refuge.

But there is also a superficial commonality with the sublime in general and in classical music more specifically: the listener, at the time of listening, witnessing, is safe, safe even from the abyss he or she is shown. However, the bleak Black Metal's listener's safety is far more illusionary than that of the listener to classical music. Abyssal classical music asks the question, what it all is good for, are our struggles worth it? And bleak Black Metal answers that it isn't. There is an abyss. It's not the case, that we live in an inimical world, that's a field for our trials and tribulations, and though the world, death will finally crush us, she and he have to acknowledge us and our struggles, futile as they may be. Rather, bleak Black Metal uncaringly states, we live in a universe that is so vast, that it doesn't even notice us, not even when it destroys

[3] E.g. the last words oft he album Fas – ite malediciti in ignem aeternam: *Deus, Judica Me* | *... et Factus est sudor eius sicut guttae sanguinis decurrentis in Terram…* | *Domine, in pulverem mortis deduxisti me* | *PERINDE AC CADAVER!* "God, judge me | … and his sweat became like the drops of blood which are running on the ground … | Lord, you have lead me into the dust of death | LIKE A CORPSE". The fact that these latin quotes are derived out of context from latin catholic tradition is of no importance for this topic.

us and even the foundations for live itself as a whole. This is particularly the case with Darkspace's music.

So, while the listener may feel safe from the abyss at the time of listening, bleak Black Metal hatefully shows him this feeling's deceptiveness. The closest, classical music gets to this, is probably Bernd Alois Zimmermann's *Requiem für einen jungen Dichter*, which shows Man's civilization just how doomed it is. But here too, this feeling is only reached through reason and an educated mind and thus less direct.

But bleak Black Metal is not content with showing the uncaring universe. It also, like Bernd Alois Zimmermann, shows Man's corruption. But while Zimmermann's despair arises from the dichotomy of Man's lofty ideas and ideals on the one hand and the evil Man did and does on the other, bleak Black Metal scornfully states, that the project Man has been botched from the very beginning. Man is not a neutral being that occasionally slips up and does bad things, no, Man is inherently evil. This is evident e.g. in Mayhem's music[4], the music of Obitus or Shining[5].

A further difference between bleak Black Metal and classical music is, that bleak Black Metal is uncompromising. While classical music allows for, and even craves subtilty and nuances, bleak Black Metal is determined only shows existence's blackest side, without even a hint of light, hope or comfort.

Insanity, futility, evil Man and above all an indifferent, vast, inhumane universe – this is the harsh landscape of bleak Black Metal.

4 An Attempt of an Answer

As described above, the experience of listening to bleak Black Metal appears to be thoroughly unpleasant. So why to put oneself through that at all, let alone in one's time of leisure?

Reading through reviews of albums of e.g. Akhlys or Deathspell Omega one notices that, first, the listeners perceive this kind of music as indeed hateful, scornful, unpleasant – "and [they] love every second of it" [6]. They describe their music as "an unsettling world of nightmarish hellscapes" [7] and musicians like Niklas Kvaforth of the band Shining state, they want to cause horror in the world through his music and live performances [8]. Why expose oneself to this?

As Joel Krueger states, music can afford new feelings [3] – and through shown, indeed being, the abyss, bleak Black Metal affords profundity and sublimity as found in no other music. It can do this because in contrast to classical music – or, in fact, horror movies [9] – bleak Black Metal doesn't provide any feeling of security or reassuring. Miranda Boorsma states, that the perception of art broadly speaking can be divided in two categories: challenging and relaxing [10]. Bleak Black Metal rather peculiarly belongs to both categories. While one is likely not aroused by listening to bleak Black

[4] Especially in the song "My Death" on the album "Chimera" which ends with the grimly determined chants: *odium humani generis* "hatred of human kind".

[5] See e.g. the album "VII: född förlorare" with songs "Människa o' avskyvärda människa" "Man o abominable man" or "FFF" with lines like: "Jag säger nej till livet, nej till mig själv och alla guds perverterade skapelser…" "I say no to life, no to myself and all of gods perverted creations…".

Metal, the kind of stillness the listener feels also cannot be described as relaxing. The best parallel, as also one reviewer puts it, is sleep paralysis [7]: one is somewhat calm while at the same time deeply unsettled and profoundly helpless. While withstanding this stressful emotion is the challenging part, the fatalistic acceptance of helplessness forms the, perhaps not "relaxing", but still part – it is the silence of ultimate defeat.

Karim Weth et al. state that chills while listening to (sad) music, is regarded an "intensely pleasurable emotional peak experiences by listeners" [11]. Accordingly, some listeners of bleak Black Metal report feeling chills [12–14], and describe the music or part of it as "chilling" [13–15]. This, in turn means, that to expose oneself to this abyss seems to be enjoyable. Since music – as art in general – say as much about the world as it does to the beholder, we can conclude, that people enjoy exposing themselves to the abyss, to insanity, to futility to hatred. As Joel Krueger points out, music provides a scaffolding to (new) emotions [3]. But it is not sufficient that this scaffold exists – it has to be climbed as well. Weth et al. stress the importance of the familiarity of music [11], while reviewers emphasize the novelty of the music [13]. The importance of familiarity for liking music has also been shown by Szpunar et al. [16], while the importance of both for developing one's music taste has been extrapolated elsewhere [17–19].

However, I will argue for a different reason, why one could find such horribleness enjoyable. For one bleak Black Metal mirrors the abyss, the insanity in Man, the knowledge of our loathsome, futile existence. This is the familiar part. It is necessary to reaching with ourselves, into this we all somehow know, to build this abyss in the first place. Yet, at the same time, most of us are not aware of this abyss in us, so we need a special kind of music, to bring it forth. This is the novel part. Or rather, to speak with Krueger, bleak Black Metal builds a scaffold to the abyss in us – and we have to be willing to climb that scaffold and witness the abyss. But if one does this, one can experience profundity unmatched, one can experience Sublimity in all its unbridled horror.

The abyss in bleak Black Metal is as real as a nightmare is real: while dreaming it, it, is real. Bleak Black Metal allows us to experience the universe as the uncaring thing it is. It is, in a sense, the most real and rawest experience of the world, we will ever have.

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Research Approaches to Service Innovation: Organizational Perspectives

Research Approaches to Service Innovation: Organizational Perspectives

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Abstract. With the evolution of the world economy from manufacturing and goods to a services context, the focus of researchers and businesses alike has shifted to building an understanding of how to foster service innovation. Design techniques, such as design thinking, have been utilized to engage customers in service co-creation to shape their service engagement for maximum benefit and to introduce new ideas and innovative approaches. This paper focuses on research approaches to study service innovation in commercial organizations, and findings from those experiences. Insights related to data and methods, organizational ecosystems, customer interactions and employee engagement will be discussed, with particular focus on how these impact service innovations.

Keywords: Service innovation · Service design · HSSE · Human side of service engineering

1 Introduction

Service innovation is a complex concept that must be addressed from different perspectives. Research suggests that, in order to design service systems that are conducive to innovation, actors from diverse backgrounds and many worldviews are needed [10]. These actors must interact, collaborate, and be able to change roles and understand diverse and conflicting views and perspectives [10]. From an SD-Logic perspective, value cocreation is a key theme in service innovation [12]. All actors (including customers) play a role in value cocreation and innovation, as ideators, designers, and intermediators [12]. Opportunities to play these roles and to innovate in service organizations are increasing with advances in data-based capabilities [1].

Design techniques play an increasing role in service innovation [1]. For example, design thinking is a recent approach that has been applied to innovation in service contexts. In this paper, we define nine organizational and service science constructs that underly our understanding of service innovation in organizational contexts. We report on and summarize six presentations from a recent workshop on organizational

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perspectives of service innovation and relate the topics of the presentations to the nine constructs. The results highlight the variety of methods being applied to innovation design and the breadth of organizations contexts being affected.

2 Organizational and Service Science Constructs

We identified nine constructs that are important and relevant to our understanding of service innovation in organizational contexts. We identify key concepts from service science that help articulate and present aspects of service innovation: *service system*, *service innovation*, and *service design*. We also include general organizational constructs such as *people*, *organization*, *transformation* and the broader *ecosystem*. Finally, we note *method* and *data* which provide insight and understanding of the service and/or organizational activity and are important inputs into service design activities to shape the service experience. Figure 1 provides an overview of these *constructs* and their relationship to each other and service design. We consider each construct in more detail below.

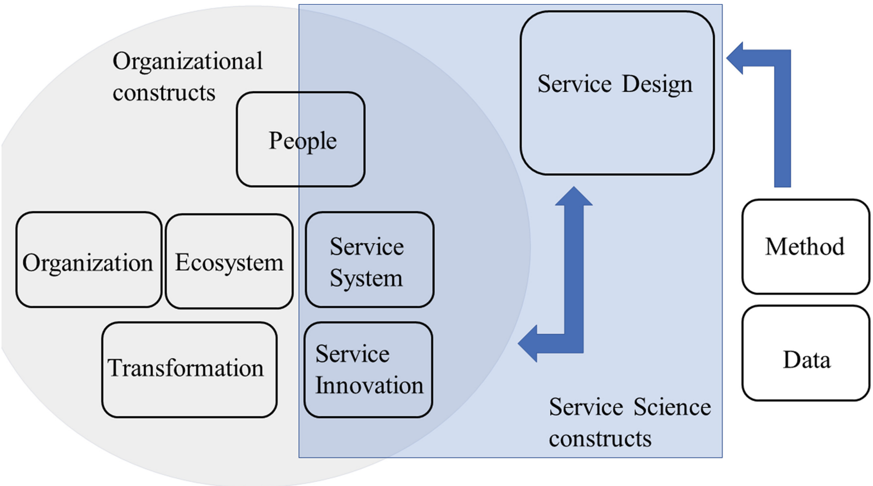

Fig. 1. Key constructs emerging from research approaches to service innovation

2.1 People

Recently, human centered design, especially design thinking is drawing attention in companies. The origin of design thinking is “designerly thinking” based on several academic research focusing on specific skills and abilities of professional designers, such as architects. Design thinking is regarded as a simplified version of designerly thinking [8]. Simon [16] defined the design as “to change the existing situation to a favorable one.” Buchanan [4] refers to the characteristics of the nonlinear design process and claims that the design process is a way of thinking to tackle "evil problems." Design thinking is gaining attention in companies because it focuses on people [7]. Design thinking, the basis of service design, empathizes with people, imagines what people think, and exposes essential problems. It is an important perspective for skill development (Sawatani) and employee engagement (Anderson & Kieliszewski).

2.2 Service Design

Service design adapts design thinking to the creation of service systems. Furthermore, service design cases and methods are discussed in companies and public services. The research area of service design has been extended from interface to interaction design since 1990. In interaction design and Human-Centered Design (HCD), the overall design is targeted for designing the user experience based on the product user interface and its use. The service design research community discuss not only the human-centered design and interactions but also service science [17, 15] and product-service system (PSS), and have expanded to service systems and service life cycles. The linkage among various objects, such as people, technology, organizations, information and the other social objects will form the relationship with innovation management (Wolf & Blomberg), employee engagement (Anderson & Kieliszewski), and service innovation (Lyons). Service design can be applied to these various relation visualization as well as evolving and analysing them.

2.3 Transformation

When adapting a solution created by design thinking or service design to a company, the company needs a transformation from the existing way. The domain of that transformation may be limited to one organization but may also extend to working with multiple organizations and other companies. Also, design thinking, and service design are not just solutions, but can also be integrated at the management or strategic level. New service systems are thus adapted and require enterprise transformation.

Introducing new technologies and skills into an organization requires choosing, adapting, assimilating and leveraging existing assets with new ones. In other words, transformation by introducing new roles (Alexander and Lyons) and building new relationships (Lyons) are important issues that frequently appear in our society.

2.4 Service Innovation

In general, innovation processes are defined as mechanisms for turning ideas into outcomes through the application of resources [2]. The SD-Logic view of service innovation puts a focus on the fact that those service innovation processes are collaborative, and the resources are not only applied but adapted and integrated in broader contexts [1]. A recent systematic literature review found that service system innovation is an underexplored area of service science [6]. Recent work has considered how people and social interaction enable service innovation [10] and how employee collective intelligence can be harnessed for service innovation in firms.

2.5 Organization

Organization is an important context for service businesses, because these internal and external structures provide process, measurement, and motivational frameworks for employees, customers, and stakeholders. As companies are influenced by macroeconomic and industry forces (Sawatani), they exert a resulting influence on the behavior of employees, customers, and stakeholders in order to survive and thrive. Creating and introducing innovation is a key differentiator between companies, and a key component of a successful business approach (Wolf & Blomberg). Organizations desire to create a corporate culture which enables their employees to innovate, and engagement – both work engagement and employee engagement – has been found to be an important factor in fostering innovation (Anderson & Kieliszewski).

2.6 Method

Our grounding in Service Science provides a rich inter-disciplinary foundation for the study of the intersection of organizations and innovation, and a diverse set of investigative and analytical methods. These methods provide focus on complex phenomena from different vantage points and with different affordances for insight. Drawing from Computer Science and Data Science, data-centric methods (Alexander & Lyons; Lyons) leverage digital data which is cross-organizational, longitudinal, and highly contextual to examine people, organizations, processes, and services in motion. These digital footprints and electronic records can be combined to form an ethnographic approach of study (Jackson; Wolf & Blomberg). Focus on the people component in organizations, particularly important motivational factors such as effectuation (Sawatani) and employee and work engagement (Anderson & Kieliszewski) provides insight and implications for other important ecosystem factors such as value co-creation (Lyons), organizational transformation (Wolf & Blomberg; Anderson & Kieliszewski), and technological innovation (Lyons, Alexander & Lyons, Wolf & Blomberg), and legal and organizational policy (Alexander & Lyons, Wolf & Blomberg). The presentations in this session focus on a range of contexts, from software engineering and open source communities (Lyons), corporate research (Anderson & Kieliszewski), large corporate enterprises (Sawatani), and industrial environments (Wolf & Blomberg, Jackson). These methods also provide options in defining the unit of analysis for study, which also provides an opportunity for new research insights.

2.7 Data

As data availability and analytics capabilities increase, there is considerable interest in using data to advance service systems [9]. Studies of service systems and service innovation make use of a variety of data and analysis techniques [Alexander & Lyons, Wolf & Blomberg]. In particular, artificial intelligence (AI) is a popular approach for making use of data to advance and innovate within service systems (Alexander & Lyons, Wolf & Blomberg). Other data-driven approaches have been applied to service system design (Anderson & Kieliszewski) service work processes (Anderson & Kieliszewski, Jackson) and exploring how data and data analytics are enabling service innovations within more traditional organizations [5].

2.8 Service System

Finally, the construct of service system from the service science literature [11] provides a unifying framework for these important components, and an abstraction to use in examining very complex entities. Just as service science has been the beneficiary of work from many other disciplines (e.g., business, management, computer science), the construct of service system is an important contribution to other disciplines concerned with people, organization, and information functioning in complex environments. A service system is defined as, "a dynamic value-cocreation configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions" [16]. Because a service system can be viewed at varying levels of granularity, cities, universities, companies, departments within companies, nonprofit organizations, government agencies, and even people can be viewed as service systems [12].

2.9 Ecosystem

Like service systems in service science, a service ecosystem in S-D logic is defined as, "a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" [17, pp. 10–11]. In an S-D logic ecosystems perspective, service exchange takes place among social and economic actors (actor-to-actor exchange) which includes more traditional client-provider exchange as well as broader configurations of actors [1, 17].

3 Synthesis of Session Presentations

The following six presentations in this session of the Human Side of Software Engineering (HSSE) track of the Applied Human Factors and and Ergonomics (AHFE) conference 2020 highlight the breadth and depth of current approaches to service innovation in organizational contexts:

1. Sawatani, Y., Effectuation model for large companies
2. Wolfe, C. T., Blomberg, J. L. Innovation-as-a-Service: Emergent Lessons from an AI Innovation Management Project
3. Alexander, R., Lyons, K. Barriers to Service Innovation using Data Science
4. Anderson, L. C., Kieliszewski, C. A., Service Design approaches to drive employee engagement
5. Jackson C., Anderson, L. C., Kieliszewski, C. A., Methodological Reinforcements: Investigating Work through Trace Data and Text
6. Lyons, K., Methods for Analyzing Service Innovation in Software Development

Figure 2 provides a consolidated view of the coverage of the six presentations across the nine constructs detailed in Sect. 2. The numbers in the first row indicate the specific key constructs (each corresponding to the secondary outline number in Sect. 2) that are covered in each paper, as well as other descriptive information. This provides a view of the landscape covered, including the range of organizational contexts; the variety of service systems and organizational contexts explored; some study method details such as use of ethnography and focus on data science; the particular focus on employees, teams, and people; and the angle on innovation.

	Alexander & Lyons	Anderson & Kieliszewski	Jackson et al	Lyons	Sawatani	Wolf & Blomberg
Constructs addressed	1,4,5,6,7,8,9	1,2,3,4,5,6,7,8,9	1,5,6,7,8	1,4,5,6,7,8,9	1,2,3,4,5,8,9	1,2,3,4,5,6,7,8,9
Data Science	yes		yes			
Ethnographic methods		yes	yes			yes
Organizational context	Broad	Research	Research	Software Engineering	Large enterprises	Large, global technology & consulting firm
Service System		Company location	Scientific Research project	Open source software development community	Entrepreneur ecosystems, departments in a large org.	Firm, clients, industry
Employee topic		Engagement	Understanding individual & team activities	Understanding coordinated activities	Effectuation	Client and other actor relationships
Innovation angle	Data science barriers affecting service innovation	Enhance employee engagement	Using organic digital data to understand communication & work	Factors associated with innovation outcomes	Application of startup ideas	Innovation as a service

Fig. 2. Consolidated view of session presentations and key constructs.

It is clear that advances in data science and analytics are driving innovation in service systems and ecosystems. There are many different methods being applied to design innovations in organizational contexts including traditional social science methods (e.g., ethnography) and data and computer science approaches. The breadth of organizations being impacted span commercial enterprises, industrial settings, research, and community-based environments. This breadth and depth in contexts and approaches will only continue to expand as new analytical approaches emerge in the coming years, and learning is applied across disciplines and environments.

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Innovation-as-a-Service: Emergent Lessons from an AI Innovation Management Project

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Abstract. Many organizations face pressures to stay on the "cutting-edge," that is, leverage emerging technologies to demonstrate currency and competitiveness in fast-changing, sociotechnical industrial environments. These challenges reside at the core of a growing array of organizations selling "innovation-as-a-service" offerings. These offerings capitalize on both clients' ambitions and also insecurities over their ability to provide state-of-the-art products and services worthy of the label innovation. What is the work required to transform novel *inventions* into *innovations*? In this paper, we report on ethnographic fieldwork studying innovation-as-a-service activities at a large, global technology and services company. These activities focus on the integration of novel artificial intelligence (AI) and machine learning (ML) capabilities in service offerings aimed to provide "innovation" to clients. Our emergent findings center on: *relationing* (nurturing the various relationships implicated in each engagement) and *bundling* (crafting compelling, yet mutable documentation for diverse audiences).

Keywords: Innovation-as-a-service · Service relationships · Service offerings · Artificial intelligence · Machine learning · Ethnography

1 Introduction

In efforts to retain their relevance and competitiveness in fast-changing industrial environments, many organizations face imperatives to be seen as leveraging novel and emerging high technology. The technologies themselves may change – for example, the personal computers (PCs), disk storage, and workplace automation trends of the 1980s and 1990s, give way to Big Data, cloud computing, and the "new" AI of today – yet the core challenges around innovation persist. How can organizations drive innovation by aligning emergent technologies, what some might call inventions, with business and societal advancements? *Inventions* (novel systems, methods, and apparatuses) are distinct from the *innovations*, or societal transformations, they might usher [4]. What work, then, is involved in transforming novel inventions into innovations?

These challenges reside at the core of a growing array of organizations selling "innovation-as-a-service" offerings. These offerings capitalize on both ambitions and also insecurities over their ability to provide state-of-the-art products and services worthy of the label innovation. These innovation-as-a-service offerings typically include some combination aimed at gracefully aligning processes (how), spaces

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(where), people (who), and experiences (what) in configurations capable of delivering innovation. Such engagements strive to offer access to cutting-edge (often newly-developed) technologies, which can be incorporated into solutions that address clients' business needs. For example, novel ML techniques may be leveraged to detect fraud in the financial industry or generative adversarial network (GANs) techniques may be adapted to accelerate new drug discovery in the pharmaceutical industry.

In this paper, we explore an emergent initiative at a large, global technology and services firm. This initiative is designed to better align two complementary aims: first, helping the firm's clients in developing innovative solutions that address their business challenges, and second, more effectively leveraging inventions occurring in the firm's research division to translate research investments into client impact. The primary technological focus of this initiative is contemporary, data-driven artificial intelligence (AI) and machine learning (ML) technologies, a key technology trend in recent years which many organizations feel pressure to harness. Distinguished from the "old" AI of previous decades (which focused on building deterministic models using concepts from planning and philosophy), "new" AI is fueled by the Big Data explosion and focuses on modelling very large datasets in high dimensionality which are engineered to learn new patterns in data over time.

In this paper, we report on early results from ethnographic data from this initiative, making note of two themes emergent in sets of innovation-as-a-service practices: *relationing* and *bundling*. In relationing, we discuss the central role of firm-client relationships and how those relationships shape the formation of business problems or "use cases" which serve as the site and target of innovation. Care goes into maintaining client relationships (providing service within the context of these relationships) as well as translating between various actors both within the firm (e.g., business consultants and researchers) and between the firm and external clients. In bundling, we discuss the work of creating innovation "assets," bundles of novel technology (i.e., AI models), legal documentation (i.e., Certificate of Originality and intellectual property clearance), and business collateral (i.e., supporting documents that explain the possible business application of the AI model). These bundles are integral in shaping the innovative potential a novel technology invention might represent – yet crafting such documentation requires expertise in not only the technology itself, but also the industrial domain and the client's specific histories and trajectories, as well as their tactical/strategic foci at hand. This careful bundling (of technology, documentation, and collateral) highlights the effort required to create configurations where meaningful co-creation – through which technological advances may be turned into business innovations – is possible.

2 Setting and Context

Our ethnographic study focuses on innovation services work at a large, global technology and services company headquartered in North America, which we call Alpha.[1] In particular, our study focuses on an emergent initiative within Alpha, which we call

[1] All proper nouns, including employee names, are pseudonyms.

Alpha-Atelier. Alpha-Atelier brings together those working as Alpha researchers (in a dedicated research division) and those working as Alpha business consultants (in a dedicated professional services division). While the relationship between these divisions is not new, the Alpha-Atelier is a strategic program that envisions a new way of working together – both internally (Alpha researchers working closely with Alpha business consultants) and also together as a unified Alpha innovation team with external clients.

This paper presents emergent findings from interviews with Alpha employees who participated in Alpha-Atelier by working on early client engagements. These engagements were intended to help define the processes and governance requirements for Alpha-Atelier and subsequent intellectual property (IP) and service offerings. The findings are also informed by participant observations: the authors attended relevant project meetings (where early client experiences were assessed, and plans were made for next interactions with clients) and they had informal interactions with researchers working on the initiative. During a three-month period from September to November 2019, eleven (11) interviews were conducted with innovation-as-a-service participants who had varied relations to the early client engagements and the overall Alpha-Atelier initiative. Five (5) interviews were conducted with people from Alpha's professional services division (i.e., business consultants), four (4) interviews were with people from Alpha's research division (i.e., researchers), one (1) interview was with a member of the corporate office responsible for research alliances, and one (1) interview was with a client executive for one of the clients involved in the initiative. Seven (7) of the interviews were recorded and transcribed; detailed notes were taken for all 11 interviews in addition to notes for participant observations. The authors met weekly to discuss and inductively analyze interview transcripts and meeting notes together to develop analytical themes. Further review and discussions resulted in conceptualizing the work of supporting innovation in the enterprise as involving *relationing*, building and caring for relationships; and *bundling*, creating artifacts that can travel within and across client engagements.

3 Findings

Our findings center on two themes. The first theme is *relationing* and the second theme in *bundling*. Relationships play a prominent role in shaping services [2]. The inductive theme of relationing draws out the integral role of service relationships, which serve as the organizing principle around which innovation-as-a-service activities arise and circulate. Care is required to arrange various actors across the service ecosystem in ways that nurture and support the relationship with the client and align the client's business objectives and goals with the company's available inventions. Another important consideration in service delivery is materiality, or the aligning of various "things" needed to leverage technological capabilities in organizational change [3, 5]. The inductive theme of bundling describes the work needed to configure innovation "assets," bundles of technologies with appropriate forms of documentation. Assets are both material assemblages (e.g., of AI models, Certificates of Originality, and business collateral), as well as conceptual resources (e.g., a "kit" of sorts, which gets unpacked, ideated, and remixed with clients). We elaborate on each theme below.

3.1 Findings Theme One: Relationing

Relationing is a core piece of innovation-as-a-service practices, shaping the activities in a number of ways. One central way is through the cultivation of business problems or "use cases," important to the client's business objectives and organizational operations. The use case is a term-of-art in interaction design, a crafty storytelling practice that aims to achieve ordinary and everyday resonance, while also creating a "hook" that feels compelling vis-à-vis contemporary industrial and cultural technological discourses [6]. Does it feel true to day-to-day life? Does it have a catchy resonance with current tech buzz? In the context of the innovation-as-a-service project, the use case is a particular narrative configured to describe a client's unique business problem around which the engagement proceeds. For example, a client may have a business need to increase the precision/recall of their forecasting techniques in a certain business process. Use cases emerge through iterative dialogue and require an interleaving of both the client's business problems, on the one hand, and novel AI/ML research in Alpha's catalogue, on the other. The use case serves as the "target" of innovation, a site at which various technologies are then proposed as possible ingredients to stir into an imagined "solution." But the two co-constitute one another – technology solutions go in search of problems and vice versa [1]. "*We started out with a very open storyline*," Siddhartha, an Alpha business consultant on the project, recounted, "*we started with a presentation of what we thought might be interesting to [the client] and then we just listened to their opinions and views and thoughts and whatnot, and then we formulated a strategy focused on three core ideas*." This is an iterative process, that can take weeks and even months of brainstorming, sculpting, and refining with clients. Siddhartha emphasized how integral this close contact with the client was in shaping the innovation-as-a-service engagement with them, matter-of-factly stating: "*Without that, it would not happen*."

Others working on the Alpha-Atelier initiative also emphasized the careful labor required to craft a client engagement's overarching narrative. "*It can be a bit of a struggle, in terms of aligning all of the different groups that are involved [internally inside Alpha],*" Andy, an Alpha business consultant, reflected. *"We have to work to get to the point where, you know, what the client is really interested in matches up with what [the Alpha] team is trying to present, and matches up with the interests of [Alpha's research arm]*," he recounted. While the ambitions of the various Alpha teams are all hopeful for a signed contract that lets the "real work" with the client begin, different pressures are felt by different roles and must be accounted for: "*I would say that the Client Team is really focused on maintaining the relationship with the client, you know, they don't want to put something in front of the client that will turn them off,*" Andy reflected. Researchers, on the other hand, are eager to see their inventions yield coveted "business impact." Yet working directly with clients can feel far afield from the daily doings of research lab life, where early-stage prototypes and proof-of-concept (PoC) demos suffice to garner support and where intellectual property (IP) generation in the form of scientific publications and patents are key metrics of success, as Finneas, an Alpha researcher expressed. Client engagements require more finesse, production, and hardening – careful thought must go into weaving together a science-forward innovation story that resonates with a business audience. Crafting these materials requires considerable effort and skill – but also importantly requires ongoing improvisation and adjustment to support and nurture the client relationship and its future within the context of an innovation-as-a-service engagement. Researchers may find themselves less experienced in this practice, requiring *in situ* learning and cultivation; further, researchers may feel tensions in the pull between scientific invention and discovery (their primary role, for which they have typically been extensively trained for through advanced credentialing) and the emergent demands of innovation-as-a-service activities (a practice for which they may fell ill-prepared for or uninterested in). Relationing also involves establishing trusting relations among internal Alpha groups who are accountable to different sets of business and performance metrics. The consultants want to be assured that the researchers are prioritizing delivering on the contract (on time and on budget) and not simply on iterating and enhancing their invention through the efforts to align it with the imagined use case. Thus, relationing involves care around the firm's relationship with clients, but also care internally for the various ambitions and affective configurations of the different internal teams who come together in working on innovation-as-a-service engagements.

3.2 Findings Theme Two: Bundling

The innovation-as-a-service activities are not selling a "product" *per se* – the AI/ML technologies woven into, shaping, and being shaped by the use cases are not hardened, commercialized products. Instead, the innovation-as-a-service initiative is selling an *experience* to clients, one that grants access to the time, energy, and expertise of Alpha's consultants and researchers – with the expectation that together hypotheses would be created for possible "innovation" value propositions and subsequently tested collaboratively through joint R&D work. "*It's a little bit of a question mark*," as Andy, an Alpha business consultant, put it, "*you know, it's not a promise to deliver a specific result so much as to complete like a research project together [between Alpha and the client,] which could yield an answer to the business hypothesis or maybe not*."

Integral to creating this experience are innovation "assets," sets of novel technologies (i.e., AI models), legal documentation (i.e., Certificate of Originality and intellectual property clearance), and business collateral (i.e., supporting documents that explain the possible business application of the AI model). Assets are both material artifacts (e.g., code, clearance docs, and PowerPoint decks), but they are also conceptual resources; bundling assets involves creating a "kit" of sorts, one that both provides clarity on its content and potential uses, but also remains mutable to be "unpacked" with clients, where whitespace is left to be (re)mixed and customized in ways unique to specific engagements.

Bundling necessitates technical expertise and regulatory understanding of the underlying technology and its IP status (How does this work? Is it cleared for public disclosure?), but it also requires a services mindset (Who might use this technology? How might they use it? What might it do for their business?) Service design is an art and a craft, as Finneas, an Alpha researcher shared, emphasizing the need for education and support for researchers in building up skills in service design: "*A lot of people, they are new to services and their vision of the world is that researchers write code, and they produce this code, and we can simply hand it over to [our business partners].*" Continuing, he noted the road to revenue realization and business innovation is long and complex: "*We have a great vision and an aspiration here, but there's still work that must be done.*"

This services mindset also involves creating a collective point-of-view for the engagement that is at once crisp and tactical, yet also has a strategic sensibility that is open towards tomorrow – there must be enough whitespace left to whet an appetite for what might come about. Innovation-as-a-service engagements are meant to be multi-year projects of co-creation and this multi-horizon nature of the projects needs to be nurtured. "*I think that it's a little bit of a balancing act*," Friedrich, an Alpha business consultant, shared, "*Because I think that when you start getting into specifics and definitions of use cases, you're getting very tactical, right. But I think that it's very important to keep, to broaden the aperture to keep them mindful that there's a bigger piece here, right. This is a multi-year commitment.*" The importance of fashioning a hybrid tactical-strategic view for the engagement was also raised by Tony, another Alpha business consultant: "*We are trying to provide the client with a strategic view, a longer-term view*," he recounted. "*Yes, we want to make it possible for the customer to put a stake in the ground, but also a dot on the horizon. That's really important*," Tony said, "*Yes, we talk about capabilities that we have today, but we are combining that with what we're doing in research, that is what gives them a perspective to a longer-term vision.*" Thus, bundling involves a thoughtful lacing up of today-tomorrow narratives, where the technical capabilities of today open up (rather than narrow down) a co-design space to be worked through and (re)mixed together with the client.

4 Discussion and Conclusions

What is the work of delivering innovation services? In this paper, we have reported on emergent empirical findings from our ethnographic study of an innovation project at a large, global technology and services company. As our findings illustrate, the vision of an innovation-as-a-service experience, capable of delivering "innovation" to clients, raises a number of challenging implications for the everyday work practices of various actors. Care must be taken to nurture not only relationships with clients, but, as we have seen, care must also be extended to tend to a wider set of concerns – both social (e.g., establishing new ways of working within Alpha) and material (e.g., bundling various resources into "kits" to support innovation activities). This raises new challenges but also new opportunities – relationships must be tended to and respected, preserved and maintained; yet the new ways of working together that the innovation-as-a-service initiative seeks to establish rest on the promise that these relationships can be transformed through joint efforts that foster more iterative, co-creative approaches to matching of client business problems with a catalogue of research assets. As enticing as this may be to many involved, making good on this potential is complicated. Various actors must navigate an uncharted landscape – despite their unity as the "Alpha team," different experiences, skillsets, ambitions, affects, and incentives shape how and when individuals may act upon and intervene in shaping the trajectories of innovation practices. Our findings point to innovation-as-a-service efforts as situated and emergent; such improvisational and unfolding interactions represent both uncertainty and risk for service relations, at the same time they can also strengthen and heighten those relations over time. In our efforts to bring about and enable innovation, we must remember that the sociotechnical transformations we call innovation cannot be engineered or built, *per se*. Instead, as we have seen, efforts must be exerted to create assemblages – artful configurations of people, experiences, ambitions, affects, skills, workflows, business goals, market conditions, lines of code, PowerPoint decks, IP clearances, and so on – through which innovation may emerge. Care must be taken when attempting to accelerate and make more efficient ways of "delivering innovation" – bonds among clients and service providers cannot be attenuated, nor compromises made that hamper the convivial and shared risk-taking inherent in and fundamental to pursuits of sociotechnical transformation.

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Barriers to Service Innovation Using Data Science

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Abstract. The benefits of adopting data science are increasingly clear in a variety of industries, yet adoption rates remain low. In this paper we examine the barriers faced by organizations in adopting data science approaches in the context of service innovation. We first characterize three types of barriers: legal framework, organizational challenges, and risks. The legal framework around data science is in a state of change, and certain aspects are outdated and fragmented. Organizational issues include recruitment and a lack of diversity. Finally, risk is inherent in any business, but data science investments may be especially uncertain due to the fundamental role that datasets play and the lack of familiarity that those making decisions may have with data science. We present results in which we identify and expand on the links between these barriers and service innovation using data science.

Keywords: Data science · Adoption · Service innovation · Regulatory framework

1 Introduction

The wide-spread adoption of data science by organizations is expected to improve economic productivity, create jobs, and bring significant value overall. This is only expected to grow, with Short and Todd finding 40% annual growth in the volume of stored data [11]. We define data science, broadly, as an interdisciplinary scientific approach that provides methods to understand and solve problems in an evidence-based manner, using data and experience. Recent studies confirm that mastering big data affords strategic advantages to corporate users, and that early adopters of the most advanced analytics capabilities outperform their competitors [7, 9]. As technologies around data platforms evolve and mature, the opportunities for local, national, and international economies to apply data science as a competitive edge will increase. Yet business leaders and legal and policy analysts around the world are also grappling with the risks and potential negative, disruptive effects that would arise from the adoption of data-driven technologies. Between 41% and 55% of work activities around the world could be automated through currently available data-driven technologies resulting in extensive job losses [5]. What's more, as these technologies advance, the impact on the existing workforce will only increase in speed. There is a potential for a digital divide across economies and socioeconomic and gender classes. Adoption of these new technologies also raises far-reaching social and ethical questions.

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Service science research has a role to play in addressing these challenges. Within service science, there is increasing interest in big data, data analytics, and artificial intelligence; in the context of service innovation and design [2]; for addressing specific service innovation contexts [10]; and, for supporting value [8]. There is also an understanding that service innovations through data science are associated with challenges such as ethical concerns [3]. Barriers to applying data science broadly in service innovation include: the need for a regulatory framework that builds trust yet allows innovation; a workforce with the skills and experience to create, apply, and maintain increasingly complex models; and, the creation of new datasets that are nonetheless reliable and train models with humanity [1]. We characterize three types of barriers: legal frameworks, organizational challenges, and risks.

In this paper, we present each of these barriers to data science adoption and discuss how service science is well-positioned to help address challenges associated with these barriers.

2 Legal Framework

The legal framework around data science is in need of change. Certain aspects, especially around privacy and consent, are outdated and fragmented [4]. And the distributed aspect of many data science applications means that the legal framework in any one state, province, or country must interact with other frameworks.

There is considerable interest in updating privacy laws. As technology advances, there is a need for the legal framework to evolve with these changes. For instance, as facial recognition software becomes more accurate and less expensive to deploy, having an appropriate legal framework in place becomes more pressing. While changing and updating the legal framework is necessary, the uncertainty that it creates is a barrier to service innovation through data science.

Innovation in data science comes from three areas: 1) new datasets; 2) new models; and 3) new applications. Those that are able to take advantage of Google-, Facebook-, or Amazon-scale datasets can quickly generate valuable results. But the capacity of many in academia and business to generate new training datasets and new models is limited because of the specialized knowledge and investment that these require. A legal and regulatory framework in which data were strictly regulated may make it difficult to create new services. However, a framework in which consumer-driven sharing happens with explicit consent, such as various open banking regulations, could allow service innovation in that area.

One difficulty with enacting legislation is that governments may simply lack the expertise to be able to evaluate the claims of leading data science businesses and are not well placed to properly forecast data science developments. Legislation that is focused on the requirements for today would place considerable barriers to service innovation in the near future as technology evolves and the economics of data science applications change.

3 Organizational Challenges

There are a variety of challenges to service innovation using data science that come from organizational constraints. These include leadership that may be less experienced with data science, specific cultural practices, a lack of an experienced workforce and associated recruitment difficulties, and, finally, a lack of diversity.

3.1 Leadership

Often the current leadership of service firms do not have extensive experience with using data science, let alone having implemented and evaluated data science approaches themselves. This may influence the strategic decisions of service innovation firms. In terms of implementing a business strategy, it can be difficult for leaders to appropriately manage teams and decide on tactics when they have little or no experience in the area. While this is a traditional management issue, it exists within this new context of data science and is a barrier to service innovation using data science.

3.2 Culture

Traditional business structures tend to become siloed because of the gains from specialization. But not only are the tools of data science largely 'silo agnostic' and able to be applied across a variety of them (in contrast to, say, accounting techniques, which tend to be largely confined to the accounting department), but they can benefit from the additional context for the data and techniques.

Domain expertise is a critical aspect in the success of any data science project. Creating short-term, high-impact, partnerships between data scientists and domain experts can be a challenge in overly siloed service businesses because of cultural mismatches.

3.3 Lack of Experience and Recruitment Challenges

The combination of skills needed to apply data science successfully in-service innovation means that there are gaps between the employees that are available and the positions. A typical data science application involves data gathering and cleaning, statistical modelling, and finally evaluation and iteration. Although some of these skills can be taught, there is a lack of experienced data scientists, relative to demand.

3.4 Lack of Diversity

Data science has traditionally been dominated by people with a relatively homogeneous background. As the applications of data science broaden there is a need to similarly broaden the community of data scientists. There is considerable benefit to doing this because usually the challenges of data science applications are context specific and there is substantial value from subject-matter expertise and a diversity of experience.

It is particularly important to increase participation of underrepresented groups, for example, women, indigenous peoples, and youth as both developers and consumers of data-driven technologies. Ensuring inclusiveness, equity and diversity in data infrastructure, data-collection processes, education and the workforce will benefit all stakeholders (including the general public) with better, more useful, and more equitable outcomes from data-science innovations.

4 Risks

Investment risk exists for any service innovation; however data science projects are especially risky for various reasons, including the fundamental role that datasets play, challenges associated with delivering on promised expectations, and ensuring equity, diversity, inclusion when implementing significantly disruptive technologies.

4.1 Availability of Appropriate Datasets

Creating, cleaning, updating, and securing datasets are difficult processes that often require substantial investment of resources. And while these are essential processes in order to extract value from data, they rarely provide value themselves which can be a challenge when making a business case and investment decision, and adds risk to the decision to adopt data science practices especially for small- and medium-sized service organizations.

Furthermore, even when algorithms exist that can help with these processes, the relevant software has to be deployed and configured in the particular environment, and, in order for the process to be of actual value, the constructed models have to be embedded in the activities of the organization.

4.2 Delivering on Expectations

The expected gains from data science adoption are significant and organizations are drawn to the promise of tremendous innovation potential. However, there is often a misunderstanding between expectations of what organizations want to do and what can actually be done. There is a risk that investments will not result in expected gains because either the underlying datasets are of insufficient quality or the associated algorithms and models are not deployed appropriately or both. In the case of AI replacing humans, for example in self-driving cars, a widespread appreciation of the benefits will only occur when the capability of the technology becomes substantially better than that of humans.

4.3 Implementing Disruptive Technologies

A unique risk of data science adoption is the potential for disruption to current jobs, including knowledge work. For instance, there is a difference between the skills that are in demand due to data science and the skills of the existing workforce. While some of the existing workforce will be able to retrain, many will not, and the social challenges of such change has been substantial in the past. It is important to understand the kinds of new skills that will be needed for the future workforce and to create new training and education materials and modules that can support those needs. This need for training and knowledge building goes beyond academic training, requiring new ways of thinking about helping employees in the workforce embark on new career paths or job transitions. A related risk is the potential that the disruptions will disproportionately negatively impact specific sub-populations, create a data divide, and increase existing wage disparities in the workforce.

5 Conclusion

A world-wide data-science revolution is underway, enabled by the capacity to generate massive amounts of new kinds of data from service applications, smart technologies and individuals [6]. Data-science technologies including AI, analytics, and smart service systems are increasing in importance as diverse, off-the-shelf tools become widely available. Data-science innovations are expected to generate substantial productivity gains, efficiencies and inclusiveness of services, and create more competitive markets and economic growth; however, there exists a variety of barriers to service innovation using data science.

Service science is well positioned to contribute to a multidisciplinary, cross-institutional, cross-border research agenda that pursues world-changing data-science research, increases productivity, efficiency, and inclusiveness across industries, furthers the transformation of existing operational systems with advanced data-science capabilities, delivers transparency, explainability, fairness, and ethics in all aspects of data-science deployment, equips policy makers and industry leaders with tools for predicting, managing, and surviving the pending disruption and economic and social consequences of adopting data science at scale.

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Service Design Approaches to Drive Employee Engagement

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Abstract. Fostering an organizational culture that builds employee engagement has received increased focus in recent years in the business, management, and organizational communication literature. A novel and promising approach to examine and foster employee engagement is to apply service design principles within an organization with a focus on value co-creation, co-design, and agility in the dimensions of people, technologies, organization, and information. In this paper, we discuss the application of service design approaches to encourage and enhance employee engagement in an industrial setting, the advantages and disadvantages of these approaches, what can be measured in a real-life setting, and future directions and opportunities for this line of research.

Keywords: HSSE · Human side of service engineering · Design · Engagement

1 Introduction

Employee engagement is a unique concept, first characterized as a personal trait expressing a disposition toward enthusiasm that, interacting with situational factors, determines a persistent psychological state of cognitive absorption in one's work, emotional dedication, and vigor (e.g., [7, 10, 15]). This attitude toward work leads to discretionary in-role and extra-role behavior that is strategically focused and tied to purpose and organizational relevance. As a benefit, employee engagement engenders better employee performance and contributes to the results of the company. Multiple antecedents and consequences are linked by direct, indirect, and reciprocal relationships. The ultimate motivation for this work is to foster organizational innovation. One facet of innovation is interaction and engagement of employees of different skills, knowledge-set or domain expertise, and tenure in order to propagate, discuss, and realize ideas. Levels and attitudes of engagement and involvement in ideation of strategic initiatives and/or skills-building exercises by employees of all levels is something that can more readily be studied than the larger construct of innovation. One promising approach to examine and evaluate engagement as a precursor to innovation is with a systematic program utilizing service design principles with a focus on people, technologies, organization, and information. We worked closely with two on-site teams whose general mission is to enhance work life and engagement at our site. Their combined objectives were to foster resident introductions and to enable residents to find common interests; build trust, goodwill, and collegiality; and ultimately promote increased effectiveness, innovation, and business results. No small feat. One was a team

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of dedicated staff with diverse experience and skills to coordinate and manage technical events and social activities for the site. The other was a representational team to extend reach into groups to share ideas, provide feedback, and create a forum for grassroots ideas to be heard, evaluated, and implemented. In this paper, we describe the beginning of an organizational practice to enhance meaningful interaction and engagement across individuals and work groups within an otherwise siloed organization.

2 Engagement, Innovation, and Service Design Principles

William Kahn, widely acknowledged as the "father" of employee engagement, defines personal engagement as "*…the simultaneous employment and expression of a person's 'preferred self' in task behaviors that promote connections to work and to others, personal presence (physical, cognitive, and emotional), and active, full role performances*" [7, p. 700]. Work engagement, a related concept is defined as "*a positive, fulfilling, work-related state of mind that is characterized by vigour, dedication, and absorption*" [15, p. 295]. The Gallup organization has conducted extensive research about engagement across and within organizations [8] and has correlated engagement positively with workplace environment and work outcomes. [10] concur with Erickson's definition of engagement [5, p. 14]: "*engagement … is about passion and commitment—the willingness to invest oneself and expend one's discretionary effort to help the employer succeed*" and expand engagement to include several additional facets (psychological state, behavioral, and trait) and recommend consideration of workplace factors such as job attributes and leadership. Employee engagement correlates with the business outcome of innovation [1]. Gallup's formula *"strengths development + engagement = innovation"* is used in their organizational and industry research [8]. [4] explore the co-occurring factors of job insecurity, job autonomy, and innovative work behavior and found mediation effects by the factor of 'work engagement'. Finally, [13, 14] discuss the cause and effect relationship between engagement and innovation and note that engagement and innovation are factors that reinforce each other. For these reasons, it is a fruitful approach to focus on engagement if the objective is to inspire, increase, or spark innovation in an organization.

The insights about engagement and innovation apply to service organizations as well as other enterprises and industries. However, there is an additional aspect of engagement that is important to consider for the service industry: external stakeholders. The dynamic of value co-creation in service contexts due to the joint activity of service provider and service customer across company and organizational boundaries is well-documented [16]. In the service context, stakeholder engagement is a critical factor for a successful service encounter outcome, as well as for achieving desired qualitative outcomes such as transformation and innovation. [2] found that knowledge gained from joint engagement with internal and external stakeholders positively contributed to innovation, if managed internally by the service provider. [6] examined the relationship between work engagement, job autonomy, and service innovation, and found that service innovation was mediated by work engagement. The review article of 112 papers in the Business, Management and Accounting discipline by [9] focuses on stakeholder engagement, co-creation, and specific to open innovation. Open innovation has become increasingly important in recent years with the acceptance of open source and open access literature. Their model also included additional factors related to interaction and collaboration such as communication, information exchange quality, and trust and commitment.

There is a very wide range of approaches to engender engagement, not surprisingly, since it is a multi-faceted phenomenon, impacted by internal and external factors [11, 12]. Bailey and colleagues [3, p. 39] note the recent emergence of "engagement as a management practice" as a research focus of interest. They highlight the relatively small number of articles focusing on organizational interventions or activities with management-introduced initiatives, identify this as a research gap, and call for additional longitudinal research in this area.

3 Establishing Methods and Evaluation Rigor

The initiative and research described in this paper addresses the gap identified by [3] and in addition takes a bottoms-up co-creative approach in driving activities by a peer-constructed team. A final differentiating approach is that the initiatives were constructed and delivered at the team level (individual working teams and collections of teams). We conducted this research at our own work location in and amongst our colleagues. The population of our work site includes a mix of enterprise organizations – product development, client business services, and research groups. The disciplines and technical work are wide-ranging, such as software engineers, materials scientists, project managers, physicists, biologists, and product support. There are common disciplines across organizational groups, such as software engineering, but sometimes it is difficult for people to identify and meet others with shared interests due to organizational structures. In general, the work site provides social and learning opportunities for colleagues of different backgrounds and on different teams to come together.

The initial focus of our work with our partner teams was to systematize and leverage existing events, such as invited guest speakers and site sponsored socials. Therefore, before making changes to any programs, we collected survey and interview data from the site population to get a better understanding of what technical events and social activities residents found value-adding through new insights, collaboration and networking, or a feeling of belonging. In this section, we briefly discuss methods employed to meet the objectives of this research. This includes employing techniques of surveys, interviews, and event portfolio analysis that resulted in co-created outcomes of community feedback analytics, collaboration photography, and improved information flow and communication mechanisms.

3.1 Evaluating What Was and Was Not Working

At the end of 2018, we conducted a site-wide survey that illustrated there were four (of 25) very memorable events from feedback to an open-response question asking what was most memorable. These were the year-end employee appreciation party, summer carnival, bi-weekly tea times, and a Halloween open house. The events represent a mix of recognition, networking, and employee family and friend activities. We see these as workplace attributes that are important to fostering a sense of belonging and building community and work pride.

Additional survey output supported these findings and that additional events (such as visiting executive speakers, all-hands, socials, accomplishments recognition) ranked highly by site residents and contributed to learning, networking/socialization, and appreciation, attributes of engagement. This surveying was the beginning of a series of data gathering methods applied to gain insights into management practices and organizational change, use of space, events and gatherings, and general local site services that impacted employee work experiences and opportunities to interact and engage with colleagues who are otherwise outside of their day-to-day work tasks.

In reflecting on the scope and variety of events, the range of explicit and implicit motivations for events became clear. We wondered about the coverage and balance across the year and impact on employee time, taking into consideration the goals and purposes of past and future events. This prompted an event portfolio analysis. We constructed a list of the goals and they tended to group into four categories: Celebrate, Learn, Connect, and Sustain. The category "celebrate" included technical and volunteer recognition, diversity and cultural events, and events that the families of the employees were invited. "Learn" covered events where residents could learn about current research and tends, technologies/products, services, and strategy. "Connect" was the dominant category that included networking and social events where residents can meet and talk with each other informally to learn of what each other or teams are doing. Finally, "sustain" refers to the site's corporate responsibility in the community and environmental stewardship.

We then evaluated each event against the goal categories and the associated cost, both direct costs for things like catering and indirect costs of the staff time to hold the event. We also took note of attendance and the evaluation of the event by attendees. In many cases, an event fulfilled more than one goal. We also found that some categories (e.g., "connect") had many more events than others. The compilation of these facts enabled strategic planning for upcoming events and the opportunity to change the mix of events to a desired level going forward (Fig. 1). In doing this data gathering and analyses, the teams were more informed about what colleagues viewed as value-add for their careers and work life engagement, and what was just nice-to-have. It also established a baseline of understanding and data collection that could easily be replicated for quick and local insights to determine if sentiment around value-add events and engagement was shifting.

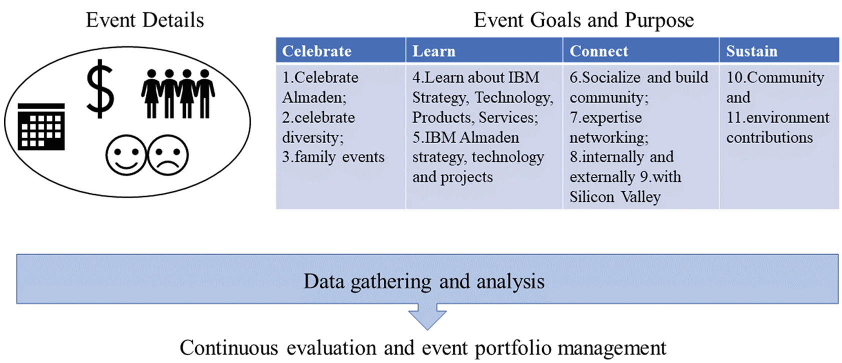

Fig. 1. Event portfolio management

3.2 Co-created Outcomes

Stakeholder relationships is a critical factor in the successful delivery of services and in value co-creation [16]. An available, easy to use, and responsive feedback mechanism is a key component of working with stakeholders. Our first outcome was to implement a two-prong mechanism to collect feedback. The first was a 24/7 online survey for specific event feedback. The second was a periodic site-wide survey to obtain reflective resident feedback over a longer time period, such as over a 12-month period (for everyone), or over the summer (for our interns). Data analysis, including resulting changes and common issues, was periodically shared and discussed with the resident population. This demonstrated that feedback is taken seriously and enacts change.

In addition to the periodic surveys, real-time communication and information flow was determined to be critical to continued engagement. As in all enterprise companies, we had an assortment of information channels to select from (e.g., email, instant messaging, slack, github, forums, communities). We found the solution to be a flexible communication tool that allowed quick posting to everyone at the site, to attend to at their leisure. The communication channel is being used for a range of topics from reminders of business events such as invited talks to how-to or how-do-I questions. The importance of the use of a single channel is that usage metrics, posting and reading behavior, and analysis of discussions (e.g., Fig. 2) can be analyzed for ongoing, real time enhanced engagement for the resident population.

Recall the creation of four event categories to aid in the portfolio analysis: Celebrate, Learn, Connect, and Sustain. These have also been turned into an iconographic communication technique (Fig. 3). Promotional materials for events include at least one icon that represents which of the four categories the event focuses. This is a simple indication to colleagues of what kind of enrichment or engagement they can expect from the event.

Lastly, we found that the use of photography – of teams, of collaborators, and of events – to be a powerful force to capture moments of engagement, team spirit, and belonging. We issued an open call for teams to be photographed, which were then posted in a prominent location near the cafeteria. The team identity was made visible, as was the range of technical activities across the teams. Capturing the moments of an event has also been powerful, for both attendees to remember and for non-attendees to get a sense of what transpired.

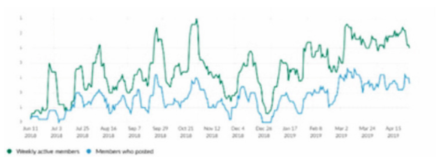

Fig. 2. Increase in real time feedback

Fig. 3. Event announcement icons

4 Discussion

Some, or much, of what we did to examine engagement through the lens of service design may seem obvious. We are not convinced. This is because small and large companies tend to make efforts to understand their workforce to improve interaction, engagement, and ultimately innovation. Yet, they can fail to do so affecting employee feelings of belonging, purpose, and retention. In this paper, we describe a few data collection activities and analyses to aid grassroots engagement efforts of one work site.

The primary challenge was determining if the technical events and social activities already in place were considered a value-add to busy schedules by residents and what adjustments should be made based on feedback. From this inaugural year of examining employee engagement, understanding what is important to site residents was critical to identify and enable worthwhile events and activities that afforded engagement. The team developed a Community Feedback Data Analytics system. This system allows the team to repeatedly gather qualitative and quantitative data for analysis, evaluation, and to course-correct when necessary. Data collection and evaluation affords the development of baselines and an interactive culture of participative and active feedback. Through data collection, we can gauge what types of events and activities residents gain the most from, without a bias towards technical or social content.

To enhance communications with site residents, four event categories and icons were developed: Learn, Sustain, Celebrate, and Connect. The categories have been communicated to the residents to establish meaning. Scheduled technical events and social activities are labeled with the appropriate event category(ies) to help people understand what is being emphasized at the event. Lastly, an improved communications channel was established for all residents to participate. It took some time for the residents to realize the channel existed and that it is monitored and tended. However, communications channel has been fruitful, with colleagues promoting events that may be of interest to others outside of their teams, requesting that certain activities be repeated (or abandoned), and helping each other out by replying to how-to questions.

5 Conclusions and Futures

Constant evaluation and calibration to enhance engagement is needed to meet expectations for our residents. This requires a systematic approach with feedback and measurement of results on an on-going basis. Feedback from our residents has led to events that drive a higher level of cross-site engagement that focused on skills (e.g., hackathons, workshops), social (e.g., teatime, cultural celebrations), and networking (e.g., open houses, intern programs) opportunities. A collaborative process in partnership with the employee population is critical, because the true benefit of these events and experiences will not be realized unless the employees also invest in them. We plan to continue and expand our efforts by building on this foundation.

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Methodological Reinforcements: Investigating Work Through Trace Data and Text

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Abstract. In this article, we present a study of scientific discovery through trace data. Using data produced from (1) scientists' interactions on computer systems and (2) meeting transcripts generated from weekly project meetings, we analyzed the interactions and conversations of scientists surrounding a scientific discovery to determine whether trace data could provide markers for the discovery. The results describe the process of interacting with computer tools and disseminating results and highlight such markers. This study shows trace data, and advanced computational techniques are useful mechanisms for identifying work trajectories and, in some cases, provide context to work behaviors.

Keywords: Human factors · Trace ethnography · HSSE · Human side of service engineering

1 Introduction

Information and communication technologies (I.C.T.s) have brought about extraordinary changes to how people in diverse organizations (e.g., finance, education, government, and medicine) work [1], with technology as a critical component which shapes work practices and activity. For many people, interacting with technology appears to constitute much of the workday as they submit financial reports, update patient charts, send emails to colleagues, and build software applications.

For researchers studying organizational work, the growing ubiquity of digital work in organizational contexts poses both significant challenges and opportunities for studying work, how it is configured in practice, and the implications for organizing. Traditional qualitative methodologies such as interviews and participant observation, while shedding much-needed light on the "sociality" of human interaction in the workplace, leave out a critical component – digital work. This is problematic as the exclusion of technological artifacts, and social interactions with them produce only superficial accounts of what people do [2]. Given the varied assemblages of technologies supporting people in workplaces, we posit that making use of digital trace data can help shed light on previously unobservable phenomenon in organizational settings.

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Many work systems generate trace data as byproducts of people's interactions on systems, such as the creation of reports, sending and receiving email, scheduling tasks in their calendars, when a record of these activities is stored in system logs. These trace data – "digital footprints" – provide a rich source of data representing what people do on computer systems. In that sense, trace data can be seen as a lens into aspects of organizational life, capturing individual practices in detail [3, 4]. System usage data has been used for many years by cloud service providers wishing to optimize the delivery of their services [5], building on the legacy methods of Service-oriented Architectures [6]. There are, however, additional opportunities for new insights in services through analytics examining the activity of people and the flow of information.

Our goal is to explore new data sources and computational methods to understand work. Making use of new data sources and methods gives rise to questions, which we address here, such as: In what ways can trace data support existing investigations? What can be learned from their insertion? What are the limitations of such data, methods, and approaches? We examine the usefulness of trace data analysis and computational insights through an ongoing investigation where we seek to gather requirements to design of work systems to track team performance.

2 Setting: Metagenomics Research Team

Our research is set in I.B.M.'s Almaden Accelerated Discovery Lab, a physical and virtual lab space organized to support research teams engaged in basic and applied research at I.B.M. Research - Almaden. We studied a group of scientists researching metagenomics. Their research goal is to identify genomic biomarkers relevant to food safety. Metagenomics is a relatively new field and has been supported, in part, by new computational tools. The team was focused on identifying characteristics of gene samples not previously known and discovering novel approaches to analyzing samples.

The original work performed by the team members consisted of analyzing the precise order of nucleotides within a D.N.A. or R.N.A. molecule in food samples. The genomic datasets of D.N.A. or R.N.A. codes were imported into software used by the scientists to produce statistical and computational results related to the identification of genomic biomarkers. The order of these nucleotides pointed to the presence of different bacteria that may reside in food samples. The genetic characterization of the samples allowed the team to answer questions such as, what does the sample contain? Is the source organism chicken or pork, and what bacteria is present?

The scientists analyze genomic datasets using the Metagenomics Computation and Analytics Workbench (M.C.A.W.), a software application that allows the scientists to upload genomic datasets and analyze them for D.N.A. or R.N.A. codes. When scientists examine the datasets, they produce statistical analysis and charts to disseminate. The results are interpreted by scientists and are used to develop knowledge for research findings and metagenomics research. M.C.A.W. logs user interaction data, recording click events as scientists run analysis over the datasets.

The scientists also hold weekly project meetings, bi-weekly technical meetings, and quarterly full team status meetings to discuss research activities by the scientists, background literature on the state-of-the-art in the field, technology being developed, and logistics for future meetings. Meeting attendees discussed software tools, research papers, and milestones related to the project. The focus of the meeting was for members to share updates about the progress of analysis projects. During these meetings, scientists share many artifacts to communicate findings (e.g., reports). The meetings were recorded and transcribed as an additional data source artifact.

3 Methods

Since the research goal of the metagenomics team is to make a scientific discovery, we based our analysis on using the trace data to identify the discovery. We used both the meeting transcripts and the system logs as data sources for examination using trace ethnography to detect evidence of work activities. We use a historical analysis approach [7] to analyze the data, beginning with an event (i.e., discovery) and then reviewed activities surrounding the discovery. We first identified a scientific discovery and then, through analysis of the trace data, determined if the trace data provided markers to shifts in how the science was conducted. For instance, as science moves from analysis to paper writing, we suspect scientists engage with different tools (visible in the system logs data) and begin to shift conversations (evident in the meeting transcripts).

3.1 Data and Analysis

Our investigation relied on three sources of data - interviews, system logs, and meeting transcripts. We conducted eight semi-structured interviews with scientists to identify a “scientific discovery.” The interviewees were allowed to use their own definition of discovery when identifying and describing their team’s discoveries. The explanations of discovery ranged widely in scope across the interviewed project, from small innovative techniques to substantial publishable findings. The interviewees were then asked several open-ended questions, such as “*Can you recall and describe a scientific discovery the team produced?*” and “*What work activities in the work system were related to the discovery?*” The interviews lasted approximately one hour and were recorded and transcribed. Findings from the interviews were summarized, and detailed discovery data of dates, tools used, and terminology were recorded. This information was used to initiate and focus our examination of the meeting transcripts and system logs. Our analysis produced a set of findings we then compared to corroborate time periods, tools, and terminology mentioned in the interviews.

Meeting transcripts were obtained from audio-recording of thirty-six weekly project meetings beginning May 2015 through April 2016. Analysis of meeting-specific topics was done to determine a central theme representative of each meeting discussion. To identify topics, we used Latent Dirichlet Allocation (LDA), which is a probabilistic model used to identify common topics in a set of documents. LDA uses a probability distribution where each document has a probability of belonging to each of k-unique topics. The LDA algorithm takes two parameters as inputs: the number of unique topics (k) to be generated, and the number of words (w) to be produced and that are representative of each topic. The term parameter is the probability of seeing the word ‘w’ given topic ‘k.’ We set the number of unique topics as $k = 7$ and the term parameter as w = 20. The results of the topic modeling supplied each document (i.e., meeting transcript) a probability of belonging to each of the seven topics. Each document was assigned to the topic with the highest associated probability.

System log data was collected from M.C.A.W. These records contain information about the software analytics programs (a.k.a., workflows) used to explore a genomic dataset. The activity was instantiated as functions such as importing and exporting datasets, analyzing datasets by referencing them to other datasets, generating charts and graphs based on the datasets, or other tasks that the scientists can define. Each record included metadata such as invoker_id (the scientist who initiated the action), workflow_id (unique id for the workflow), action_description (free-form text the scientists use to describe the work), an initiated_at and finished_at timestamp.

The meeting transcripts point to the emergence of ideas and discussions around work while the system logs provide a rich history of interaction between the scientists and the analysis software. We combined the findings to produce a timeline determined by the data sources that reveal a history of activities as discoveries emerged.

4 R.N.A. with Introns and Exons

Based on our analysis of the interview data, we identified two scientific discoveries which we label - *The Case for R.N.A.* and *R.N.A. with Introns and Exons*. Table 1 lists pertinent information related to the discovery that allows us to go into the trace data. These include the terminology used to describe the discovery, the relevant scientists, and engineers who were responsible for conducting analysis and presentations related to the discovery, applicable software, and the timeframe the discovery occurred.

Table 1. The results from interview notes on one scientific discovery.

Discovery	Description	Related words	Time period
R.N.A. with introns and exons	Samples with unexpected bacteria discovered	R.N.A., D.N.A., eukaryotes, introns, exons, contamination	Fall 2015 and Winter 2016

Once the transcript corpus was prepared, we analyzed the aggregated documents for global topics and each transcript for meeting-specific topics. Global topics were those found across the corpus of meeting transcripts in the data we collected, whereas meeting-specific topics were those found for individual meeting transcripts. The output of the topic modeling can be seen in Fig. 1. Each row represents one of the seven topics, the 20 most associated words that comprise the topic, and the individual meetings associated with the topic. Based on the analysis of the topic words, we concluded that Topic 5 was reflective of general project management, Topics 2 and 6 have a recognizable function. The remaining meeting transcripts (N = 7) are associated with Topics 1, 3, 4, and 7 and are representative of meetings with a general biology focus.

The results of the interviews show words such as *R.N.A., D.N.A.*, *eukaryotes*, *introns*, *exons*, and *contamination* would appear in trace. The topic modeling revealed that Topic 4 shared the highest similarity in terminology with the interview findings with the words: *R.N.A.*, *exon*, and *intron* overlapping with interview notes. (exon and intron are unique to Topic 4). Topic modeling also revealed meetings with the highest likelihood of belonging to Topic 4 (5 January and 12 January 2016), which aligns with the Fall 2015/Winter 2016 discovery period referenced by the scientists.

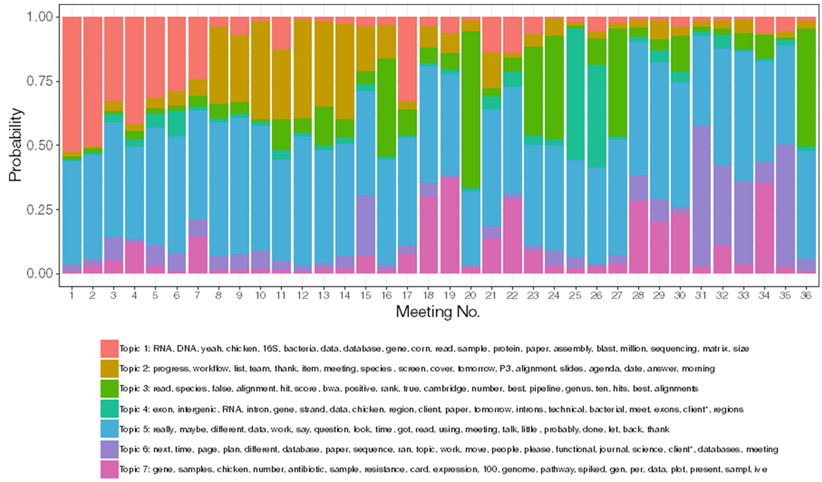

Fig. 1. The results of topic modeling showing each of the seven topic model clusters, terminology most representative of the topics, and the month-day of associated project meeting transcripts.

Figure 3 illustrates the intensity of Topic 4 words used across all meeting transcripts. There were increased mentions of all words during the discovery period in January. However, the words *exon*, *intron*, *intergenic*, and *strands* spiked during the discovery period in January, and little mention of these words leading up to and following this increase was observed. For example, the term *intergenic* was used on 69 (85%) occasions in the two January transcripts and only 12 incidents in the remaining ten meeting transcripts. Additionally, *exon* was mentioned a total of 134 times, with 133 (99%) occurrences during the discovery period and only one within the remaining 34 meeting transcripts. Similar patterns exist for the words: *intron* and *strand* (Fig. 2).

Interviewees noted that the BedAnnotator workflow was the primary tool used in the discovery. Analysis of application system logs showed this to be accurate and that participants 4 and 8 were the primary users of the workflow. Figure 3 provides an illustration of the number of times the BedAnnotator workflow was used by the scientists on a given day (the size of the dots corresponds with usage statistics). The first use of the BedAnnotator workflow was on 12 December by Participant 4. Afterwards, it was mostly used by Participant 8 from late December 2015 through early February 2016. We observed concentrated use of the workflow in the timeframes before the discovery period meeting dates of January 5 and 12. During the two weeks before 5 January, BedAnnotator was used 117 times. After 12 January, there was a significant drop-off in use, with the workflow used less than ten times in the subsequent two weeks.

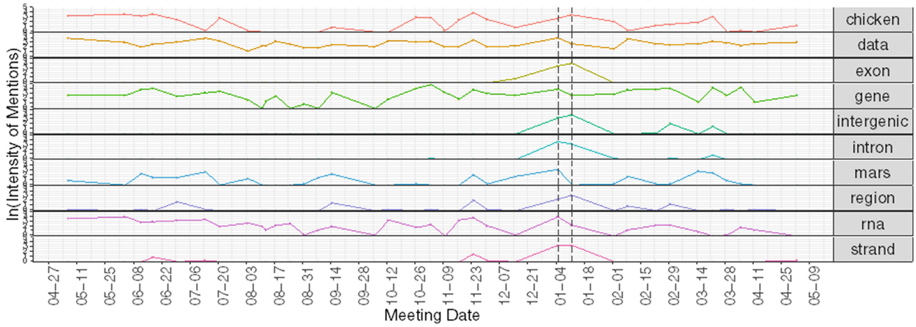

Fig. 2. Results of work frequencies from the topic modeling output. The x-axis indicates the meeting dates (month-day), and the y-axis represents the frequency of word mentions during each meeting on a natural log scale. Vertical lines indicate the discovery periods.

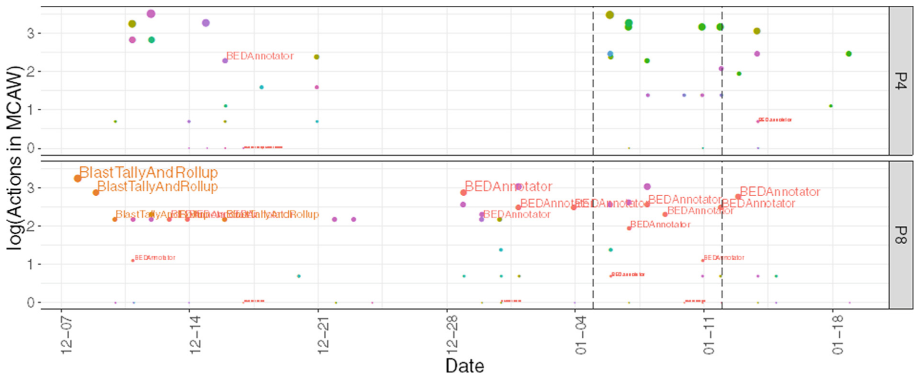

Fig. 3. Use of the BedAnnotator workflow Participant 4 (top) and Participant 8 (bottom).

5 Discussion and Conclusion

Blending computationally derived insights into how new tools are used increased our understanding of the work the scientists conduct. Trace data allow us to examine human and technology dynamics, and computational approaches will enable us to mine digital artifacts more efficiently (e.g., presentations, code samples), which are essential modes of communication for teams. The project meeting transcripts and application system logs as digital trace data sources reveal two critical findings. First, by using topic modeling, we could corroborate the words and timeframes associated with *The Case for R.N.A.* and *R.N.A. with Introns and Exons* discoveries identified in the interviews. Second, through the analysis of the project meeting transcripts for changes in targeted terminology and the system application logs for workflow use, we discerned increased activity levels by scientists that were associated with the discovery periods.

We concentrated our efforts on discoveries and determined through analysis of trace data sources markers in the use of analysis tools and text, the discovery period. The question emerged about whether intronic genomic regions being observed in R.N.A. samples were accurate. Analysis of project meeting transcripts revealed discussions about the discovery that occurred with a notable spike in the introduction of new words (exon, intron, and intergenic) and an increase in relevant words (chicken and strand) compared with general meeting discussion. Additionally, the application system logs revealed the emergence and increased use of BedAnnotator during the time periods surrounding the discovery.

In conclusion, through analyses of the trace data we observed changes in work activities that overlapped with the discovery. We can start to reconstruct the discoveries as a timeline of activity to create a scaffolding for the emergence and story of discovery. The requirements for tracking work through trace data are not without challenge. The obstacles that we encountered were siloed application systems, access to systems, and a deluge of data required to make sense. With the advent of enterprise social networks and more integrated data sharing and analytics systems, the obstacles should lessen over time. We suggest the inclusion of digital trace data sources with more traditional methods to examine practices of teams who are heavily supported by I.C.T. to perform their work.

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Service Design Techniques: Healthcare Applications

Architecture and Its Multifaceted Roles in Enabling Value Co-creation in the Context of Human-Centered Service Design

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Abstract. Architecture is critical to Human Centered Service Design (HCSD), which is understood as an outside-in-viewpoint that focuses on value creation and social value from a human perspective [1, 2]. The architecture has many roles to play that are relevant to the process and output of HCSD, especially for the coordination, integration, application and governance of resources and organizational capabilities.

In this way the motivation of this work is to answer the question to what extent architecture enables and supports the value co-creation process.

Keywords: Architecture · Value co-creation · Service Dominant Architecture

1 Introduction

Architecture is critical to Human Centered Service Design (HCSD), which is understood as an outside-in-viewpoint that focuses on value creation and social value from a human perspective [1, 2]. Human centered strategies are characterized by customer orientation and the systematic, purposeful building of resources and capabilities that lead to co-creation and the exchange of resources for mutual value generation.

Architecture as process and output has many roles to play that are relevant for the tight alignment between Human Centered objectives and the availability and applicability of capabilities.

In this way the motivation of this work is to answer the question to what extent architecture enables and supports the value co-creation process in the context of Human Centered Service Design.

2 Methodology and Approach

For answering the central questions, the Design Science Research Methodology (DSRM) is used. DSRM interprets design as an "act of creating an explicitly applicable solution to an problem" [3] that serves as a commonly accepted framework [3–5]. In order to be human centered service design and not art, the creative act and its results

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must serve human needs and goals. All designed artifacts address concrete challenges and solutions to human problems [6].

Referring to DSRM the research process is divided into six activities which are presented in the following briefly.

In activity (1) the signification of architecture as enabler of value co-creation is explored. In conclusion, as motivation of this research we formulate the core question of our work: to what extent architecture enables and supports the value creation process in the context of Human Centered Service Design.

Activity (2) defines the objectives of a generic solution concept. Therefore a set of theoretical concepts of Service Science and S-D logic is used to build a conceptual framework understood as a set of definitions and concepts used to describe the phenomena, formulate questions and make generalisations [7, 8].

Activity (3) design and development [3] as an act of creating an explicitly applicable solution for the key questions. Based on architectural design pattern that systematically name, motivate and explain a general design that addresses a recurring design problem Service Dominant Architecture as research design artifact is described [9].

In activity (4) the architectural design pattern is implemented for and utilized by entities as a set of service systems. The use of SDA to answer the research question is demonstrated in the context of the HCSD based case study of the German insuretech.

Activity (5) observes how well the Service Dominant Architecture (SDA) answers the research question.

In activity (6) the utility and novelty of the answers given by the MVP of SDA and the implementation of SDA on a technological platform are communicated.

3 Theoretical Foundations and Conceptual Framework

The conceptual framework is understood as the set of concepts and contexts used to describe the phenomena, the territory and the objectives of a generic solution concept. This research uses the theoretical concepts and foundations of Service Science and S-D Logic for analyzing the relevance of architecture for the process of value co-creation [7, 8].

S-D Logic provides the foundation for a general theory of markets and marketing. Service – understood as the application of specialized skills and knowledge - is the fundamental unit of exchange. Value co-creation is the core of the narrative and process of S-D Logic. In this process service exchange happens through actors integrating resources enabled and constrained by institutional arrangements nested in service ecosystems [10–12].

The interactive relationship during value co-creation results in added value that improves one's own state or condition. The value of this co-creation can be differentiated between a subjective (experience) and an objective (result) value [13]. This characteristic is also reflected in S-D Logic, which describes value as always uniquely and phenomenologically determined by the beneficiary [10–12]. The so-called value co-creation takes place in service systems. Service systems are defined as "[…] a dynamic value-cocreation configuration of resources, including people, organizations, shared information (language, laws, measures, methods), and technology, all connected internally and externally to other service systems by value propositions.". Overall, service systems foster a systems perspective for studying and understanding service ecosystems, and their influence on service-for-service-exchange and emerging digital markets [14–20].

The value of service systems and its resources is a function of the context in which they are embedded. Therefore, the distinction between value in use, value in context, and value in social context is relevant. This means that resources can generate more value in use and benefit in one context and less in another [21, 22]. "Value is idiosyncratic, experiential, contextual, and meaning laden" [23]. The unique and subjective character of value is based on a differentiation between value in use [11] and value in context [21, 24] including value in social context.

Building on the foundations of Service Science and S-D Logic we strive in the next step to derive requirements of Service Science and S-D Logic for a conceptual framework. Based on presented foundations, S-D Logic requires capabilities that service systems need to implement. Thus, we derive requirements from the S-D Logic axioms that the conceptual framework must consider for facilitating the process of value co-creation (Table 1):

Table 1. Requirements of S-D Logic for architectural design pattern enabling value co-creation

S-D Logic axioms [25]	Core elements of a Conceptual Framework for Value Co-creation
Service is the fundamental basis of exchange	– Service-dominant perspective on value (value in use, value in context) – Application of operant resources as main basis for mutual benefits
Value is co-created by multiple actors, always including the beneficiary	– Integration and coordination of multiple actors in value creation – Explicit integration of the customer
All social and economic actors are resource integrators	– Enabling resource integration and the inclusion of all necessary actors
Value is always uniquely and phenomenologically determined by the beneficiary	– Focus on the actual value of the integrated actors. Consequent orientation on customer's preferences, needs and requirements – Data driven customer understanding
Value cocreation is coordinated through actor-generated institutions and institutional arrangements	– Integration of actor-generated institutions (pattern, rules, norms, practices) – Development of new, and adaption and integration of existing institutions

4 Architectural Design Pattern: Service Dominant Architecture

In order to meet the requirements of the conceptual framework Service Dominant Architecture (SDA) defines design patterns of three systems and a Data Lake. In the following, the design patterns of SDA are introduced [26, 27] (Table 2):

1. **System of Operant Resources**: The system of operant resources is the heart of the SDA. It represents the workbench, where the various ingredients (resources) are brought together and processed. For this, this system applies certain logics or processes. In line with S-D Logic, the focus is not on, mostly physical resources. Instead, intangible resources like competence, knowledge, skills, software code, are used and brought together to build up capabilities for Human Centered solutions. An important target of this system is to achieve required resource density.
2. **System of Interaction**: The system of interaction, enables interaction and a bidirectional data flow between the provider and the customer. The customer can also participate in the design and personalization of a particular solution by responding to value propositions with engagement, i.e. with their own resources (e.g. conscious and unconscious data input). The customer takes over the activities and acts as a co-creator.
3. **System of Participation:** The concept of co-creation includes other co-producers in addition to the respective customer. The system of participation enables actor-to-actor orientation and the resource integration of third parties, i.e. other external resources.
4. **Data Lake:** From a company's point of view, data received and generated by interacting with the customer should be systematically recorded and evaluated in real time. In this way, the company can learn continuously and by this, deepen the data-based understanding of the customer, their preferences and needs. On this basis, a company is able to achieve a continuous improvement of value propositions and service.

Table 2. Architectural design pattern

Architectural design pattern	Purpose
System of operant resources	– Resource integration and resource density – Bundling, un-bundling, orchestration of resources – Aggregation of capabilities for value propositions
System of interaction	– Interaction; value co-creation; service provision – Databased understanding of customer and context – Resource integration. service exchange
System of participation	– Actor-to-actor orientation – Connecting/integration partner and co-producer – Resource integration: external actor
Data lake	– Customer data (context) – Customer record/history – Contextual data – Event driven value propositions

Figure 1 shows the three Service Systems and the Data Lake of the implemented SDA design pattern. The circle surrounding the SDA Service Systems represents defined institutions and its purposeful use. This is of importance in the sense of rules and norms for the coordination and connection of actors, and by this for the facilitation of resource integration, value co-creation, and the targeted development of capabilities.

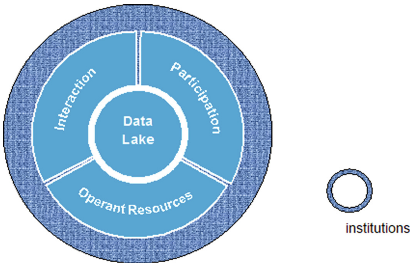

Fig. 1. Design pattern of Service Dominant Architecture

5 Demonstration in the Context of HCSD

In Germany, approx. 2.6 million care applications are applied for each year. For each applicant, for service provider and for insurance companies the process of first application today is a process that is heavily based on manual (duplicate) work and takes a time from 5–9 days due to postal communication.

Referring to a study of the company SDA SE in cooperation with University of applied sciences Münster for those in need of care, the situation regarding the necessary process steps, actors, and media is not transparent and orientated. In addition, there is a high administrative burden for the family members and this in an emergency context. Normally, neither the process nor the contact persons of the insurance companies or the involved external experts for the external opinions are known. So, it's a process that from user's point of view can be described as poor design.

Based on the Service Dominant Architecture, the process was completely redesigned together with customers, relatives and UX designers. The focus now is on human centered design and on an administration app under the name edith.care[1], which can be used by the applicant or family members to solve all administration tasks of care application quickly, securely and trustfully. From the customer's point of view, edith.care connects all participants of the care ecosystem in Germany and serves as a partner of cost bearers and service providers. External experts (e.g. service provider MEDICPROOF for private health insurance or MDK for statutory health insurance) are connected via the System of Participation. The connection to the backend systems (System of Records) of the insurance companies is made via the system of operant resources.

[1] https://www.edith.care.

By connecting actors and enabling resource integration SDA enhances the level of resource density. Missing functionalities or capabilities (e.g. real-time capability) were supplementary implemented on the SDA in order to obtain a continuously automated process. The System of Interaction enables the edith.care app to perform real-time interaction with the care applicant, who is guided with the help of a structured process for orientation purposes.

The SDA concept, implemented as three service systems, a data lake and institutions, made it possible to redesign the specific, existing care application process and to co-create a human-centered new application process: Offering guidance and a structured process, edith.care enables value in use for those in need of care and their relatives. Uncertainties regarding contact persons and the process flow were eliminated and the process was considerably accelerated from the original 5–9 days to approximately 5 min.

6 Observations and Outlook

In the context of Human Centered Service Design architecture sets the institutions which coordinate resource integration and service exchange among actors; organizes the process of bundling and un-bundling of resources and orchestrates and facilitates the development and application of Human Centered capabilities.

In summary, architecture enables Human Centered Service Design by organizing both; on the one hand the services and capabilities as input for value propositions and on the other hand service as a process of coordinating actors, resource integration and service exchange. By organizing this architecture is highly relevant for market shaping and the process of value co-creation. In particular the importance of architecture for the emergence and the shaping of markets offers interesting fields of research.

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Value Co-creation as the Core of Service Innovation: Impacts of a Case Study of a Fully Digitized Health Insurance Company

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Abstract. Insurtechs are changing the insurance industry more and more. A major driver for these changes is their ability to quickly build capabilities that create direct value for their customers. Value co-creation and actor engagement are key mechanisms at play in the design of straightforward, innovative value propositions and the stimulation of service design and new service development. Subsequently, we present our case study research of a fully digitized health insurance company in Germany which is striving to innovate by (re)designing practices to institutionalize new health services and solutions. Our aim was to study and understand environmental properties, roles, and relationships of actors and resources in service innovation in the given real-life business context.

Keywords: Service innovation · Value co-creation · Resource orchestration · Service Dominant Architecture · Human-centered service design

1 Introduction

Insurtechs are changing the insurance industry more and more. A major driver for these changes is their ability to quickly build capabilities that create direct value for their customers [1, 5]. This paper analyzes the relevance of value co-creation for the emergence of service innovations from a theoretical and practical point of view. For this, the S-D logic perspective was used as a starting point for the study of value co-creation and service innovation. Building on the basic concepts of S-D logic [4, 6, 7, 15], the prerequisites for and characteristics of the emergence of service innovations are presented. The practical relevance and transferability of these S-D logic–derived characteristics regarding the significance of value co-creation for the emergence of service innovations will then be examined with reference to a digitized insurer based in Germany. With this work, two objectives are being pursued: first, we are investigating how and to what extent the basic concepts of S-D logic are suitable for explaining the relevance of value co-creation in the emergence of service innovations in practice; second, we want to explore whether the consistent use of S-D logic–based concepts can provide impulses for practical solution designs to foster value co-creation and actor engagement. The paper is structured as follows: first, we present and explain our

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research methodology. Next, we briefly overview the theoretical foundations which are relevant and help us to set up and analyze our case, namely value co-creation and service innovation. Then, we present the results and insights gained from studying the real-life case of an insurtech company in Germany. After a brief discussion of the results, we highlight major points in a summary and end with concluding remarks and an outline of the next research steps.

2 Methodology and Approach

As methodology, this research uses a longitudinal single-case study approach in combination with a service innovation framework. The case study methodology was chosen because we had to deal with a set of research material which needed to be analyzed, such as documents, artifacts, interviews, and observations [2, p. 12]. Control over behavioral events was not required and needed. The subject of our longitudinal single-case study is a German-based digitized health insurance company. We will illuminate actions taken and relevant decisions and choices to design and implement service innovations by drawing on existing conceptualizations and frameworks, primarily Lusch and Nambisan's S-D logic–based service innovation framework [3]. Another research question to be looked into is how institutional innovation [6, 7] and actor engagement [8, 9] can be used to design and implement service innovations in the targeted domain (healthcare). The research results will be used to evolve our research on SDA (Service Dominant Architecture) [1, 13, 20, 21].

3 Foundations of Service Innovation and Value Co-creation

In the last few decades, the character of innovations has changed. Previously, innovations were mostly developed within companies; now, they are mostly created in networks of highly diversified actors. The consideration of the innovation output has also changed. Instead of the features of the innovation output, the value in use that arises in the course of the process of co-creation with other actors is increasingly the primary interest. One particular field of application of S-D logic in a practical context [3, 6] is service innovation and value co-creation, so this will be our focal point.

3.1 Service Innovation

Innovation can therefore be interpreted as a value-generating outcome of a collaborative process occurring in an actor-to-actor network [3] or service ecosystem. [3] summarize these concepts and issues in three core themes that build a tripartite framework of service innovation, namely (1) service ecosystem, (2) service platform, and (3) value co-creation [20]. Furthermore, four metatheoretical foundations are derived from S-D logic which are relevant to service innovation: (1) resource integration, (2) actor-to-actor networks, (3) resource liquefaction, and (4) resource density [20]. Subsequently, we analyze the value co-creation and macro-level concepts and prepare the ground for designing and implementing an S-D logic–informed strategy for human-centered service design. Furthermore, digital service innovation is investigated on the basis of a longitudinal case study approach. Conducted research illuminates how S-D logic concepts, in particular value co-creation, are implementable on the meso- and micro-level, referring to a case study providing a practical, realistic context for our action-oriented research. Subsequently, the focus is on the transferability of value co-creation as a macroconcept to the meso- and micro-level management perspective [8, 10, 11] with reference to a real-life context and case.

3.2 Value Co-creation and Actor Engagement

Instead of strictly dividing actors into producers and consumers, S-D logic takes a more generic view in the sense that actors co-create value with other actors [18, 22]. Accordingly, in S-D logic, all social and economic actors are seen as resource integrators and engage in service exchange in the process of co-creating value [7]. While the process of value co-creation [22] is the core theme of S-D logic organization of the actors (service ecosystem [3] and service systems [9]) and the place for service exchange (service platform), there are further core themes with regard to service innovation. Value is viewed as co-created through resource integration and application [17]. Many examples of digital innovation are observably not so much a "[…] matter of inventing new things as it is identifying opportunities to deinstitutionalize and reinstitutionalize practices. This requires both innovative agency and the continual monitoring of practices and their contexts" [6, p. 181]. Hence, this is in essence a crucial capability for companies to compete in digital markets. Institutions are understood as sets of conditions and rules for transactions and interactions [7, p. 16] [19]. On the micro-level, actor engagement [9, p. 7] [8, 21] is a key mechanism at play in the design of innovative value propositions and the stimulation of service design and new service development. Value propositions are understood as an invitation from actors to one another to engage in service [9, p. 6]. The behavior of social systems can be studied by analyzing the situated activities of actors to integrate resources and engage in transactions. Actors are connected to resources and indirectly to one another through "control over resources" and "interest in resources" [10, p. 28]. Actor engagement reflects "[…] a psychological state, which occurs by virtue of interactive customer experiences […]" within an agent or object within a specific service relationship [9, p. 9]. In [9, p. 9], five properties of engagement are cited which are important for understanding how value propositions invite engagement, namely (1) temporal connections, (2) relational connections, (3) future disposition, (4) past disposition, and (5) present disposition. Further analysis of engagement properties [9] on the micro-level promises valuable insights into the internal and external properties influencing actor engagement. In addition, IT plays an essential role in realizing co-creation environments and experiences [12, p. 10]. Four building blocks of interaction can be highlighted which create an appropriate environment of value co-creation: (1) access, (2) transparency, (3) dialogue, and (4) risk benefits [12, p. 9]. Engagement platforms [21] nurture the emergence of new resource integration patterns [8, p. 3013] that are used to institutionalize innovative solution designs to create service innovations and new markets. In the next section, we present the case study of an insurtech company and how it applies value co-creation to develop service innovations by means of its engagement platform [1, 8, 21].

4 Insurtech Case Study

Subsequently, we present a case study of a fully digitized health insurance company in Germany. Our aim was to study and understand the roles and relationships of actors and resources in service innovation in a given real-life business context.

4.1 Company Profile: Insurtech and Service Innovator

Founded in 2017, ottonova [14] has been reinventing the way customers interact with their health insurance by building a completely new technology platform with a user-friendly front-end mobile application. Simple processes, transparency, and a wide range of digital services are fundamental to ensuring maximum satisfaction among customers in all matters relating to their insurance and health, while also saving as much time as possible. ottonova strives to shape and design service innovations for its customers. The company has a clear focus on creating better resource density for its customers. ottonova came out top by some considerable distance in the 2018 KUBUS study of private insurance companies for its high levels of customer satisfaction, very good value for money, and customer service. ottonova offers a holistic health approach by defining health spaces using the capabilities offered by its collaborative space (based on a service platform accessible through its app) (Fig. 1).

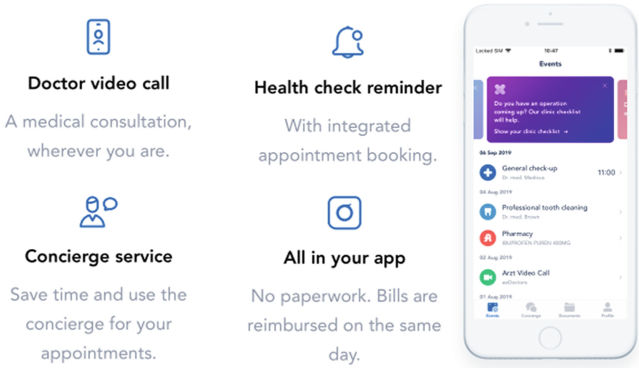

Fig. 1. Customer-oriented approach: all processes are managed directly using ottonova's app [16]

Table 1 provides an overview of ottonova's service offerings and value proposition. We focused on two value propositions, namely (1) the Concierge service and (2) health X. health X is ottonova's innovative reward program, which is a new way to gain customer insights and provide incentives to engage in service through ottonova's service platform. In the reminder, we concentrate on the service innovation health X which is a reward system stimulating interaction and customer engagement to co-create service innovations.

Table 1. Service innovations and use case development [14].

Use case/service	Description
Concierge service	Support service to arrange visits and appointments with doctors and healthcare services
Health check reminder	Health assistant reminds and helps customers to engage in and plan their medical check-ups
All in your app	Digital patient files to facilitate paperless processes and service through a digital document repository and information exchange
Doctor video call	Medical consultation service which simplifies interaction between patient and doctor
health X	Reward program to engage customers in value co-creation to co-design service innovations

4.2 Use Case: Health X Service

The health X service [16] aims to gain new customer insights and a better understanding of customer preferences. Any ottonova customer can be part of health X. The newly launched service offers a reward system which engages with customers in an unprecedented way. Its central aim is to yield deeper customer insights concerning customers' preferences and needs.

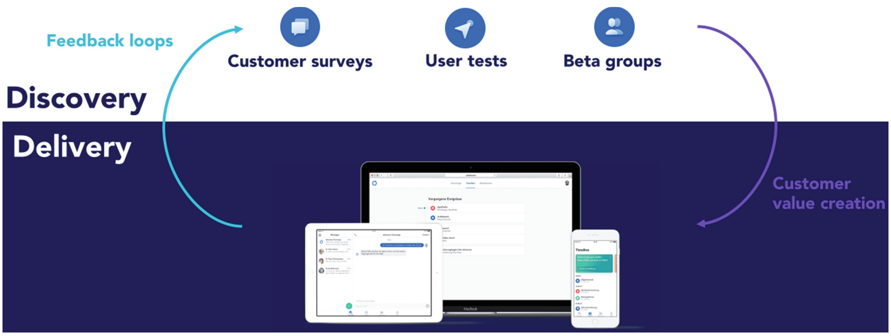

Fig. 2. Service platform: customer engagement for continuous discovery and delivery of service innovations [16]

In this way, ottonova aims to shape the future of health insurance by using its service platform to integrate resources which support customer processes and activities. By interacting with its customers, the insurtech strives for deeper insights and a better understanding of customer needs. This is achieved by engaging customers in product discovery with the aim of receiving customer insights via various feedback iterations. That means customers become an integral part of service design and development. Customers are rewarded for sharing insights concerning their preferences and needs (context), and are engaged through a compelling incentive system which offers them access to health benefits and value-added health services (Fig. 2). By continuously co-designing a compelling value proposition entitled "experience your health," the insurtech's declared vision is to help its customers to improve their personal health provision, enabling a healthier lifestyle and a happier, balanced life.

5 Findings and Discussion

Ottonova's service platform [1] allows actors to internalize new process logics and to integrate required resources into the newly designed processes and activities. In this way, actors understand their new roles and responsibilities as well-assigned tasks and resource requirements. In consequence, ottonova is able to establish new innovative value propositions and co-create new business models with its customers and partners in the service ecosystem. Customers are able to discover services from helpful apps to innovative wearables by spending their awarded credit points and rewarded budget. Customers are invited to discover innovative value propositions and new service designs to receive early feedback and comments. Through this continuous interaction, services can be co-designed and tested in specific customer contexts [19]. In addition, continuous interactions with the customer help to understand customer preferences and needs. In turn, customers learn and experience service and can influence design and personalization. Individual preferences and behavior are thus reflected and used to design and nurture resource integration patterns, as well as institutional arrangements to establish solutions. The central aim of the insurtech is to create a happy, healthy, and loyal customer base. Secondary goals are changing perceptions of the insurance business and enhancing customer engagement [21] to create institutional innovations: (1) enhancing customer experience, (2) increasing customer loyalty, and (3) increasing customer touchpoints.

6 Summary and Conclusion

In this paper, we have presented research in progress in the form of a longitudinal case study of an insurtech in Germany. We investigated and illuminated actions, decisions, and events in the context of designing and implementing the value co-creation concept on the basis of describing environmental properties which stimulate and influence micro-foundational processes of service innovation by looking at a real business scenario (use cases). By continuing this research, we are striving for further learning effects and fruitful insights for managers and researchers to better understand how S-D logic concepts can be used. Companies can take advantage of emerging behaviors at the micro-level by moderating intentions and institutionalizing the resulting new patterns and properties as service innovations [1]. Architectures are of great importance for the bidirectional relationships and mechanisms between the macro-, meso-, and micro-level, namely as a concept for connecting, coordinating, synchronizing, and structuring the situational mechanisms. SDA (Service Dominant Architecture) [1, 13, 20, 21] provides guidance and offers a means of analyzing, designing, and configuring resources to introduce service innovations.

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Improving the User Experience for Healthcare Professionals Using a Conversational Agent to Complete Business Intelligence Analysis

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Abstract. We explore using a conversational agent to simplify healthcare user's access to business intelligence. We are extending an initial prototype based on the observations from a user study. As we describe, the improvements enhance the user experience and facilitate user's completing tasks. Most basic we extended the agent to help users become familiar with using the conversational interface itself. Related to the agent's business intelligence, we expand examples and descriptions. Finally, the improvements broaden the audience so that even non-healthcare experts can complete some tasks even if they might not fully appreciate the insights of the results. This work is part of IBM Watson Health's initiative to leverage cognitive computing to create healthcare solutions.

Keywords: Human factors · Human-systems integration · Conversational interfaces · Healthcare · Business intelligence

1 Introduction

Professionals with expertise in one domain almost need a second degree as a data scientist to extract insights from his/her organization's volume of data; the professional may have the opportunity to work with a data scientist. Otherwise, there are a wide variety of business intelligence tools available to slice and dice the data, given the person has training on the tool.

We explore solutions to simplify a professional's access to insights from the data through a conversational experience with a chatbot, which we refer to as the healthcare assistant. A professional types his/her questions using familiar domain language like he/she would say to a colleague. The healthcare assistant interprets the question, asks clarifying questions, and answers the question. We focus on business intelligence questions in the healthcare domain related to paid claims that an insurer or pharmacy benefit manager processes. A question might be "what are the top drugs by cost in the incurred year?" The healthcare assistant's answer is a chart where the x-axis shows the top drugs.

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The healthcare assistant is integrated into business intelligence tooling, specifically Cognos Analytics in our case. The tooling already has the user's data and many analytical tools. Once the user has generated a chart through the healthcare assistant, the user can use the chart with the remainder of the tooling.

Often in an enterprise, business decision makers rely on a team for analysis. Our solution enables them to answer elementary questions more independently and frees the support team to focus on more in-depth analysis. Of course, analysts can also benefit from getting simple questions answered while they focus on the more advanced techniques.

2 Conversational Interface Design

The healthcare assistant needs to interact with the user, interpret what the user says, and follow up to clarify. We give a design overview for each of these aspects. We discuss a general mechanism for business intelligence, and we use healthcare as an illustration.

For the interaction between the user and computer we apply the Natural Conversation Framework (NCF), a design framework from IBM Research [1]. It consists of a series of 100 design patterns. Each pattern addresses one type of interaction, for example, the Paraphrase Request pattern consists of the user asking, "what do you mean?" and the computer responding with a description for the current step. The NCF is flexible to accommodate the next turn the user takes and responds accordingly. When we refer to "natural conversation," we mean the experience is similar to when two people are conversing.

The convenience for a person to use domain language is that one sentence captures many details. Our system uses an ontology to map terms and phrases the user mentions to specific elements in the data model. Users will refer to concepts such as a facility, hospital, or clinic. The data model will have many attributes about facilities. In the context of the conversation, the ontology maps facility to the facility standard name. As shown in Fig. 1, the user asks, "what are the top facilities by cost?", the chart will show facility standard name on the x-axis and cost on the y-axis. Cost is an example of a translated concept. Cost is a general term and the ontology in our case maps to the allowed amount, which is the cost from an insurance standpoint.

In addition, users will refer to specific data elements or instance values. A user is unlikely to enter the exact string matching the desired value. Our system uses NLP and indexing techniques to capture the partial words or phrases and calculate possible candidates. Then the system prompts the user to select a specific value (This is the NFC's Open Request pattern).

The user's overall utterance indicates the type of desired information; for example, the user asks, "What is the trend for cost?". This indicates the user wants to see the cost over time so the x-axis will be time, such as year. Our system categorizes users' utterances by intent that are processed by a machine learning model.

As the person gives information, the system is checking for a specific question it can answer. As information is provided, the system calculates what information is missing, and prompts the user for the missing information. In the example shown in Fig. 1, the system prompts the user for the time frame. Finally, the system generates the chart answering the user's question, as shown in Fig. 1.

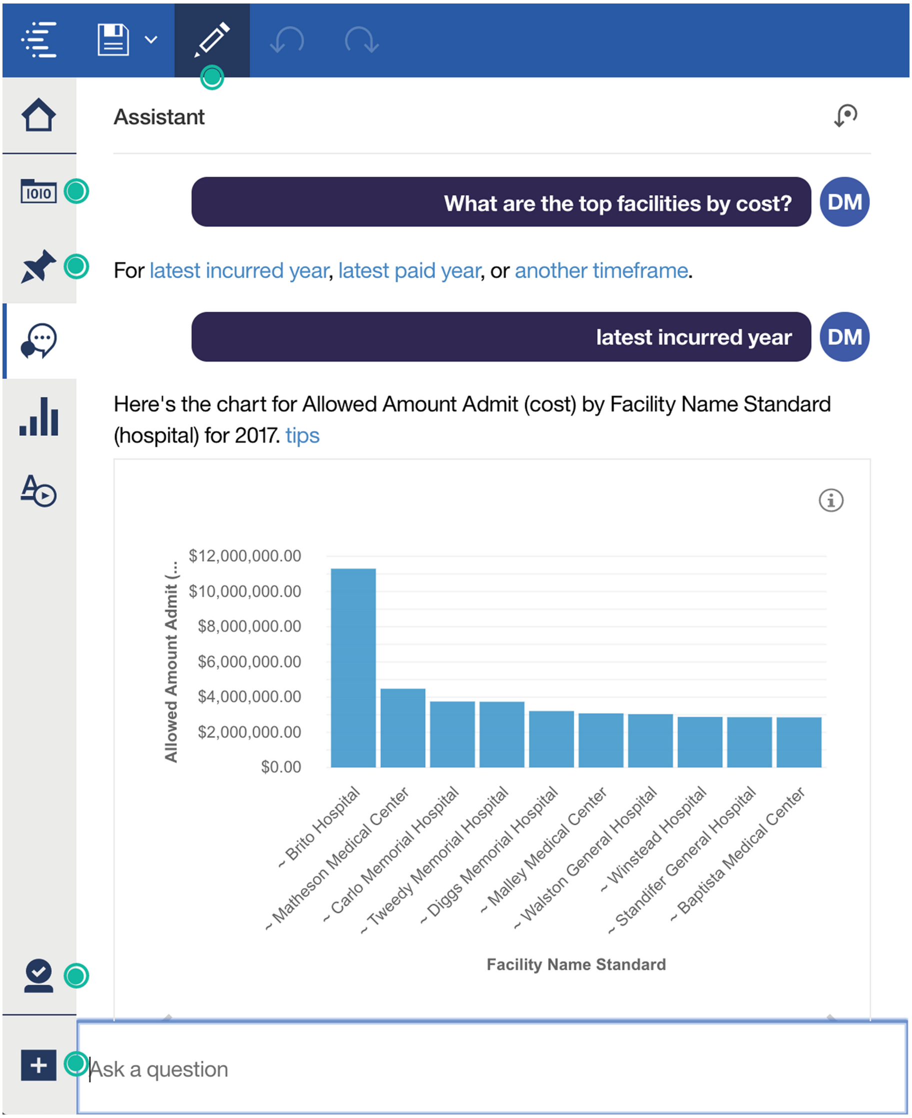

Fig. 1. Sample conversation in the healthcare assistant prototype. User DM enters text shown in the dark bubble and the assistant responds. The chart is the answer to the user's question, specifically Brito Hospital (a fictional place) has the highest cost in incurred year 2017.

3 System Prototype

Our prototype is based on integrating Cognos Analytics (a business intelligence tool) and Watson Assistant. The IBM Watson Health Insights Explorer product [2] makes healthcare data available to customers through Cognos; using this tool, healthcare experts apply analysis tools to distill insights from the healthcare data. Cognos recently introduced the Cognos Assistant feature, through which users ask business intelligence questions, and Cognos answers in the form of charts. Cognos is domain agnostic, so it supports general business intelligence language, such as *measures* and *dimensions*. Our research explores making the assistant aware of healthcare domain language. Like Cognos Assistant, answers in our prototype are in the form of charts.

Our prototype has its own assistant to support the healthcare domain language. Our assistant is implemented with IBM Watson Assistant and the Natural Conversation Framework from IBM Research [1]. We developed scripts to convert language captured in the ontology and load it into the Watson Assistant components automatically.

4 Background

Conversational interfaces are popular in industry and research. Business intelligence tools, such as Ask Data Tableau [3], Power BI [4] by Microsoft, Microstrategy [5], and the Cognos Assistant [6], are supporting natural language. These systems as well as our healthcare assistant use the same approach to map measures and dimensions to a chart.

Our healthcare assistant adds more support for domain terminology, as well as natural conversation features. Non-Cognos solutions give a user a graphical user interface to define a single sentence with the details to construct a chart. In the case of Cognos, the conversation is broken into a back-and-forth between the user and assistant so that the assistant can gather the necessary information. Also, in each turn a user can change their thought process to switch topics or get more information on the assistant's current utterance.

5 Informal User Study

We conducted an informal user study to rapidly iterate on design improvements. We created the process for a moderated study where participants were asked to complete a series of tasks. A task is a broad one-sentence description, and we observe the approach participants take to complete them. We ask them to think aloud, and we say as little as possible. Finally, users are asked about their experience. Between two participants we identified high priority improvements and implemented them. Then we could gauge the improvement with the next participant. With only five participants we were already more confident in the basic flow of the assistant. Table 1 is an overview of the participant interactions.

Table 1. Overview of participants interactions in the informal study

Participants	Average turns	Average charts
5	140	13

The five participants averaged 140 turns in a session. A turn is when the user makes an utterance and the healthcare assistant responds. On average the participants used the healthcare assistant to generate 13 charts. This reflects the pace participants worked through a moderated session.

5.1 Results

The user study gave us the observations needed to extend the capabilities of the healthcare assistant from the users' perspectives. At the start of the study, the assistant supported the barebones capability to create a chart based on business intelligence measures and dimensions. Here is a summary of the main capabilities we added.

Conversational interfaces are relatively new, so we needed to help the user become familiar with how they work. Typing is the main input for the conversational interface, however for convenience, the system's responses include clickable text. When clicked, the text functions the same as typing the utterance. Users were not inclined to click the text, so we made instructions explicit to click or type the text.

Like graphical interfaces, help is available within the conversational interface. Similar to natural conversation, the help topic is broken into multiple parts of 1–2 sentences. The user continues to the next part by clicking "OK" or typing a range of terms including "ok," "uh huh," "mhmm," "yes," "great" and more. Alternatively, instead of saying one of these continuers, the user can ask "what do you mean?" or "can you give an example" after a particular part before continuing to the next. In this way the help narrative is interactive. The help narrative ends with the user saying, "thank you" or "never mind". As with natural conversation, these indicate that the user is done with the topic, although the former suggests success and the latter, failure.

We also added descriptions of the assistant's capabilities and examples to the opening of the conversation. Our insight is that it is useful for the system to explicitly inform users of its capabilities throughout. Also, the user can type or click "tips" to see other utterances for generating additional charts based on the current chart.

Another discovery was that the vocabulary of business intelligence, such as "measures" and "dimensions," was not familiar to many of our users. Consequently, we changed the language of the assistant to be more general. For example, colloquial references to time are far more varied than we expected. The user study was an excellent opportunity to gather domain-specific language that our participants actually use. We then incorporated these into the ontology, which will also improve the NLP capabilities of the Watson Assistant.

We ended the participant sessions asking about the participants' trust in the results. Multiple participants explained that the information displayed in the charts depends on the data it is based on. Broadly, building this trust is a challenge for many analysis tools. In the future, we will consider how to incorporate trust into the design of the conversation. For now, we envision that users use the conversation to explore broad insights into the data. Users can ask follow-up questions to learn about additional aspects of the data and use the business intelligence tooling to verify data integrity.

6 Future Work

Our team's immediate focus is expanding the conversational capabilities of the system to be more useful for healthcare professionals and applicable to their analysis. From a research perspective, conversational interfaces needed to be expanded to support a wider range of questions, beyond the questions to generate a particular chart.

Healthcare professionals and others ultimately seek insights into their data. The business intelligence tools can use analytic techniques to compute recommendations or summaries. Once available, these can be communicated through a conversational interface. For example, the assistant or user could initiate a discussion about insights in a particular area, and the assistant could offer an explanation, supplemented with charts.

Inevitably, users will ask questions the assistant is not prepared to answer. Ideally the assistant should respond in as useful a way as possible. Two kinds of cases may occur. First, there are questions that are in-scope but not supported. These are relevant to the use case, but beyond the current scope of the application. The assistant should recognize these requests but tell the user it cannot fulfill them at this time. In our system this terminology for unsupported requests would be captured in the ontology. Second, there are more general questions, for example, a request for a recommendation, or "what should I do?" The assistant needs to recognize these and steer the user toward more concrete questions that it can answer.

7 Conclusion

Our study for the healthcare assistant helped us improve our prototype. We rediscovered basic design requirements in the context of a conversational interaction. Although our study was informal, it was very helpful for us to quickly iterate improvements. We have gained knowledge and experience to continue to add new capabilities.

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Design Principles for Health Service Innovations: Nudges from the IBM Health Records Service Platform

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Abstract. In times of digital transformation platforms gain increased relevance in service ecosystems. Despite this relevance, design knowledge for digital platforms is scarce. To bridge this gap, we build upon a longitudinal case study of the IBM health records service platform to analyze several phases within its lifecycle and derive design principles that aim for service innovation in digital platforms. Thus, we shed light on the design and the application of mechanisms to coordinate value co-creation on service platforms embedded in service ecosystems.

Keywords: Service innovation · Value co-creation · Design principles · Health service platform

1 Introduction

The motivation of the electronic health records service platform was to initiate a service ecosystem for health service innovations. By offering a secure digital safe for health data and by giving the coordination mechanisms to co-create value in the healthcare ecosystem service innovation is leveraged. Thus, advantages emerge for all actors connected via the health records service platform: e.g. insured individuals, doctors, hospitals, insurance companies, additional digital health service providers. On the one hand, the quality of medical care increases when doctors are aware of pre-existing conditions or if they are reminded of preventive medical check-ups or informed about the interdependency between drugs; on the other hand, additional health services are being offered.

We analyze the relevance of design principles for health innovation in a service ecosystem perspective. Its purpose is to investigate how design principles as mechanisms of coordination are involved in value co-creation and contribute to service innovation in healthcare. The SDL perspective of Service Innovation [1] has been considered as the starting point to structure and analyze which design principles are relevant for service innovations and for affecting actors [2, 3] in order to engage themselves.

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2 Theoretical Foundations

By setting an understanding of markets characterized by actor-to-actor orientation with all actors fundamentally doing the same things – to integrate resources and to engage in service exchange – in the process of value co-creation, SDL addresses the key issues for explaining service innovations in the health ecosystem [4]. Therefore, the SDL perspective has been considered as the starting point to derive practice-driven design principles service innovation in the healthcare industry [2]. SDL uses the term service to reflect the process of acting beneficial towards a beneficiary. Service is the common denominator of the exchange process. A key concept within service science is the understanding of value co-creation as a collaborative concept to engage actors to jointly create value [5–7]. Additionally, contextualization emphasizes joint value creation by a configuration of actors and resources [8–10]. As a consequence, value occurs by utilizing a service that always is dependent on the situational context. Both facets of services are reflected in service-dominant logic (SDL) as a guiding framework for service science [11, 12]. Building on SDL, Lusch and Nambisan broadened the perspective on service innovation by reconfiguring the facets of service with regard to SDL and capturing these in three pillars; service ecosystem, service platform and value co-creation [1]. In this regard service ecosystems are described as “a relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange” [13, p. 24]. Thus, service ecosystems emphasize the human factor, its organizational surroundings and institutions [14, 15]. Adapting information technology, such as service platforms, emerged as a phenomenon that facilitates communication and coordination of relationships and thus engagement between actors and the creation of new services [16, 17]. Finding the right configuration of actors, resources, and information technology is a key activity for interactive value co-creation [18].

3 Research Design

This research is based on a multi-method study. We conducted a longitudinal study on the evolution of a service platform in the healthcare ecosystem and combined this case with three retrospective in-depths case studies about the instantiation of a service platform as a central actor for a service ecosystem; the chosen methodology makes it possible to illustrate why certain decisions on design principles were made [19–22]. Furthermore, we like to point out that the methodology is characterized through participant-observation because the researchers are actively involved in the activities of the cases.

By combining a longitudinal case study of the development of the health records service platform with three retrospective case studies with the same phenomenon of implementing a service platform. On the one hand the design- and process-focus of the longitudinal case study of a healthcare platform and on the other hand multiple cases to broaden general validity [19–21].

4 Longitudinal Case and In-Depths Episodes of the Evolution of the Service Innovation Platform

The longitudinal case of the IBM health records service platform offers valuable insights into the design and evolution of a digital platform that aims to foster service innovation. The initial development started in 2008 with the aim to digitize paper-based exchanges between medical doctors and service providers and as their counterpart insurance companies. Based on this initial scope the insurance service hub emerged that enabled end-to-end encrypted transfer of healthcare related data and constitutes the first episode. **Insurance Service Hub 2010:** The initial service platform was developed to enable rule-based routing of service providers to insurance companies. This initial approach aimed to improve the efficiency of accounting processes. This limitation in scope enabled the involved actors to gain shared understanding and structured requirements assessment. Additionally, there was no need for a centralized data management nor a demand for customer-facing frontends and related usability and especially security requirements.

Based on the experience of the initial version of the insurance service hub the need to improve the independence on proprietary exchange formats emerged. Thus, the next step of the evolution, **Insurance Service Hub 2012**, aimed at streamlining data exchange and interoperability by establishing standards for exchange, i.e. ICD 10. The third iteration, **Insurance Service Hub 2014** further increased efficiency of the processes by establishing a customer frontend. By doing so, novel services were possible like an app to take photographs of healthcare-related bills that are covered by an insurance company. Thus, leading to an increased processing time and an improved customer satisfaction. Another consequence is that the reimbursement can be automatically processed. In cases where despite the photograph questions remain, the app was designed to be the mobile point of contact and thus handle these requests.

Building on these milestones, the Insurance Service Hub further improved and is nowadays a platform that implements electronic health records holistically. Over time more and more actors were integrated on the platform to leverage the secure environment that heavily relies on trust of all actors involved. Thus, a constituent characteristic is the strong emphasis on privacy based on the understanding that customers data belong to them and sovereignty of this valuable data source relies on the customers side. Based on this understanding, a centralized data management was established that includes all customer data to reduce fragmentation and deliver a holistic representation of the customer. By realizing a trusted execution environment, privacy and data sovereignty can be preserved despite this centralization. Likewise, standards for data exchange where developed further, i.e. IHE, HL7, FHIR.

The established platform lead throughout the longitudinal study to several service innovations as the backbone, the service platform, was open and independently designed so that novel actors, innovators and traditional healthcare providers could benefit and propose novel service offerings and service bundles. In turn data has to be added to the customers profile to keep a recent state of the data and enable reusability. This has led to a potential of about 25 million customers on the platform.

Table 1. Key issues and resulting design principles for IT artifacts

Pillar	Key issues	Design principles
Service ecosystem	Structural flexibility	– A modular approach is needed to ensure flexibility and the ability to adapt to changing environments and institutional arrangements (*modularity*) – Flexibility regarding novel service propositions is needed. By enabling the use of technological advancements novel services appear that need to be integrated (*openness*) – Multi-level interoperability (*independence*) is needed regarding data management, data provision and use of data while rigorously implementing security and privacy measures
	Integrity of loosely coupled actor network	– Implementing standards to ensure applicability and data quality; i.e. IHE and HL7 (*openness*)
	Architecture of participation to coordinate services	– Aim for inclusiveness regarding novel service propositions while building upon existing data and services, efficient means of service orchestration are needed
Service platform	Leverage resource liquefaction	– Single sign on enables all actors convenient access and leverages utilization of the platform – Health ID is used as core identifier towards actors
	Enhance resource density	– Allocation of services to the individuals record (*transferability*) – Individuals record is single source of truth (*scalability*) and data is continuously added (*reusability*)
	Security	– End-to-End encryption is needed for data exchange – Trusted computing environment to pertain privacy
Value co-creation	Resource integration process	– Service offerings are made to the customer and based on perceived value of these, the customer can integrate these resources
	Actor roles	– Data Sovereignty is guaranteed towards customers as every use of a customer's data needs to be acknowledged and access granted
	Supportive environment	– By relying on standards and high degree of openness and independence, accessibility for novel actors is ensured

5 Summative Derivation of Design Principles

Design principles as institutional agreements enable value co-creation and resource integration in actor-to-actor networks. The case of IBM health records service platform shows how key value propositions in the health ecosystem – like holistic solutions involving service providers while retaining customer's data sovereignty - are facilitated with the help of design principles as institutional agreements. The design principles seek to guarantee the security and privacy of customer data (public-private keys), user-friendliness (single sign-on) and interoperability for acter-to-actor networks (HL7, ADA, FHIR). The design principles vary from technical norms to ensure resource integration of customers or service providers to general standards for the exchange of clinical or administrative data. The case studies demonstrate that design principles are of central importance for establishing service platforms and ecosystems. Over the 10-year course of the case studies, the significance of the design principles as institutions for facilitating value co-creation and resource integration is elaborated. A detailed description of the key issues that needed to be addressed and the resulting design principles is given in Table 1.

6 Findings and Conclusion

These results have theoretical and practical implications as they show how design principles help to shape and evolve health service platforms that foster customer-centered service innovation. Given the criticality of healthcare, special consideration is given to security and sophisticated measures for privacy. Within such critical service ecosystem, building and pertaining trust is crucial to the value and success of such a service platform. Likewise, the longitudinal study lays out how the scope of the platform increased incrementally. Thus, such approach seams transferable and worthwhile to introduce focal platforms in critical industries.

The research highlights how design principles affect service innovations. Each of the three pillars of the service innovation framework is significantly influenced by the design principles the platform is built upon. Design principles are of central importance for the exchange of resources (operands as well as operant resources) and thus for the process of collaborative value creation, for generating resource liquefaction and resource density on service platforms and for the organizing logic of service ecosystems.

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A Conceptual Framework for Workforce Management: Impacts from Service Science and S-D Logic

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Abstract. Over the past four decades the service sector shaped advanced forms of interaction between human and technology actors with a wide range of actor combinations like human-to-human, human-to-technology, or technology-to-technology. The understanding of workforce, on the other hand, has remained largely unchanged in recent decades. Workforce, workforce planning, workforce management, workforce diversity and so on, focus almost exclusively on the human actor. Therefore, the authors see the need for a new understanding of workforce and for the explanation of the mechanisms and interdependencies of workforce management. Based on the theoretical concepts of Service Science and S-D Logic as well as the approaches of meso- and micro-foundation the context of workforce and workforce management is studied and a conceptual framework for workforce management and a new definition of workforce is derived.

Keywords: Workforce · Workforce management · Conceptual framework of workforce · Workforce design

1 Introduction

Work and its characteristics are highly dependent on social and technological developments. Historically workforce and workforce management has referred exclusively to human resources, which since industrialization has been changed with the machine as a kind of contrast. Over the past four decades the service sector shaped advanced forms of interaction between human and technology actors with a wide range of actor combinations like human-to-human, human-to-technology, or technology-to-technology [1–5].

These developments show that instead of the historical rather confrontational and replacing relationship between human and technology, now new forms of interactions and combinations of actor like people, technology and other resources arise and the relationship is getting more complementary, supportive and co-creative.

New forms of actor interaction and value co-creation change activities, roles and processes and are a central part of organizational strategies, productivity and social

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transformation. For example, demonstrates the technology-supported workplace – a actor combination of human-software-hardware - how strongly these developments influence forms of interaction, forms of work, work and social transformation.

The understanding of workforce, on the other hand, has remained largely unchanged in recent decades. Workforce, workforce planning, workforce management, workforce diversity and so on, focus almost exclusively on the human workforce [6, 7].

Therefore, the authors see the need for a new understanding of workforce and for the explanation of the mechanisms and interdependencies of workforce management.

2 Research Methodology

This research applies the Design Science Research Methodology (DSRM). Following [8] the research intents to deduce a commonly accepted conceptual framework for workforce management as research design artefact [8–10].

Based on the theoretical concepts of Service Science and S-D logic [11–14] as well as the approaches of meso- [15] and microfoundation [16] the context of workforce and workforce management is studied and a conceptual framework - understood as a set of definitions and concepts used to describe the phenomena, formulate questions and make generalisations - designed [17].

Referring to DSRM [8] our overall research proceeding is divided into six activities (see Fig. 1) which are presented in the following briefly.

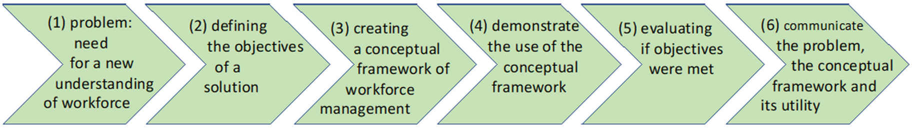

Fig. 1. Research process

In the (1) problem identification and motivation, we point out that the existing definitions and interpretations of workforce and its specifications refer only to humans and thus are not suited to correspond to the advanced and diverse interactions and combinations of humans and technology.

As we (2) define the objectives of the solution, we aim at

– explaining the wide range of actor combinations and the advanced forms of interactions
– outlining the process of value generation and the combination of actors
– approaching a new definition for workforce and a consistent concept for workforce management.

In activity (3) we create a conceptual framework of workforce management based on

– theoretical Foundations of Service Science and S-D Logic
– micro- and meso-foundation for value co-creation.

Activity (4) demonstrates and evaluates the conceptual framework of workforce management.

Activity (5) evaluates if the objectives were met.

Finally, we (6) communicate our findings, the role of the conceptual framework and derive a first suggestion for a new understanding and definition of workforce.

3 Creating a Conceptual Framework of Workforce Management

In order to model and represent the different actor combinations as well as the process of value co-creation on different effect levels, approaches and foundations of Service Sciences, S-D logic, Social Theory, meso- and microfoundation were used and combined to develop a conceptual framework for workforce management.

3.1 Theoretical Foundations of Service Science and S-D Logic

With reference to Penrose (Penrose 1959), the force for the organization does not come from the single form of the resource itself but from the services the resource render (p. 25, Penrose 1959). In this sense the term service will be used in line with Service Science and S-D Logic which uses the term service to reflect the process of doing something beneficial [11, 18]. Service is understood as the application of resources (human competencies, knowledge, skills, products, technical services, augmented capabilities through technology) for the benefit of another entity [5, 18, 19].

S-D Logic provides the foundation for a general theory of markets and marketing. Service is the fundamental unit of exchange. Value co-creation is the core of the narrative and process of S-D Logic. In this process service exchange happens through actors integrating resources enabled and constrained by institutional arrangements nested in service ecosystems [11, 20, 21].

Following the foundational concepts of Service Science [4, 22] it is obvious to address the actor combinations of workforce by using the abstraction service system or service system entity, "which is a configuration of people, technologies and other resources that interact with other service systems to create mutual value" [23]. As specified by Spohrer and Kwan (2009) service systems are dynamic value co-creation configurations and "all service system entities are resources, but not all resources are service system entities" [22]. In contrast to service systems the concepts of systems or organizing systems are more abstract arrangements of resources that interact and form a whole [1, 17] – but the character of value-proposition based interactions for mutual value generation is not mandatory.

Therefore the definition of actor combinations as workforce systems consciously distinguishes itself from the definition of service systems, because as recognizable in organizations the key condition for service systems to interact to co-create value is not always fulfilled [24]. Therefore, workforce systems can be basically divided into three categories: organizing systems as resources arranged to enable interaction [1]; systems as arrangements of resources that interact [17]; and service systems as configurations of resources that interact in the sense of value co-creation with other service systems to create mutual value [22].

3.2 Coleman's Boat and the Microfoundation Movement

Coleman's boat or also called Coleman's diagram or in the German-speaking world it is also called Coleman's bathtub is one of the most famous visualizations in sociology [25]. The boat addresses the relation of large-scale things - the macro level - like organizational or social events to smaller-scale things - the micro level - like individual behaviour. By providing a systematic way to think about the macro-micro relations the central motivation of the microfoundation movement is to "unpack collective concepts to understand how individual-level factors impact organizations, how the interaction of individuals leads to emergent, collective, and organization-level outcomes and performance, and how relations between macro variables are mediated by micro actions and interactions" [26].

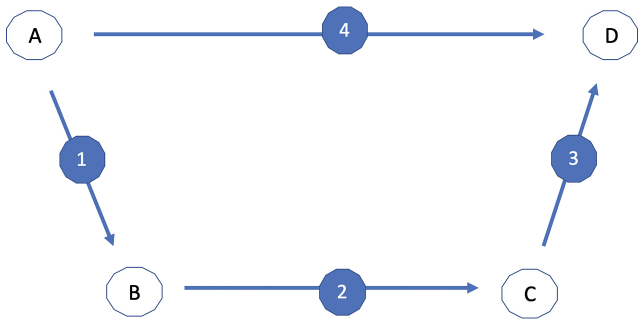

Fig. 2. Coleman's boat

The nodes (A) and (D) refer to the macro facts that might be cited as causes of social, economic or political phenomena. On the macro level (D)'s are the macro facts to be explained. It is relevant to note that (A) and (D) represent not the whole macro level but only a part of it. Coleman's scale of macro is flexible and can scale from two persons to organizations and nations [16, 25].

Arrow 1 between (A) and (B) reflects the observance that the state of (B) at micro level changes when the state of phenomenon (A) at macro level changes. Arrow 1 shows that the phenomenon (A) is a boundary condition according to which the actor aligns his actions. (A) may be the cause or only one reason for the change in the state of actor (B).

Arrow 2 shows how the de facto actions of the actors bridge between changes in states of (B) and outcomes of (C).

Arrow 3 then shows how a new macro phenomenon is aggregated out of the sum of the actions and that the relation of (C) and (D) is one of logical implication [25].

As pointed out in Fig. 1 the boat is the visualized result of macro-micro explanations where changes in macro level initiate observable actions on micro level (arrow 1, macro-micro mechanisms); individual actors adapt the new context with action (arrow 2, micro-micro level) and the transformation and aggregation of these outcomes describes how macro level changes (arrow 3, micro-macro level) arise.

3.3 Mesofoundation by the Extension of Colemans Boat by Storbacka et al.

Storbacka et al. [2] explain S-D Logic concepts with Coleman's boat. Arrow 1 in Fig. 3 shows the macro-macro explanation of S-D Logic "which implies an outcome of value co-creation based on service exchange within the context provided by the institutional logic of a service ecosystem" [2].

'Referring to Coleman's boat and by incorporating the insights of the microfoundation movement [26, 27] Storbacka et al. underline that macro-macro level explanations can be lacking in explanatory power. Therefore, Storbacka et al. anchor and reveal the causes of the more abstract macro concept of value co-creation with micro (actor engagement) and meso (sets of actors and their resources) level mechanisms.

Institutional logic on macro level forms the meso level conditions and context for actors to engage with their resources on engagement platforms (arrow 2) and influence by this the disposition of the actor (arrow 3). This leads to a change in actors' disposition and to engagement activities that can be characterized by observable engagement outcomes (arrow 4).

The engagement of many actors leads to the emergence of various resource integration patterns (arrow 5); on the meso level the extant resource configurations of the actor are transformed which leads to value co-creation (arrow 6) [2].

By exploring the relevance of individual actor engagement on micro level in service for service exchange and resource integration Storbacka et al. show actor engagement as a microfoundation for value co-creation. It is shown "how the interaction of individuals leads to emergent, collective and organization-level outcomes and performance and how relations between macro variables are mediated by micro actions and interactions" [26].

As emphasized by Ng [15] or Dopfer et al. [28] "The domain of change in an evolutionary process is neither micro nor macro but meso", the transformation mechanism, i.e. the transfer of a multitude of actions from different actors, can best be explained by the meso level.

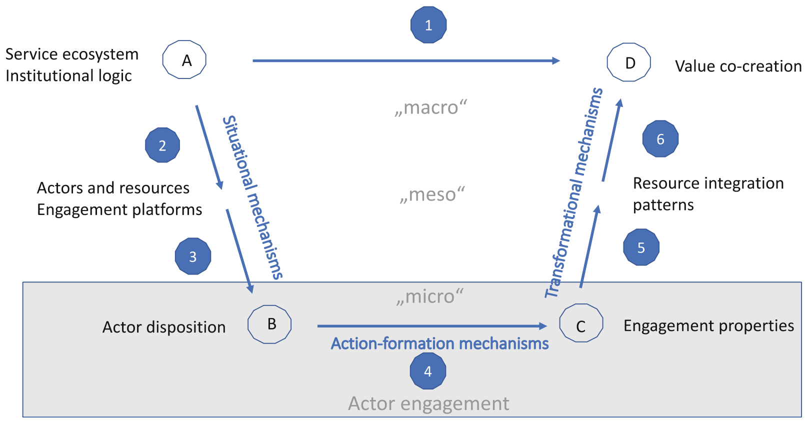

Fig. 3. Storbacka et al. (2016). The Coleman bathtub: Actor engagement explains value co-creation.

3.4 A Conceptual Framework of Workforce Management

Building upon the microfoundation movement in strategic management and the SDL based conceptualization of actor engagement as a micro foundation for value co-creation by Storbacka et al. the authors use the approaches to derive a foundation for the concept of workforce.

Applying the transdisciplinary perspective, “actors are viewed not only as humans but also as machines and various combinations of humans and machines.” [2]; the approach of actor engagement can also be applied to workforce engagement.

Starting on the macro-macro level, arrow 1 (Fig. 3) explains the macro-macro relation which implies an outcome of value co-creation and organizational development. According to Service Sciences and Service-Dominant Logic the outcome is based on service exchange within the context of a service ecosystem and its institutional logic.

The service ecosystem is defined as “relatively self-contained, self-adjusting systems of resource integrating actors that are connected by shared institutional logics and mutual value creation through service exchange” [20, 29, 30]. The service ecosystem of an organization depends from its positioning, that is its business model, customers, partners, employees and other stakeholders.

The organization, its strategy, its service ecosystem and the shared institutional logic forms the context for actors to engage with their resources. As shown by Storbacka et al. [2] these situational mechanisms form the meso level conditions for influencing actor or workforce engagement at the micro level (arrows 2 + 3).

The situational mechanisms lead to actor’s disposition to engage and to outcomes (arrow 4) like engagement properties which can be observed. Therefore, a change on macro level e.g. in organizational strategy and an associated development program of talents, skills and competences influences the situational mechanisms of actors and resources and triggers workforce engagement. By this engagement activities of workforce resources like people, technologies or their combinations, start (arrow 4). The observable outcome of workforce engagement are engagement properties for instance workforce systems like skill database, talent management system or eRecruiting system.

At the meso level, transformation mechanisms and integration patterns lead to the result that the workforce systems (engagement properties) being transferred into value co-creation.

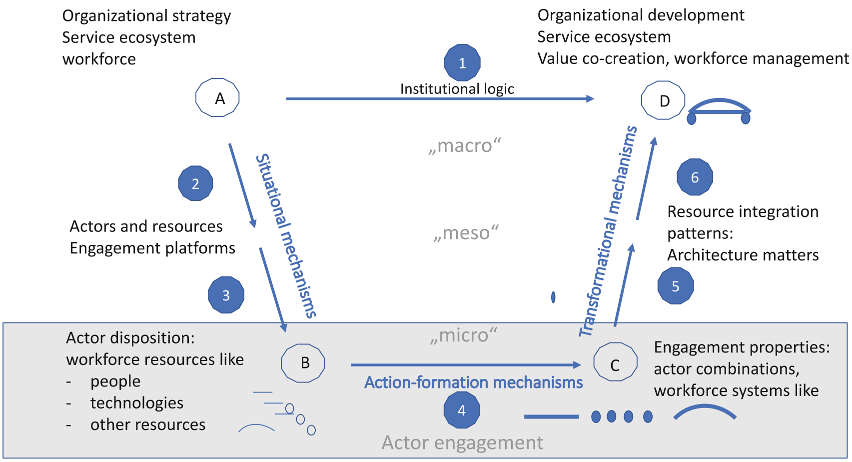

Fig. 4. The Coleman boat: Architecture matters as transformation mechanism

4 Demonstration and Evaluation of the Conceptual Framework

We examine the conceptual framework from Fig. 4 using a practical example from the workplace productivity tool sharepoint (office 365, Microsoft). Sharepoint is a new, modern platform which enables shared access to information like presentations, interaction, and collaboration by desktop sharing. Teamwork can occur anywhere and anytime quickly, reliably, and securely. Shrinking search and travel times and faster coordination cycles are the result.

Macro level: The organization decides to make greater use of the technical possibilities to increase cooperation and productivity by introducing new workplace technology (A). On the macro level institutions like company affiliation, personnel number or authorisation system are necessary to create conditions for workplace-related value co-creation (arrow 1).

Meso level: At the meso level, situational mechanisms such as engagement platforms are necessary both as a concept that presents the new possibilities of workplace technologies and their possibilities for the company and the individual employee (arrow 2) and as a facilitator for the actors' engagement (arrow 3).

Micro level: (B) as a result of meso level changes actor dispositions at micro level change. Actors like human (employees), technology (software like office 365/sharepoint) or other resources like hardware (server) engage in action-formation mechanisms. Workforce systems as actor and resource combinations like human-to-human; human-to-technology (e.g. employee training on office 365/sharepoint), or technology-to-technology (server and application) arise. This is how engagement properties emerge (C, arrow 4).

Meso level: The transformation mechanisms on the level of engagement platforms now decide whether there is a process of mutual value creation between the engagement properties (workforce systems) and the organization. Here the resource integration pattern is of great importance to enable interaction and service exchange. If this process of mutual value creation between the configurations of resources (organization) and the engagement properties succeeds, then workforce systems of the category service systems will be created: office 365/sharepoint will be used to improve team collaboration and enhance productivity (arrow 5).

Macro level: (D) coming back to the macro level organizational development is enhanced, understood "as improving the ability to adjust, integrate and apply the organization's resources" (arrow 6) [31].

5 Approaches for a New Understanding of Workforce and Workforce Management

On the basis of the conceptual framework derived from Service Science, S-D Logic, Social Theory, meso- and microfoundation, a new understanding of workforce and workforce management can be established.

The new understanding of workforce does not limit workforce to the human being but stands for all actor combinations that contribute to an organization [32].

How deduced in the conceptual framework (Fig. 2) the actor combinations and workforce systems as engagement properties do not have in every constellation a value for the organization. The value for the organization is only created with implementation of the process of interaction between the workforce system and the organizational service systems characterized by resource integration and mutual value generation.

The significance of workforce management is to create the conditions for this and to ensure the process of value creation cooperation and mutual value creation. Workforce management therefore can be understood as the set of activities and efforts facilitating the process of interaction and resource integration between workforce systems and organizational service systems for mutual value creation.

As a result, workforce management makes the difference whether a workforce system becomes a service system that creates mutual value with other service systems of the organization or not. If this process cannot be initiated, then workforce systems will remain organizing systems or systems as arrangements of resources, but they will not become service systems [1, 17, 19].

If the workforce management succeeds in enabling this process, the organization improves its ability to use the available resources and organizational development - understood "as improving the ability to adjust, integrate and apply the organization's resources" (arrow 6) [31] – takes place.

6 Findings, Conclusion and Outlook

The theoretical concepts of Service Science, S-D logic, Social Theory, meso- and microfoundation are suitable for describing the mechanisms of the wide range of actor combinations and the process of value co-creation.

In conjunction with the micro- and mesofoundation it is facilitated to point out, model and describe the workforce mechanisms not only in the actor-to-actor context but also to consider, model and describe the workforce mechanisms between macro-, meso- and micro-level.

With the help of the derived conceptional framework for workforce management, it is thus possible to explain the manifold actor combinations and initiate a new understanding of workforce taken as all actor combinations that contribute to an organization and workforce management as the set of activities and efforts facilitating the process of interaction and resource integration between workforce systems and organizational service systems for mutual value creation.

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Microfoundations for Building Systems of Engagement: Enable Actor Engagement Using Service Dominant Architecture

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Abstract. The paper proposes a multi-level design framework on basis of SDA (Service Dominant Architecture) for building Systems of Engagement (SoE). Meso-level transformational mechanisms (processes) play a key role in linking the micro-level actor engagement with the macro-level of co-creation of value. SDA proposes a framework and design environment to design and operate service systems. SDA provides a knowledge base of design knowledge which can be translated and incorporated into solution designs. Focus of our research is on how organizations can enable actor engagement building Systems of Engagement (SoE) using Service Dominant Architecture (SDA). This is a continuation of our previous research endeavours and yielded results on SDA.

Keywords: Service innovation · Service Dominant Architecture · Actor engagement · Value co-creation · Human centered service design

1 Introduction

One of the key aspects of digitalization are new emerging market structures which are drawing from novel institutionalized solutions established by "market makers" [13]. Our research context is the health care sector, specifically an insurance company in Germany, which is currently undergoing a digital transformation to compete through service innovations by creating new innovative value propositions for the health care sector. [19:3015] emphasize that service ecosystems are "[…] partly designed and partly emergent". Hence, this implies that new market structures and related institutional solutions can be nurtured and stabilized by organizations (on the meso-level) if they are able to influence and design appropriate engagement properties and resource integration patterns. As actors strive for better density and improved ways for value cocreation which brings the focus on the mechanisms that can enhance such activities. Service platforms are seen as critical to helping make this happen but require a multi-level design approach [11:159–162]. Our research context is the health care sector, specifically an insurance company in Germany, which is currently undergoing a digital transformation to compete through service innovations by creating new innovative value propositions for the health care sector.

The paper is organized as follows. Firstly, we review briefly systems of engagement and propose a multi-level design framework for implementation. Secondly, we shed

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light on the implementation of engagement platforms using SDA in real life contexts. Then, we discuss briefly our findings and finalize with a brief summary and concluding remarks.

2 Methodology and Approach

Followed research design and methodology is eclectic and grounds on various disciplines and related practices. Our research embraces IS development as research approach [14]. In addition, we incorporate elements and requirements of Design Science Research (DSR) which show significant relevance to achieve our research objectives [1, 8, 10, 16]. Furthermore, we embrace a multi-level design perspective [9, 18] with a clear focus on the microfoundation perspective [6]. Microfoundations are seen to bridge the existing gap between macro level research and micro level research on engagement of actors and individuals [18]. The aim is to evolve the SDA as research artifact which will support our action-oriented and explorative research approach [2, 17].

3 Foundations of Systems of Engagement

Systems of Engagement (SoE) are seen as “the next stage of enterprise IT” [15] which bring companies new communication and collaboration capabilities “[…] to engage with their customers and suppliers, and vice versa, with a focus on communication to enable collaborative business in real-time with all the benefits of mobility and speed” [15] [26:8]. The microfoundation movement of strategic management intends to bridge the gap between macro-level concepts, e.g. value co-creation, and related micro-level concepts (e.g. actor engagement) [9:2]. [9] propose a multi-level design framework for service systems which is used subsequently to evolve the SDA framework by reflecting the needs as well as adopting and integrating appropriate elements for the SDA multi-level design approach. [18] motivate to overcome difficulties and barriers in applying macro concepts such as value cocreation in organizational (meso-level) or individual context (micro-level). Thus, subsequently we look at the microfoundations for value cocreation, specifically at actor engagement [9]. Actor engagement [3] can be conceptualized as microfoundation for value co-creation within service ecosystems [19:3014]. [18] suggest delineating three levels to analyse mechanisms and properties for “actor-formation” and “transformational mechanisms”. The authors identify five areas further research: (1) the engaging actor, (2) engagement platforms, (3) actor dispositions, (4) engagement properties, and (5) resource integration patterns. Actor engagement can be conceptualized as “[…] both the disposition of actors to engage, and the activity of engaging in an interactive process of resource integration within the institutional context provided by the service ecosystem” [19:3015] [4]. [19:3015] introduce an engagement platform, that they define as “[…] multi-sided intermediary that actors leverage to integrate resources”. Engagement platforms are an interesting field of research as the concept is not yet clearly defined. Engagement platforms can be both intermediary or mediator [19:3015] [3].

Institutions form a context for actors to engage with their resources [4, 5, 22]. Hence, the institutional set up is essential for the design of service systems. Institutional design includes hence besides the refinement of institutional set-up such as value proposition as well the appropriate configurations of actors and resources [9:6]. This approach relates to typical problems of the discipline of business process management and engineering. One of the major challenges for organizations is to internalize varying processes induced by changing customer or in general actor behaviour.

This means that the process of value co-creation (macro-level) cannot be fully controlled on the level of actors (micro-level) but can be influenced and designed through required mechanisms to "drive emergence" [19:3016]. Further, resource integration patterns are a useful concept which allows to analyse and understand institutional set ups. Resource integration patterns are defined as "[…] distinct combinations of actors, engagement platforms, actor dispositions and engagement properties" [19:3015]. Resource integration patterns "[…] provide the fundamental structure […] to better understand and manage effective value co-creation" [19:3015]. Actors, action and agency are central concepts at the micro-level. Behaviour of systems can be studied by focusing on actors' intend and dyadic relationships.

4 Building Systems of Engagement with SDA

S-D (Service-Dominant) logic [12, 19–21] underlines for companies the pivotal role of service innovations and value cocreation along the various steps of their digital transformation journey. Institutions are salient to understand the managerial opportunities offered by new emerging technologies and new digital markets. Value cocreation needs to be viewed as embedded in service ecosystems and service systems. Challenges to apply S-D logic in a real business context, can be related to design and development activities, such as "[…] developing compelling service offerings and value propositions, developing more innovative service offerings, or designing and reconfiguring markets and potentially industries" [12:197].

Meso-level transformational mechanisms (processes) play a key role in linking the micro-level actor engagement with the macro-level of co-creation of value. Key mechanism at play are processes of resource integration. Two types of processes for resource integration can be distinguished: (1) based on summative or aggregative relations between resources (homopathic resource integration) and (2) based on emergent relation between resources (heteropathic resource integration) [19:3014-16]. Through the lens of social systems, action takes place at the level of individual actors (micro-level) and organizations (meso-level). From this point of view, the "system level" exists solely as emergent properties and applied rules which characterize the behavior of systems [6:28]. Through emergence of structures the consequences of individual's action to other individuals and rules are affecting macro-level outcomes as combination of individuals' actions [6:19]. [19:3015] emphasize that service ecosystems are "[…] partly designed and partly emergent". Hence, this implies that new market structures and related institutional solutions can be nurtured and stabilized by organizations (at the meso-level) if they are able to influence and design appropriate engagement properties and resource integration patterns. Actors seek better density and improved ways for value cocreation which brings the focus on the mechanisms that can enhance such activities. Service platforms are seen as critical for realization and solution designs [11:159–162]. Figure 1 illustrates our conceptualization of the multi-level design framework and future research approach and explicates the salient role of SDA to facilitate a multi-level service systems design.

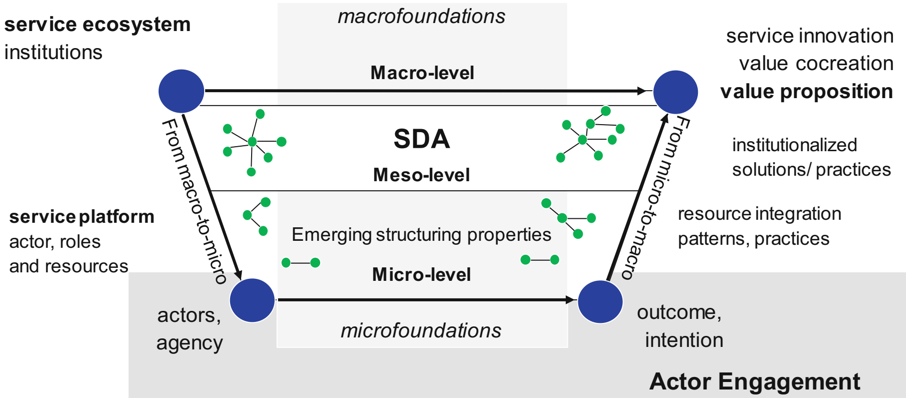

Fig. 1. SDA and institutions: microfoundations for actor engagement (modified from [6, 7, 18]).

SDA can offer a framework and design environment to design and operate service systems. SDA provides a knowledge base of design knowledge which can be translated and incorporated into solution designs. Following an action design approach [2, 17] SDA framework needs to be positioned on the meso level to support companies in understanding and (co-)designing of "[…] actor engagement, resource integration and corresponding service system […]" [9:6]. Combined with the multi-level design framework, SDA delivers required capabilities to design service systems in real-world environments.

We argue that SDA proposes an environment to follow an "[…] explorative approach […] to support continuous service systems growth and [to] provide a mechanism for resource mobilization and actor engagement" [9:14]. Based on the SDA framework, systems of engagement can be built, which constitutes the foundation for developments, such as planning, building, operating and managing service systems. "For instance, encouraging actors to leave their traditional, conventional modes of interaction and engaging continuously with other actors is challenging. In addition, mechanisms must be identified regarding how the initial design could cope with limitations identified while evaluating, especially in the intervention phase" [9:14]. Service platforms play an important role for implementing systems of engagement. Service platform is defined as "[…] a modular structure that consists of tangible and intangible components (resources) and facilitates the interaction of actors and resources (or resource bundles) [11:162].

Next steps foresee to further expand the knowledge base and theoretical foundation to deal with resource integration and value cocreation in the context of the SDA [25].

5 Findings and Discussion

S-D logic encourages companies to rethink and reconfigure their current value propositions and to engage with actors and to compete on digital markets. S-D logic offers new innovative perspectives on value creation activities and guides managers and decision makers to take advantage of novel forms of engagement with actors. However, transferring S-D logic concepts (e.g. value cocreation) in a real-life context is difficult task and a cumbersome endeavor [24]. It requires to understand the micro-foundations of value cocreation, namely actor engagement. The paper concentrates on the key challenge of implementing value cocreation in a real-life context [24]. Service Dominant Architecture (SDA) has been proposed by [23, 24] to overcome previously mentioned design challenges. As IS (Information Systems) artifact, the SDA has aimed originally to develop new capabilities in the context of EIS (Enterprise Information Systems) but is now expanding to emerge into a more comprehensive methodology and process, which is able to guide companies along their digital transformation process. The originality and value of SDA lies on the one hand in its concreteness and applicability and on the other hand in its link to foundations of SDL and service science. Our next research objective is to clarify and broaden the knowledge base of the produced IT artifact concerning implemented mechanisms and expected effects. Focus of our research is to further explore actor engagement following an action-design oriented research approach by building Systems of Engagement (SoE) using SDA. This is the logical continuation of our previous research endeavors and yielded results on SDA [23–26]. Furthermore, conducted research contributes to develop managerially-oriented frameworks which offer a deeper understanding of design elements of the value co-creation concept. To achieve this, we have adopted a multi-level design approach and framework. [9:14] conclude "from a methodological viewpoint, further research is needed to understand the systematic engineering of service systems under conditions of instability and change during the design process and to provide guidance for service researchers and practitioners within these dynamic service environments to design sustainable and value-adding service systems". Our research on SDA contributes to addresses in particular two key themes in service innovation which have been motivated by [11:163]. Firstly, to investigate, how digitally enabled service platforms need be structured and positioned so as to enhance resource density and thereby maximize the opportunities for service innovation. Secondly, future research needs to explore required mechanisms and IT support for actors in searching for and bundling (mixing and matching) resources within and across service platforms and service systems [11:163].

6 Summary and Conclusion

The paper introduced Systems of Engagement (SoE) as key element of S-D logic informed digital transformation strategies leveraging actor engagement and value cocreation. Digital transformation and new emerging technologies are challenging established perspectives on value constellations and how value is created. Observably we are facing (as well) in the health care systems "frame-breaking reconfigurations"

[13:242] of established practices, offerings and value constellations, which bring along substantial challenges for incumbent organizations. Evaluation happens iteratively at the end of each development step by an assessment through use cases or practitioner feedback by developing concrete value propositions and use cases. Following the DSR process as suggested by [1, 17], we intend to commence our study of the utility and usefulness of the created IT artifact in the given concrete organizational context. SDA operationalizes and deploys respective capabilities through its purposed subsystems [23, 25, 26]. The solution constitutes the core of a real-life experiment to explore the possibilities and to learn from piloting and testing the SDA in the context of our case company. Our research objectives are to further clarify and broaden the knowledge base of the produced IT artifact concerning implemented mechanisms and expected effects in the health care domain and beyond [25].

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Analyzing the Role of Artificial Intelligence in the Development of Human-Centered Service

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Abstract. Developing new service business models that provide human-centered service offerings rely on deep insights on the needs and requirements of customers. Companies that have been on the market for some time, often collected large amounts of data on their customers that can be applied to achieve deep customer understanding and develop artificial intelligence. Applying a single case study that comprises the development of a personal health advisory service for stroke prevention in Germany, this research analyzed the mechanism of AI in the development of human-centered service offerings. With this, we briefly analyze and discuss the role of data, artificial intelligence and its explainability to gain customer understanding and proximity and to achieve human-centered service.

Keywords: Service business models · Artificial intelligence · Data · Human centered service · Platform architecture

1 Introduction

Developing new service business models that provide human-centered service offerings rely on deep insights on the needs and requirements of the customers. Gaining these insights is a key challenge for most companies. Companies that have been on the market for some time, often collected large amounts of data on their customers. This data is to be applied to generate customer insights and to enable the development of new service business models. However, often this data is not enough. In this situation data needs to be supplemented by data of partners that are, in our case, connected to each other by a service platform; here based on a service-dominant architecture [1, 2].

This research aims at analyzing the interconnection between human-centered service design and generated customer insights based on artificial intelligence. As human-centered service design focusses on the needs of a respective customer, by emphasizing

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them and his natural behavior, artificial intelligence (AI) generates and applies customer insights that are based on models derived from customer data. Hence, both topics create a reciprocal symbiosis that establishes a mutual reinforcement.

In the following, firstly, theoretical foundations regarding business models, human-centered design, and AI in medicine are outlined. Based on these foundations, the research methodology is introduced. Thereafter, a single case study that comprises the development of a personal health advisory service for stroke prevention in Germany is presented and discussed. Finally, the paper closes with a brief conclusion.

2 Theoretical Foundations

2.1 Business Models

There is a variety of different business model understandings and definitions [3–5]. Comparing the understandings, some similarities can be discovered. Key aspects of business models are value creation and value propositions. Value creation comprises the application of tangible and intangible resources in order to create a respective value. The value proposition comprises the offered value to the customer.

Due to the lack of definitional clarity, alternative conceptualizations of business models exist (e.g. [6–8]). This conceptual diversity results in a variety of ontologies and representations. Three of the most common ontologies are e3-value Ontology [9], the Business Model Ontology (BMO) [10], and the Resource-Event-Agent Ontology [11].

Based on the Business Model Ontology [10], the Business Model Canvas [12] is developed. It is one of the most frequently used business model approaches [13] and have been extended over the last several years. A service specific example is the Service Business Model Canvas (SBMC) [14] which helps to illustrate, analyze and design service-based business models (see Fig. 1).

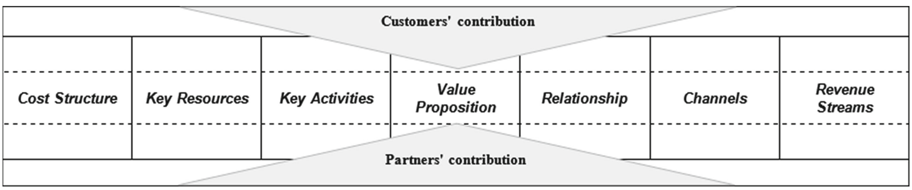

Fig. 1. The service business model canvas

The overall logic of the SBMC is to depict the contribution to and benefit of the business model for each actor, hence the co-creation. In contrast to the value proposition of the BMC, the value proposition in the SBMC allows representing the value proposed to each actor, including the focal actor. The customer relationship dimension of the BMC was renamed to relationship, because it covers the contribution to maintaining the relationship of all actors. Channels describe the interaction points between actors. The revenue stream dimension presents possible revenues for each actor. Key resources and key activities represent the contribution of each actor to service provision. In particular, these dimensions illustrate the contributions of customers to the resources and the process of providing the service. Lastly, the cost structure shows which costs each actors bears as part of the business model [14].

2.2 Human-Centered Design in Service Environments

The roots of human-centered design are situated in the context of computer science. Based on a human-centered approach it aims to overcome the poor design of software products from the user´s point of view. This is done by emphasizing the needs of the specific users of the software [15, 16]. Following this approach, human-centered design focusses the understanding of the user and its desire to engage in a mutual value creation with a software product. In this sense, it acts in the context of socio-technical systems where technology and people interact to co-create value [17].

In a service context human-centered design is placed in human-centered service systems. Whereby, service systems that are defined “as configurations of people, information, organizations and technologies that cooperate together for mutual benefit” [18]. Starting point for human-centered design is the understanding of the human being as actor and part of his ecosystems and thus, the understanding of the human-centered service systems [18].

2.3 AI in Medicine

Artificial intelligence (AI) methods are increasingly developed for the clinical setting and for patient-centered healthcare [19]. In particular in stroke, there have been promising results both in imaging and clinical data analyses [20, 21] and big data enables more precise and personalized approaches [22, 23]. While high-performant models are a prerequisite for the implementation, integration in the workflow requires human-centered solutions. Here, it is paramount that AI products follow the state-of-the-art with regards to usability and presentation of results.

Training and testing of models is essential and scientific evidence must prove that AI-based models are superior to traditional methods: Thus leading to personalized medicine with better outcome. But only when explaining the generated models and their impact on the user, patient or doctor, the acceptance of AI-based decision support will be sustained. The herewith presented HealthAdvisor app utilizes proprietary AI models to provide quantified and personalized risk assessment for stroke. Furthermore, the HealthAdvisor identifies the most efficient intervention on an individual level to empower patients to reduce stroke risk. The underlying technology employs machine and deep learning technologies and, in contrast with existing - and mostly failing - standards of preventive strategies, considers the individual features of every patient.

3 Methodology

In this research, we apply a single case study that comprises the development of a personal health advisory service for stroke prevention in Germany. The use case stroke addresses a major cost driver in the German healthcare, incurring annual costs of around US$13bn. Our use case is implemented on a service platform that facilitates the interaction between the provider of the Personal HealthAdvisor, the insurance company, and the customer. Only in the combination of the different actors mutual value creation is possible.

Applying the selected methodology allows us to observe and analyze the interconnection and dependencies between human-centered service design and artificial intelligence in designing and improving service business models. As analysis framework, the Service Business Model Canvas [14] is applied. This canvas enables to describe, analyze, and understand the interaction between the cooperating actors in the service design process.

Conducting this research, we describe the interplay of different actors in the development of a new service business model based on artificial intelligence. For this, we analyze the integration of data and derivation of customer insights from a service business model perspective. This approach provides the unique opportunity to understand the interaction and exchange in context of artificial intelligence.

4 Description of the Case Study

The presented case study considers a personal health advisory service for stroke prevention in Germany. The underlying prediction model was developed with machine learning algorithms on basis of clinical data on patients with increased stroke risk. The stroke prevention is implemented on basis of a service platform and offers both strong patient benefits and significant benefits for insurance companies. The overall business model is depicted in Fig. 2. In the following, the business model is introduced.

Value Proposition - As illustrated, the business model of the Personal HealthAdvisor comprises the support of the customer in their lives. Guided by a risk assessment, customers get information on behavior changes that lead to a stroke risk minimalization. With this offering, changes in customer behavior that lower stroke risk becomes feasible. Furthermore, the insurance company can become innovation leader in digitization and AI. The provider of the HealthAdvisor gathers additional training and testing data that continuously will improve the AI models as well as the usability of the product.

Key Resources - To make the offering possible, the provider of the HealthAdvisor must combine clinical and epidemiological data on strokes as well as domain knowledge to develop artificial intelligence models. These models are the basis of the value proposition and enables evidence-based, AI-supported strategies for stroke prevention. For its application at the customer side, the customer must use his mobile phone and install the mobile app of the insurance company. Moreover, the company insurance provides historical health data on the specific customer.

Key Activities - As the basis of the offering, the AI models must be trained, and the app will continuously be developed by the provider. The insurance company has to integrate the HealthAdvisor in its existing mobile App. Additionally, existing interoperable health data are connected to simplify usability. By this, the user does not need to enter data manually but rather synchronization is possible. Finally, the customer has to use the app.

Channels – The AI model is integrated into the HealthAdvisor mobile app. This service is integrated into the existing customer app of the insurance company. Moreover, the insurance company has to approach/target the customer after risk identification.

Relationship – To maintain the relationship, the HealthAdvisor must integrate guidance for a healthy life. This is crucial part in the relationship between the app and the customer. From the insurance company perspective, the HealthAdvisor is a part of the health insurance offering. It is offered as premium value proposition to the customer.

Cost Structure – Mainly, the costs are incurred by iterative app and model development as well as the integration of the app into the existing customer app of the insurance company. Furthermore, the insurance company pays license fees.

Revenue Streams - From a monetary perspective, the insurance company lowers their costs due to prevention and thus, less strokes. The provider offers licenses to insurance companies.

Customer
- End customer

	Cost Structure	*Key Resources*	*Key Activities*	*Value Proposition*	*Relationship*	*Channels*	*Revenue Streams*
Customer	-	- Mobile device	- App usage	- Personalized risk assessment - Lowering threshold for most efficient behavior changes - Stroke risk minimization	- Permanent usage	-	-
Personal Health Advisor	- App and model development	- Clinical and epidemiological data - Domain Knowledge (Medicine, in particular stroke) - AI expertise (Machine/Deep Learning)	- Model training and testing with incoming data - Sequential releases of improved models	- Big data training sets, with every user (who provides informed consent) - Feedback on UX/UI	- Hints for a healthy life	- Smartphone App	- Licensing with Insurance companies - White label dev
Partner perspective	- Integration in customer App - Licensing fees	- Historical health data - EMR - Access to cus-tomers/patients	- Integration in existing customer App - Integration of existing data	- Leader in innovation - Better Disease Management Programs - Lower costs by prevention of stroke (and cardiovascular diseases) - Data insight and stratification of patients	- Offering as part of the health insurance	- Existing customer App or Website - Direct approach after insurance identifies risk	- Decreased costs due to decrease of number in strokes and healthier customers

Key Partner
- Insurance Companies

Fig. 2. Business model of the personal HealthAdvisor

5 Discussion

Our use case is an example, how AI based human-centered service are working, and which mechanisms are implemented to achieve optimal customer focus and understanding. For this, we analyzed how the provider of the Personal HealthAdvisor, the insurance company, and the customer are interacting, to enable mutual value creation and lastly, superior value for the customer. To enable value creation, the use case is implemented on a service platform based on the Service-Dominant Architecture (SDA). Based on a service-based mindset, the SDA "[…] provides an architecture that defines how to structure, integrate and orchestrate resources into agile, flexible and collaborative service offerings in real time" [1, 2]. In the following, we discuss briefly the way how value with high customer focus is generated and continuously improved.

During the preparation of the service offering, the provider is depending on clinical data of the customer. The data is a crucial factor for the training and testing of the AI models and thus, basis for the development of a human-centered service. From a human-centered design perspective, this situation can be compared with the software engineering process. As human-centered design focuses on the understanding of the users and their desire to engage in a mutual value creation, the understanding of the customer is a crucial part of engineering. Developing AI based human-centered services requires customer insights, like the requirements and wishes of customers. Depending on data that fits to the identified requirements and wishes, it is possible to develop respective AI models. In our use case, the desired value is a better and healthier life of the customers. To meet this request, clinical data on patients with stroke risk are applied in the development of the AI models.

However, even if the development of the AI model is already focusing on requirements and desires of the customer, especially the interaction with the customer via the mobile app and the integration into the service platform is of particular interest.

While using the service offering, the customer is continuously interacting with the mobile app and the implemented AI model. During the interaction, the mobile app is collecting additional data like input or data on the behavior of the customer. This data is used to improve the underlying AI model. In the context of human-centered design, this procedure extends the traditional engineering approach to a continuous process that permanently improves the customer understanding and by this, the value proposition of the service offering.

Lastly, as the application of AI models requires specific input data, the integration into the service platform is of utmost importance for design of a convincing and functional user experience. In our case, the integration into the platform enables to connect existing data of the insurance company and extracts input features for the AI models. Taken together, we showed that by AI based individualization of stroke prevention and integration of data, the next generation of human-centered service is feasible.

6 Conclusion and Outlook

This paper analyzed the mechanism of AI in the development of human-centered service. As human-centered service is characterized by its high customer proximity that focuses on the needs of the respective customers, by emphasizing them and their natural behavior, artificial intelligence generates and applies customer insights that are based on AI-based models derived from customer data.

As our analysis shows, AI has the potential to achieve superior customer understanding and thus, is a promising basis for the development of next generation human-centered service offerings. In this context, we discuss the necessity of customer data for the development of AI models as well as the ongoing gathering of new customer data. Both enable a continuous development and adaption of AI to achieve a permanent and flexible human-centered service offering.

This research allows a first glimpse in the interdependency between AI and human-centered service. This adds to the body of knowledge by analyzing a reciprocal symbiosis that establishes a mutual reinforcement of human-centricity and opens the way for further research.

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Predicting Future Accident Risks of Older Drivers by Speech Data from a Voice-Based Dialogue System: A Preliminary Result

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Abstract. As the world's elderly population increases, driving accidents involving older adults has become an increasingly serious social problem. Previous studies have suggested cognitive impairments as one of the risk factors for future accidents. However, it remains unclear whether and how such future accident risks related to cognitive impairments can be predicted by using health monitoring technologies. In this study, we collected speech data from simulated conversations between 38 healthy older adults and a voice-based dialogue system. We followed up with the participants 1.5 years later and found that 17 of them had experienced near-accidents within the past year. We then built a binary classification model using the originally obtained speech data and found through leave-one-out cross-validation that it could predict whether a person would have a near-accident experience with 78.9% accuracy. Our preliminary results suggest that speech data from voice-based interaction systems might help older drivers recognize future accident risks.

Keywords: Health monitoring · Smart speaker · IoT · Older adult · Speech analysis · Cognitive impairment · Longitudinal observational study · mHealth

1 Introduction

With the rapid growth in the elderly population worldwide, driving accidents involving older adults has become an increasingly serious social problem. To prevent such accidents, previous studies have investigated the relationship between the accidents and cognitive function assessed by neuropsychological tests and suggested cognitive impairment as one of the predictors for future accidents [1–3]. In this respect, if we can infer cognitive impairments related to accident risks from behavioral data in everyday situations, it would be beneficial for accident prevention.

Speech might be the behavioral data with the most promise. Many studies have demonstrated an association between speech data and cognitive impairments resulting

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from aging and diseases such as Alzheimer's disease [4–9]. At the same time, there is growing interest in speech data collected in everyday situations due to the expansion of voice-based interaction systems such as smartphones and smart speakers used as healthcare applications [10, 11]. However, it is still unclear whether and how speech data collected in everyday situations can be used for predicting accident risks of older drivers. In previous studies, we suggested that interaction with a voice-based dialogue system would change according to the level of cognitive functioning and could be captured by speech features [4] and hypothesized that such cognitive impairments captured by speech features could be useful for predicting future accident risks of older adults.

In this study, we investigated the relationship between speech data and future driving experience related to accidents in 38 healthy older adults with no diagnosis of dementia. Specifically, we simulated typical application scenarios on modern smart speakers and voice assistants and collected the speech data during interactions with a voice-based dialogue system. We followed up with the participants 1.5 years after the speech data collection with a questionnaire on their driving experience related to accidents within the past year. We then investigated whether we can predict accident risks of older drivers from speech data during interaction with a voice-based dialogue system. Our machine learning model built using features automatically extracted from speech data provides the first empirical results demonstrating how speech data with a voice-based dialogue system can help monitor future accident risks of older drivers.

2 Methods

2.1 Participants

We recruited 40 healthy older adults through a local recruiting agency (20 females, 20 males; 61–79 years; mean (SD) age: 69.9 (4.8) years). The criterion for recruitment was "older than 60 without any serious diseases or disabilities including neurodegenerative diseases such as dementia". All participants were evaluated with the Mini-Mental State Examination (MMSE), a screening measure of global cognitive functioning [12], and showed a mean MMSE score $\pm$ SD of 28.0 $\pm$ 1.5. All participants had a perfect score on the Barthel Index for activities of daily living. Of the original 40 participants, 38 consented to the follow-up study (20 females, 18 males; 61–79 years; mean (SD) age, 69.6 (4.8) years). They were contacted again 1.5 years after the experiment (range: 16.0–18.7 months; mean (SD): 17.5 (0.8) months) with a questionnaire on their driving experiences within the past year. This study was conducted under the approval of the Ethics Committee, University of Tsukuba Hospital.

2.2 Experimental Procedure and Apparatus

In the experiment, we simulated conversations with smart speakers and collected the speech data during interactions with a voice-based dialogue system. Three task scenarios were prepared to simulate typical application scenarios on modern smart speakers and voice assistants: information retrieval (asking for tomorrow's weather), shopping online (booking a movie ticket), and personal schedule management (creating a calendar event). In each scenario, participants started the task by speaking a wake word. The tasks were ordered to start with a simple scenario and then advance to more complicated ones. The questions presented by the system during the tasks consisted of four categories:

- Open-ended: Participants respond with a free sentence to answer the question (Fig. 1).
- Multiple options: Participants choose a response from the options stated in the question.
- Prepared input: Participants respond with the information (e.g., passcode) specified by the experimenter.
- Confirmation: Participants need to accept or reject what the system has stated.

For more details, please see our previous paper [4].

(Open-ended question)
S: What kind of movie would you like to watch?
P: Ummm... I'd like a... (pause) comedy film.

(Open-ended question including an intent recognition error)
S: What can I help you with?
P: Please add a calendar event of watching a movie.
S: Sorry, I couldn't understand what you said. Please try again.
P: Well,... could you... ummm... add an event please?

(Open-ended question including a speech recognition error)
S: What time will that event be?
P: 10:30.
S: OK. The event is scheduled for 10:00.
P: No, it's not 10:00. Please set it for TEN-THIRTY.

Fig. 1. Examples of open-ended conversations. Questions by the system (*S*) include simulated errors. Responses by the participant (*P*) include pauses and filler words.

To conduct the experiment, we developed a tablet-based application for use with the iPad Air2. We took a Wizard-of-Oz approach so that we could conduct quantitative analyses with a limited number of trials by controlling the content of the conversations. Participants sat down in front of the tablet and talked with the system through the tablet to perform the tasks (Fig. 2). The tablet showed a screen indicating whether it was speaking or listening. Each experimental session took approximately 30 min per person.

Participant's turn to talk System's turn to talk

Fig. 2. Overview of experimental setup for speech data collection with our voice-based dialogue system.

We followed up with the participants 1.5 years after the experiment and administered a questionnaire on their driving experiences within the past year. Specifically, we asked them if they had any accident and/or near-accident experiences within the past year.

2.3 Data Analysis

From the speech data of each participant, we automatically extracted 160 features consisting of 45 acoustic features, 48 prosodic features, and 67 linguistic features. To extract acoustic and prosodic features, we used Praat [13]. To extract linguistic features, we converted audio data into text data by using the IBM Watson Speech to Text service, which transcribes not only clearly uttered words but also speech disfluencies such as filled pauses. For preprocessing, we used the Japanese morphological analyzer MeCab [14] to perform word segmentation, part-of-speech tagging, and word lemmatization.

For the acoustic features, we extracted Mel-frequency cepstral coefficients (MFCCs) and used the first 12 MFCCs, which represent the short-term power spectrum of the speech signal. We also extracted shimmer and jitter (local and APQ3), which are measures of the cycle-to-cycle variations of fundamental frequency and amplitude. We then used the mean, median, and standard deviation of these three features.

For the prosodic features, we calculated pitch, the first five formant frequencies, and the duration of speech and silence segments. We then calculated their mean and standard deviation values for each response and used their statistical values across all responses including mean, median, and standard deviations as features.

For the linguistic features, we extracted four types of feature sets. The first feature set, related to part of speech, consisted of 28 features. We extracted the part-of-speech information by using Mecab [14] and then computed the frequency of occurrence of different parts of speech (nouns, adverbs, verbs, prefixes, adjectives, auxiliary verbs, particles, symbols, interjections, and conjunctions). We also computed ratios, namely, each part of speech normalized by the total number of word tokens in the document. We also calculated the ratios of noun to verb, noun to adjective, verb to adjective, and pronoun to noun as well as the frequency of occurrence of filled pauses.

The second feature set, related to vocabulary richness, consisted of three features: type-token ratio, Brunét's index, and Honoré's statistic [15]. This feature set measures lexical diversity, which tends to be reduced in individuals with cognitive impairments such as Alzheimer's disease [15].

The third feature set, related to syntactic complexity, consisted of 21 features related to length metrics as well as dependency relations. For features related to length metrics, we calculated the number of words in each response and computed the mean, median, maximum, minimum, standard deviation, and summation of the values. We also calculated the total number of words, total number of responses, and total character length in all responses of each participant. For features related to dependency relations, we calculated maximum dependency distances per response, and then calculated their statistics including mean, median, maximum, minimum, standard deviation, and summation. We also calculated the total number of dependencies of a participants' speech, the average dependencies per response, and the total dependency distance in a participants' speech. To extract the dependency structures, we used CaboCha [16].

The final feature set, related to perseveration, consisted of 16 features. We converted responses into term frequency–inverse document frequency vectors. We then calculated the cosine similarity between responses and used their statistics including mean, median, maximum, minimum, and standard deviation. In addition, we calculated the proportion of response pairs equal to 0 and below nine thresholds from 0 to 0.9 in increments of 0.1.

We used a support vector machine (SVM) model [17] as the binary classification model for differentiating individuals with accident/near-accident experiences. To avoid overfitting, we performed the feature selection through an improved SVM recursive feature elimination algorithm with a correlation bias reduction strategy in the feature elimination procedure [18]. For determining the hyper-parameters including kernel types, we performed a grid search.

3 Results

According to the follow-up questionnaire, 17 of the 38 participants reported accident and/or near-accident experiences within the past year. One participant reported both an accident and a near-accident experience, and the others reported a near-accident experience.

We then divided the participants into two groups, 21 with no accident and 17 with accident/near-accident and investigated the relationship with the speech features collected 1.5 years earlier. Statistical analysis showed that 22 of the 160 speech features showed significant difference between the two groups ($p < 0.05$, two-tailed Mann-Whitney U test with false discovery rate correction). These features included those related to silence, shimmer, filled pause, and pronoun, which have frequently been used for detecting patients with cognitive impairment resulting from Alzheimer's disease and mild cognitive impairment [5–9].

Next, to investigate whether we can predict the individuals with accident/near-accident experiences from the speech data, we built a binary classification model with an automatic feature selection method. The results of leave-one-out cross-validation showed that the model achieved the accuracy of 78.9% (chance: 55.3%).

4 Conclusion

In light of the increasing demand for preventing driving accidents involving older adults, we investigated the possibility that future accident risks related to cognitive functioning changes could be automatically predicted by means of passive and obtrusive monitoring. We focused on speech data to take advantage of the expansion of voice-based interaction systems such as smartphones and smart speakers. Speech data were collected from healthy older adults during interactions with a voice-based dialogue system in simulated typical application scenarios followed 1.5 years later by a questionnaire about their driving experiences related to accidents within the past year.

We first automatically extracted a series of speech features used in previous studies aimed at detecting cognitive impairments resulting from aging as well as diseases such as AD [4–9] and then built a model to predict individuals with accident/near-accident experiences within the past year. The results of leave-one-out cross-validation showed that our model could achieve the accuracy of 78.9%. These preliminary results demonstrate that speech data collected by voice-based interaction systems in everyday situations might help older drivers recognize the risk of future accidents through passive monitoring.

One of the limitations of this study is the small number of samples, so our future work will involve the collection of more data with a greater number of participants. Even so, as this work represents to the best of our knowledge the first empirical study on the relationship between speech data with a voice-based dialog system and future accident risks of older adults, we are confident that our results will help with future research on preventing driving accidents of older adults by using health monitoring technologies.

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Predictive Analytics and the Return of "Research" Information to Participants

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Abstract. The World Health Organization (WHO) estimates older adults aged 60+ will double by 2050 with 80% living in low to moderate income countries. As remote research studies supported by digital devices increase separation between researchers and participants, it is important to maintain participant trust. Research participants have expressed an interest in accessing both group and individual level results, which are not readily available. To bridge this gap, we engaged residents of a local continuing care senior housing community (CCSHC) to co-design documents used to convey information about study results. The process informed the refinement of informational materials for communicating scientific research that the CCSHC community considers accessible and meaningful.

Keywords: Digital health · Return of research results · Participant engagement · Older adults

1 Introduction

Globally, the number of adults aged 65 and older is currently one in 11 (9%). By 2050, that number is expect to grow to one in 6 (16%), with the absolute number set to double from 0.73 billion to 1.55 billion [1]. With the increasing population of older adults, research involving those over 65 is also increasing where technology plays an increasingly important role. Often referred to as 'digital' or 'mobile' health research,

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sensor technologies may be used to monitor and/or intervene with older adults with chronic diseases [2]. Digital health research is increasing across all demographics including hard to reach and vulnerable subpopulations [3]. Researchers can now obtain continuous participant data in real-time and over long durations with minimal involvement from research participants, creating unprecedented data that can answer important research questions. Moreover, digital tools are changing the research landscape with respect to how participants are involved in research. The Precision Medicine Initiative, also known as the All of Us Research Program (AoURP), is a case in point. In this study, one million people will contribute to a research database to help researchers observe how genes, behavior and environment influence human health [4]. Each participant will contribute psychological, physical, lifestyle and environmental data and will be expected to not only contribute at study onset but also to remain engaged for longitudinal data collection. This ambitious research platform has not only advanced the dialogue about participant involvement in the design of research but also in determining what will motivate participant ongoing engagement – both short and long-term.

Questions about participant engagement has prompted discussion about whether and how to return study results to participants. While sharing results may seems intuitive, for many valid reasons it is not a common practice due to clinical relevance, premature diagnoses, and feasibility issues [5]. However, researchers are increasingly interested in how to influence participant engagement to increase retention in longitudinal studies. Concurrently, participant demands for greater transparency has been on the rise. In 2018, the National Academies published a consensus report of recommendation for the return of research results drawing attention to the potential benefits, harms, and costs [6]. Related research has documented the benefits of greater transparency but, also has recognized that research data may not be accurate nor make sense to the individual [7].

During prior research, participants expressed a desire for accessible and personalized feedback at both the group and individual level [8]. The study reported here builds on this interest by studying how to communicate study information to research participants. This study is part of a larger longitudinal, observational study of physical, cognitive, and mental health in participants residing independently at a continuing care senior housing community (CCSHC) [9].

2 Methods

The study purpose was to obtain participant input on strategies to communicate group- and individual-level research information. The UC San Diego Institutional Review Board approved this research.

2.1 Study 1: Return of Group-Level Research Information

Study 1 used a qualitative approach to obtain feedback regarding communication of group-level research results. Participants for this co-design session were recruited by sharing study information with retirement community residents. Those interested in a

60–90 min focus group session met in November 2019. The lead researcher (CN) facilitated the group discussion with an undergraduate research assistant (SW) managing audio recording and notetaking. Informed consent was obtained prior to commencing the session.

To identify how to share group level research results, we identified two peer-reviewed publications reporting data collected under the parent study in *Healthcare* and the *American Journal of Geriatric Psychiatry (AAGP)* [8, 9]. In addition, we obtained documents reporting on each publication in the form of an article in Forbes Magazine and a press release created by the university science communications. From publications and public facing documents two infographic materials were created with a goal of conveying study questions, approach, analysis, study results and conclusions (see Fig. 1 (c) and 2 (b)). Participants were asked to review and comment on these three formats for communicating group-level study information.

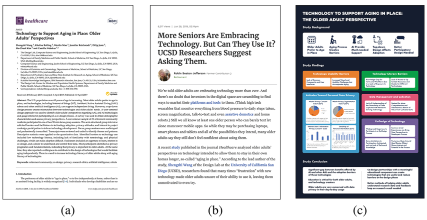

Fig. 1. (a) is the peer-reviewed publication in *Healthcare*, (b) is a Forbes Magazine article based on it, and (c) is the infographic summary.

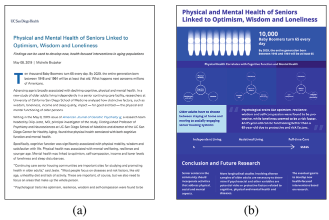

Fig. 2. (a) is the press release and (b) is the infographic summarizing about research published in the *AAGP*.

2.2 Study 2: Return of Individual-Level Research Information

Study 2 was designed to communicate individual-level wearable sensor data to participants, with two separate phases.

Phase 1: Development of the Return of Information Protocol. The Fitbit Charge 3 wearable fitness sensor was selected for use in the parent study to assess sleep, heart rate, and physical activity in free-living environments [10, 11]. The Fitabase platform [12] was used to monitor the devices and data collection. Participants were recruited through community-wide talks that described the study and devices. Research staff taught participants how to operate the device and navigate the Fitbit app. Participants without smartphones were visited by staff weekly to download device data. Participants were instructed to wear the device continuously to allow for 24-h monitoring. After 2–4 weeks, the device was retrieved, and data was migrated from Fitabase to a database. Researchers developed feedback reports to create understandable visual representations of the individual-level data, based on the research group's input.

Phase 2: Providing Individual-Level Return of Value and Evaluating User Experience. Researchers met with participants in a one-on-one setting to share individual-level data reports. The research staff explained the findings, monitoring the participants' understanding of the data and encouraging them to contact their clinical providers for concerns. Participants were asked to rate using the device and app, and availability of staff help [on a 5-point Likert scale ("Strongly Agree" to "Strongly Disagree")], as well as what they enjoyed most and least about the study.

3 Results

3.1 Study 1: Return of Group-Level Research Information

A total of six residents (three male and three female) participated. Several participants were relatively new to the retirement community and a few had contributed to our earlier research in 2018 that prompted our interest in communicating research information.

Open Access Journal. Participants displayed apprehension about understanding the material due to unfamiliar vocabulary and phrases. While the material "seem[ed] very extensive," it looked "very intimidating." Participants preferred a more concise summary "to say this study is about such and such, and this is what we found out." While most preferred fewer details in favor of clarity, one participant liked reading academic papers for deeper and more comprehensive insight into the research.

Forbes Magazine Article. Participants were more receptive to this "public-friendly" version of the studies due to their more concise and understandable language. However, participants saw this method of synthesizing the research study as too generalized, commenting that it "[doesn't] tell me where I stand." It also lacked specific research details seen in the research paper and was not written with research participants in mind.

Infographic. The group indicated it was "nicer" and that it used accessible terminology. Particularly appreciated was the use of charts and iconography, as well as the contrasting color palette of "dark with bright colors," to differentiate blocks of information.

When asked how it could be improved, participants mentioned the terminology used still posed challenges to understanding the material. Participants suggested conveying the results in simpler language, saying that "even here there [are] words that are not familiar." The physical size was also a source of frustration, with some pointing out that a smaller font size makes colored text blocks harder to read. "For this audience and age group, I think it can be a reasonable size and make it larger, split it up."

Taking into account comments across from both infographic examples, new designs were developed with a focus on emphasizing the visual characteristics by enhancing contrast and segmentation between sections. Given the participant desire for larger size of the content, text and graphical content were resized and reorganized across three pages. Complexity of terms and phrases was also considered, resulting in a rewrite with simpler terms or with extra footnotes to explain a technical phrase (Fig. 3).

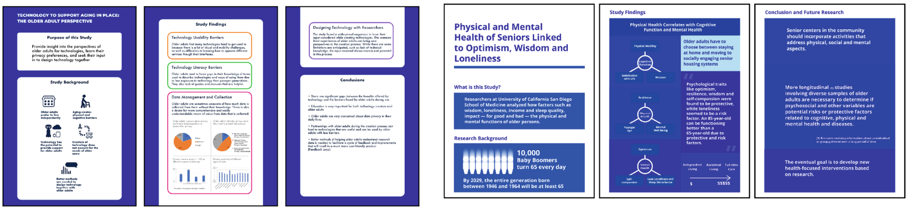

Fig. 3. Improved multi-page infographics

3.2 Study 2: Return of Individual-Level Research Information

Phase 1. Seven participants (six women, one man) wore the device for 2–4 weeks, with usage ranging from wearing/charging it to active self-monitoring daily activity levels.

The information available to participants from the device and app was limited to the current day's steps, calories and heart rate. The Fitbit app displayed weekly activity and sleep parameters but lacked day-to-day trends over multiple weeks and summary data. The app data had limited explanations, requiring paid subscription services to analyze restlessness and lacking definitions of terms like Sleep Score. The app and device interfaces were not geared toward older adults: small font and non-intuitive navigation.

With these limitations in mind, the plan to return information considered which data to include and how to best display the data. The preliminary feedback reports were based on Fitabase output (unique in format and structure from the app and device data) from research team members who wore the device for two weeks. Eight half-page graphs and charts were created to display longitudinal information on sleep efficiency, bedtimes, restlessness, wake after sleep onset, daily steps, daily distance travelled, daily steps vs. distance travelled, and activity level. The graphs were presented to the research team and streamlined to remove measures that were potentially confusing, unclearly depicted, or lacked clinical utility, resulting in four charts.

The final feedback report prepared for each participant displayed longitudinal trends of daily bedtimes, total sleep time (and sleep efficiency), step count, and resting heart rate. Study staff met with participants to explain the reports. Based on their suggestions, the report was altered to maximize readability with large font (≥ 16 point), one graph per page, and use of bright, contrasting colors. A short description under each graph explained the meaning of each measure and provided context to interpret the data in comparison to other older adults (Fig. 4).

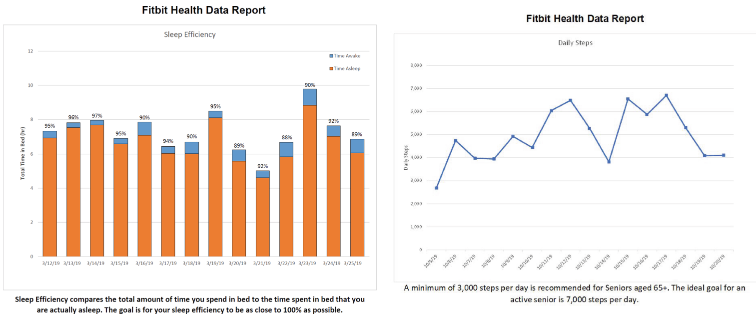

Fig. 4. Example of the Fitbit feedback report given to participants.

Phase 2. Participants reported high levels of satisfaction with their experiences during the study overall. During feedback sessions, participants expressed interest in personalized results and appreciated the visualizations. While all participants agreed or strongly agreed that the device was comfortable, three noted itchy wrists or skin irritation, and one noted an oversized wristband. The device rated as "easy to sync" in the neutral to strongly agree range. The Fitbit app/device was rated easy to use from neutral to strongly agree. On average, participants agreed that the research staff was available for help. Five participants noted that they most enjoyed "learning about health info," "usefulness of data feedback," and "data tracking was interesting."

4 Discussion

The literature on return of research results has focused on the return of individual-level information. In fact, Institutional Review Boards (IRB) have typically discouraged the disclosure of participant results with some exceptions – incidental or secondary findings. For example, in research involving brain imaging, the research team and IRB must determine the medical significance of the observation and how to communicate it to the participant. The ethics literature on reporting incidental or secondary findings has focused on brain imaging [13, 14] and genetic sequencing [15–17]. The research reported here was conducted in response to a shifting research ecosystem where participants are more engaged in the process as partners and are interested in what is being learned about them as a group and as individuals.

While the return of group-level information gets little attention, it is increasingly an expectation of participants who have contributed their time and data to the research. When vetting the materials depicting group-level results, participants were eager to learn about how their participation was making a difference to the scientific community. How the information is presented influences both access to and usefulness of the communications. Peer-reviewed publications are written in scientific language and in many cases, require a fee to access. By creating and evaluating our initial steps of making a peer-reviewed publication accessible to those who contributed, we are demonstrating our respect for participants and our value of their partnership.

With respect to the return of individual-level information, participants found information useful and engaging. All expressed interest in learning more about their health patterns, a key factor in motivating their participation. To return information in an understandable and meaningful way, shared findings should be limited in scope and the user's experience should be continually assessed. While the Fitbit study would be easiest to deploy within a tech-savvy subset of the population (i.e., those with smartphones and prior experience with wearable sensors), it is paramount that such studies recruit people with less experience with technology to prevent bias.

Despite limitations such as a small sample size and lack of long-term followup, we were able to develop prototypes for communicating both group and individual-level information in an accessible, aesthetically pleasing, and potentially meaningful manner.

5 Conclusion

Involving participants in the process of designing research and reporting study results is an important step toward authentic engagement of participants as partners. In this study, a small sample of participants contributed to shaping how we communicate the return of individual and group-level research results. Future research is needed to assess the extent to which accessible communications of research results influence participant motivation to engage in longitudinal research over the short and long-term.

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The Use of Digital Technologies and the Transformation of Work in a Hemodialysis Clinic

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Abstract. This study aimed to identify how technology transforms the work of hemodialysis nurses. The methodology was field research with a qualitative approach using the analysis of the subject's speech. Eleven questionnaires were administered to nurses working in hemodialysis clinics in the city of São Paulo, Brazil. The results pointed out that technology evolution gives conflicting expectations to the nurses that can be positive and negative. A positive expectation is the hope of enhancing care through the improvement of the contact nurse-patient. However, they also fear that technology causes dependence and expertise loss.

Keywords: Technology · Transformation of work · Hemodialysis

1 Introduction

The digital transformation brings along the change of work context, new qualifications demands, and, at the same time, enhances the abilities of workers, as, for instance, the increase of the workers' capacity of understanding the whole operational system by the use of Information Technology in the shop-floor [1, 2]. This change has been studied mainly for manufacturing, comprising technical and operational aspects, while the service sector got minor attention.

Among service enterprises, healthcare stands out on new digital equipment usage, receiving a significant amount of studies, on the so-called Health 4.0 [3]. However, the investigations on health 4.0 emphasize the use of telemedicine, the Electronic Health Record, the delivery of health service, and other technical-operational points [4]. The impact of technology evolution on healthcare work has earned more secondary attention, although remarkable articles can be mentioned [5].

Therefore, this research analyzes the nurses work in a situation of rapid technology change - the case of hemodialysis clinics. The main activities of nursing work involve the caring of human beings, which requires the ability to perceive the cared person in a holistic manner while discerning the individuality of each one. Besides, their work demands knowledge to identify the health situation of the patient and to operate the

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equipment, the ability to use tools and methods, as well as attitude to implement the praxis effectively.

The hemodialysis nurse delivers assistance to patients with chronic renal failure. Her or his activities comprise interacting directly with the patient, identifying his needs, and implementing the required actions. Also, this job demands constant observation of the signs and symptoms presented and referred by the patient during the procedure, monitoring the machine and the hemodialysis materials, and analyzing and making decisions to resolve the occurrences, thus benefiting patient safety [6].

Besides health knowledge, this work demands familiarity with hemodialysis, classified as a procedure of high complexity [7]. The hemodialysis machinery had been through a substantial technological evolution in the last decades [5], and the new technology demands trained professionals with specific skills and abilities to operate the new machines [6].

Therefore, this research goal was to identify how digital technologies changed the work of nurses in hemodialysis clinics. The methodological approach was qualitative, applying discourse analysis.

2 Theoretical Background

The continuous evolution of digital technologies is forcing the transformation of workflow and thus redefining the role of the workers [8]. Currently, the technology based on the internet can give cognitive and physical assistance, transforming the human-machine interaction in a way never forseen [1, 9, 10]. Accordingly, Industry 4.0 promotes the design of operational systems that use the Internet of Things (IoT), Cyber-Physical Systems (CPS), and Internet of Services (IoS), seeking to improve efficiency and operational capabilities of the production system [11–13].

As a consequence, the technical system can improve some of the professionals' capacities. For instance, the processing of data present in the mentioned technologies, IoT, IoS, and CPS, enlarges the cognitive ability of the workers [1].

Likewise, there is an expectation that similar or even more impacting transformations are occurring in healthcare. This change is supported by the information and automation systems that make it possible to exchange information, execute commands and monitor work processes in real-time [4].

The use of these technologies in healthcare should allow gradual virtualization that can strengthen the personalization of health care, providing real-time information for patients and health professionals [14].

Indeed, this is the case of the hemodialysis procedures, a field that changed significantly because of recent technological innovations [15]. In the old hemodialysis machines, the nurses defined and controlled all parameters manually, whereas the new equipment does a significant part of the nurses' manual work. Also, it deals with most operational problems automatically, impacting the activities and performance in the hemodialysis process [15]. For these reasons, this technological change is a representative study of the transformation of the work organization it brings.

Healthcare is a central sector in the studies of service operation management and work organization and ergonomics. Some authors, for instance, analyzed the coordination of activities among teams of health professionals and found out that elements like familiarity, mutual respect, technical knowledge, shared values, and trust facilitate the exchange of information [16]. Besides this set of subjective factors, the literature stressed that a meaningful operation process is critical to support the activities interdependence created by the division of labor [16].

In the same way, studies on the coordination of care pointed out the importance of up-to-date and correct data, demanding information exchange among professionals to complete a framework shared by the team. This shared framework is the foundation of decision making, and is critical to the success of the group [17].

On the one hand, the information system could improve communication among professionals and patients. On the other hand, higher demands can arise in terms of technical problem solving, abstract activities, and management of a complex environment. The health professional shall need to develop information technology skills and become more independent to do his work [18]. These demands increase the cognitive activity of the nurses, thus changing the ratio between the physical and cognitive load [19].

3 Method

The methodology used was field research, descriptive, with a qualitative approach. Eleven questionnaires were applied in January of this year, to a group of nurses who are taking Postgraduate courses in Nephrology and who work in hemodialysis clinics located in the city of São Paulo in Brazil. As an exclusion criterion, the health professionals who were not nurses or who worked in another field were not accepted.

The questionnaire posed open questions about:

- the advantages and disadvantages of technology in their work,
- the relationship between the technology and autonomy in work,
- how was their work before the event of the connected hemodialysis machines?
- whether technology favors the nurse-patient relationship, and
- what types of technological resources the hemodialysis machine provides?

Before the field research, a theoretical reference search was carried out through articles published from 2007 to 2019, using the databases of Latin American Health Sciences Literature - LILACS, International Literature in Health Sciences, MEDLINE and Scientific Electronic Library - SciELO. The eligibility criteria for the articles were: correspond to the descriptors "Technology", "Work Transformation" and "Hemodialysis", be a scientific article and be available in full. Books were also used that addressed the topic in a current and meaningful way.

The analysis of the subject's speech is a flexible text reading methodology whose object of study is the speech [20]. The results were then compared with the literature to obtain the research synthesis.

3.1 Results and Discussion

The questionnaires reveal a discrepancy of opinions about the use of technology in the caring of hemodialysis patients. The evaluations are positive at times and at others, a risk. This discrepancy is by itself a result, showing that the use of the technology is not consolidated and that the technology evaluation and choice should be part of their work, as Arone and Cunha well stated [21].

Currently, there are several types of hemodialysis machines that provide modern technology. Some of the nurses referred that they use machines that make data available in real-time, with a remote monitoring system covering the procedure, and a magnetic card that stores the information of the patient. At each session, past information, as well as current information, becomes available to the health professionals involved. This kind of automation is similar to those of Health 4.0, as showed by Mitchell and Kan [4].

Other nurses work with more traditional machines that provide data on the machine panel, such as blood pressure, blood ultrafiltration programming, temperature control, alarms, and safety devices, among others.

A crucial factor reported by the interviewees is information exchange. They stated that technology had made communication more accessible, precise, and trustful among the medical team, nursing technicians, nutritionists, and other professionals. Because of the better communication, relationship among the professionals gained trustfulness, and procedures planning had also improved. Researchers have already asserted that ICT makes healthcare not only more efficient but also safer [22], while others found out that trust enhance activities coordination [16, 17].

However, the interviewees do not have a general agreement about the information system. A part of the respondents claimed that technology generates work overload during systems updates, even if they acknowledge the benefits of ICT. It was also mentioned that technology could hold nurses hostage, or that they could feel accommodated with the facilities. Additionally, the nurse's lack of knowledge and ability to master the technology can generate underutilization of the resources provided by the machines. Finally, it was a consensus that technology does not always generate advantages and is not neutral. Likewise, the literature maintained that the benefits of a new technology depend on the design, implementation, maintenance, and use of it [22].

Specifying these benefits, the nurses declared that the technology provides agility and autonomy at work, provides time for the provision of adequate care, and favors access to patient information through the database. Some reported that the system helps even to respond to the health surveillance agencies, in case of inspection. As Arone and Cunha said, technology provides not only objectivity but also adds ethical and social values that commit the nurses to the patient and other health professionals [21].

That became clearer when comparing procedures with modern technology and the former one. The nurses mentioned that previously there was an overload of work that they performed manually. Problems occurred when documenting the patient's situation, so sometimes the information registered was not complete; besides that, access to data usually took time. As a result, assertive decision making was difficult, and the work was exhaustive. Regarding the assistance provided, there were many health problems presented by the patient, that could be prevented with an automatic alarm system.

To summarize, the nurse's work was hard, but the results were insecure. Thus, the provision of care using emerging technology had a significant impact on health organizations and the assistance provided by nurses in the case of hemodialysis, reinforcing the literature [22].

As a final remark, the interviews brought an unexpected result as they pointed out that the new technology helps to train the work team and to give the educational orientations to the patients. The procedure has been simplified and is easier to understand. The details of the old procedure that consumed the nurse's effort and produced a remarkable impression on the patient are now invisible to laypeople, done by the machine. This way, the health agent can focus on the relevant pieces of information, facilitating the learning process.

4 Conclusion

It is the nurse's sole responsibility to plan, organize, coordinate, execute, and evaluate the services where nursing care is recommended. He also should collaborate in the decision of whether adopting certain technologies. For this reason, nurses need to understand the use of the technological apparatus in order to benefit the work done.

This investigation indicates that technology transforms the work of hemodialysis nurses positively, offering the possibility of improving the care provided to the patient.

However, it is not possible to depreciate the fact that technology can cause dependence when there is a failure or deficiency of professional's training.

The inquiry also suggests that the main benefit of the new technology is the possibility of favoring nurse-patient contact and thus performing qualified and safe assistance.

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Emerging Research Innovations in AI, User Experience and Design

Thoughts on Design Education's Future

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Abstract. The general design process starts with defining problems or understanding the target audience. The world is moving toward a more technology-driven society that is pushed by machine learning and artificial intelligence which is also called the 4th wave of the industrial revolution. From this, questions arise regarding how to prepare design students for this changing paradigm in their future careers. Creativity, critical thinking in decision making, and complex problem-solving skills are becoming essential in the era of the 4th wave of the industrial revolution. This paper presents personal perspectives based on the author's experience in the graphic design process over the last 30 years, starting with questioning the design process and methods that have been used in the design disciplines. The ultimate goal of this study is to open a dialogue, through a case study, on how to prepare students in this rapidly changing world and discuss the future direction in design education.

Keywords: Design education · 4th wave of the industrial revolution · Design process

1 Introduction

Technologies have influenced design disciplines since the introduction of mass production methods. Each industrial revolution changed the way people work, live, and communicate. Now, the world is moving quickly toward a more technology-driven society that is pushed by emerging technologies such as machine learning (ML), artificial intelligence (AI), robotics, and nanotechnology. These technologies are called the 4th wave of the industrial revolution [1]. The field of design is greatly impacted by technologies. The computer and the internet have changed the design eco-system, and the areas of design have expanded into various forms. Students who grew up with the computer, wireless internet, and smartphone, have changed in attitude toward the design process. Students heavily rely on the computer and information from online resources in the design process. Students are used to finding visual references from Instagram and Pinterest. In the classroom, when a theory introduced, students began to search for information online rather than focus on the lectures. Some students have questioned why they need to be in the classroom for the studio classes. Along with changed students' perspectives and attitudes in design education, online services based on algorithms such as autodraw (https://www.autodraw.com), and logo generator (https://www.tailorbrands.com/) allow non-designers to create logos and images

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without a computer skill or design knowledge. Because of these changing paradigms in the design field, questions arise as to how to prepare design students for their future careers. If future jobs are dominated by automation, then social and creative skills, especially in decision making and complex problem solving [1], will be essential not only for design students but also for other disciplines.

The ultimate goal of this paper is to open a dialogue, through a case study, on how to prepare students in this rapidly changing world and discuss the future direction in design education.

2 Design Process, Ideation, and Creativity

The design process has been emphasized in various design disciplines. The typical design process starts with an investigation of needs and problems [2]. Once the needs and problems are identified, the information gathering process and understanding the audience is the next step. In the design thinking process, empathy, which is understating the people, emphasized before defining the problems [3]. To understand the targeted people, various methods have been used, such as interviews, surveys, observation, focus groups, participatory design, and user testing. The following areas brought me a consideration on developing different ways to introduce class projects and assignments in my graphic design studio teaching.

2.1 Design Process

Machine learning (ML) and artificial intelligence (AI) can generate big data, which is used for understanding people and can be accessed in real time. Big data, which is collected from various sources, brings new ways of approaching the design process. But there are issues that need to be discussed, including privacy and challenges to data analytic capabilities. Big data is not just numbers, but also could be photos, emails, video, stories, tweets, and text messages that are digitized, analyzed, and stored [4]. In this context, big data will have a significant impact on the design process and the traditional methods used to understand people. Big data can help designers make informed decisions in real-time, and it will affect the speed of decision making.

The Super Bowl 2013 advertising stories of Coca-Cola and Audi are excellent examples for showing how big data can be used in real-time from responses on social media feeds. Modifications from the first ads were implemented in the second ads based on the reactions during the short time between them [4]. So, what are the impacts big data will have in the design process? Will the typical ideation process still be appropriate in the future?

2.2 Ideation

After identifying the design problems and the needs of the target audience, brainstorming for ideation starts in the design process. Brainstorming can be performed in group or individual activities. All ideas are welcomed in the beginning stages of brainstorming and narrowed down toward the final solution based on the identified design problems and the target audience. A mind map is one method that encourages students to show relationships between various ideas at the beginning of the design process. Design students seem more comfortable visualizing their ideas using a mind map that can include images along with words. Creative coding was introduced in the design fields, and it has already influenced various areas. If AI, based on ML, can generate thousands of possible design variables in a short period and collect necessary information in a short time, would brainstorming or mind mapping methods still be relevant in the 4th wave of the industrial revolution?

2.3 Creativity

It is not easy to define creativity, and many researchers in different disciplines are involved in this study. Kaufman and Sternberg summarize that creative ideas present something different, new, or innovative; need to be of high quality, and must also be appropriate to the task [5]. It is critical to bring new, different, and proper solutions to the problems.

Guilford's divergent thinking theories are known because they are associated with creativity. The divergent thinking factors that Guilford proposed were related to a person's ability to produce a large number of ideas, the ability to create a wide variety of ideas, the ability to generate unusual ideas, and the ability to organize the details of ideas [6]. In the design process, students are encouraged to try many different ideas and unusual risk-taking approaches. Heilman supports that breaking the existing theories, ideas, beliefs, practices, and products is essential to developing new ideas [7]. A good example of the unusual risk-taking approach is the challenge match played between AphaGo from Google DeepMind, and Korean world champion Sedol Lee in 2016. It is an excellent example of breaking the rules. Sedol Lee won one game and lost four games to AlphaGo. Lee won the one game because he played with unusual moves that he never used before. On the other hand, convergent thinking drives to find a single best answer. This requires knowledge, logic, and decision-making strategies [8]. According to Crople, knowledge is vital because "it is a source of ideas, suggest pathways to solutions, and provides criteria of effectiveness and novelty" [8].

If AI generates design ideas even without designers, what would be the role of creativity in the future design process? How does the designer decide between the ideas created by AI or ML? If 'disengagement and divergent thinking' [7] are the key for creativity, how do we encourage students to think differently or creatively? What would be a better way to educate design students if this knowledge is important for making decisions?

3 Case Study

While considering the above questions and divergent and convergent thinking, a project was developed for junior graphic design students. When students become juniors in graphic design at my institution, we expect that they understand design principles and elements as well as the typographic elements and rules from their sophomore year. During the junior year, students are encouraged to develop their own visual vocabularies based on the knowledge they obtained from the previous years.

In this studio project, which addresses the questions of divergent and convergent thinking, I reversed the design process to seek different approaches to design. The project is divided into two phases. Each phase was introduced one at a time to avoid any preconception of the second phase.

3.1 Design Phase 1

In Phase 1, students were encouraged to develop ideas without any of the constrains in the design process, such as considering target audience, design concept, or goals. As mentioned earlier, most junior graphic design students are familiar with the typical design process that starts with defining the design problems and studying the target audience before beginning ideation. Often, this design process prevents students from exploring risk taking approaches.

The intention of this project was to encourage visual expression without any limitations, such as defining the problems or needs. Students were required to explore visual vocabularies using various materials, not limited to digital or physical, without any consideration of design problems or target audiences. I told the students that my expectation of this project was to see unusual and surprising results. Students had a difficult time starting the project and requested some guidance. As a solution, one adjective and one noun, such as electronic rainforest, distinct tiger, and odd planet, were randomly created by students and given to students. Then the students had to explore visual expressions of the given word combination.

In the typical ideation stage, many ideas are required for a project. I did not require a quantity of ideas for this project. Instead, I encouraged students to explore different expression methods and materials that they were not familiar with or have not tried before. More than half of the students had a difficult time exploring the ideas without defining a problem and the target audience. The design process that students learned as sophomores seemed to influence the students' thought process, and it prevented some students from exploring ideas without constraints.

3.2 Design Phase 2

In Phase 2, after students created images using various media and materials, they were asked to apply one of the visual images to a relevant application. The purpose of this phase was to see how students can connect the visual images they created to practical applications. This phase required students to consider the purpose of the applications and define the target audience. The student who worked with the words "electronic rainforest" created a series of wine label designs. For the phrases "distinct tiger" and "odd planet," the students gave up on finding a way to apply the visual imagery they created in Phase 1. Half of the students chose to develop something else instead of using the imagery they created in Phase 1. I found that one fourth of the students considered a final design applications while they created the imagery, even though it was not required in Phase 1. Some students expressed that if they knew the purpose of Phase 1, they could have developed better ideas in Phase 1.

3.3 Thought on the Studio Project

The project was successful for less than half of the students. The expectation on the outcomes of Phase 1 was to try varies things and experiment. Students seemed uncomfortable with failing even though Phase 1 was framed as an exercise rather than a project, and I tried to make the experimentation fun and show that it was okay to fail. Also, I learned that it was not easy to break the knowledge that they acquired in the typical design process and make them think differently. Finally, some students were not comfortable with exploring visual images without any purpose or reason.

The results of this project led me to consider the curriculum of the first- and second-year design education: what should be introduced, how to explore different ways thinking, and how to encourage the exploration of ideas rather than learning design principles and rules. If I introduce this type of project to lower level students before introducing the typical design process, would they be able to explore ideas without hesitation or fear how the images will be used? With the coming new technologies that have been named the fourth industrial revolution, what would be the more important aspect for the design education? It will need significant debate on the future direction of design education.

4 Conclusion

In the last 30 years of my experience, the computer become a design tool and the Internet changed the way we communicate. Now new technologies bring new challenges. As a design educator, how do I prepare design students for the upcoming highly technology-driven society? In 1995, Papanek described the seven abilities that designers should have [9]. The abilities included "the capacity to develop appropriate answers to new or newly emerging problems" and "the talent to combine form-giving with rigorous technical considerations and with a sense of humane and social factors and aesthetic enchantment." Papanek's statement is still relevant to the current time period. Innovation will come from risk-taking approaches such as Sedol Lee's play against AphaGo. Also, organizing and synthesizing information will be critical in the decision-making process which involves the many different design options that are generated by algorithms, AI, and ML.

As Schwab mentioned in his book, The Fourth Industrial Revolution, creativity, critical thinking in decision making, and complex problem-solving skills are becoming essential in the era of the 4th wave of the industrial revolution [1]. The abilities of convergent thinking and synthesizing information, such as big data, as well as making the best decision will be more important in the future. However, the creativity to generate novelty will be critical for designers in bringing new and innovative solutions.

The question of whether design principles and rules prevent creativity or whether the knowledge of design principles and rules help creativity, I defer to future discussion.

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Locked Out: Engaging Design Students in UX and Access Design Processes to Address Homelessness in Los Angeles

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Abstract. The Design Department at California State University, Long Beach held an interdisciplinary design thinking and communication workshop, *Homeless in LA: Access Design for the Other 90 Percent*, on December 6, 2019. This workshop, facilitated by Ruki Neuhold-Ravikumar of the Smithsonian, was designed to engage a broad audience of stakeholders in a series of activities that explore the subject of homelessness in Southern California. This case study examines a collaborative approach to user engagement as a way to generate innovative strategies to address homelessness in our community and to communicate design ideas around this issue to a broad range of stakeholders.

Keywords: Access design · Collaboration · Connectivity Model · Design thinking · Innovation · Museums · Student engagement · UX

1 Introduction

Engaging students in cross-disciplinary activities that address societal issues is an important educational strategy. In addition, participating in significant learning collaborations with non-academic partners can be an effective way to introduce students to concepts and ideas outside the typical curriculum. While universities are often encouraged to collaborate with industry partners, our research has shown that museum collaborations bring a novel set of opportunities in the areas of education, storytelling, and engagement with societally-significant historical and cultural context.

The Department of Design at California State University, Long Beach held an interdisciplinary design thinking and communication workshop, *Homeless in LA: Access Design for the Other 90 Percent*, on December 6, 2019. This workshop, facilitated by Ruki Neuhold-Ravikumar of the Smithsonian, was designed to engage a broad audience of stakeholders in a series of activities that explore the subject of homelessness in Southern California. This case study examines a collaborative approach to user engagement as a way to generate innovative strategies to address homelessness in our community and to communicate design ideas around this issue to a broad range of stakeholders. The use of student-led brainstorming, classroom engagement, and a design sprint to engage large numbers of stakeholders in addressing

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the issue of homelessness in our community will be discussed. The specific methods, tools, UX strategies and outcomes of this unique event will also be presented. In addition, the application of these UX processes as an innovative strategy for community engagement, data collection, research, design thinking, and design communication around a range of community issues will be addressed.

2 Research Strategies and Frameworks

Courses from various programs contributed to data collection, ideation, and other research activities leading up to the workshop, including qualitative data collection processes to engage a large number of design students in brainstorming and idea generation. This process involved sophomores through seniors in DESN268 - History and Theory of Sustainability in Design, DESN300 - Designers In Their Own Words, DESN333A - Industrial Design Methodology, DESN431A - Senior Industrial Design Studio, and DESN481/581 - Designing for User Experiences, among others. These courses and their related disciplinary research strategies were integrated by developing and seeding brainstorming boards featuring the research topics of the workshop [1–4]. We posed critical access questions using a “how might we” model to deduce how access to sustainable food, clean water, technology, healthcare, education, and transportation impacts homelessness in Southern California. Students also used the Connectivity Model, a UX research model based on social, emotional, motivational and physical parameters, to assess and develop these concepts and the qualitative data surrounding these questions [5]. In addition, the gamification of relevant data acquisition on the topic of homelessness in LA was done via a series of “get the facts” posters displaying a large QR code corresponding to a factual news story on this subject.

The culminating experience of the UX data gathering strategies was a two-part design sprint workshop, *Homeless in LA: Access Design for the Other 90 Percent*. Students and other stakeholders were given the opportunity to form interdisciplinary teams and utilized the idea generation boards containing crowdsourced data on homelessness in LA and its relationship to questions of access. Participants engaged with critical thinking, problem solving, and prototyping strategies as they apply to design solutions for the complex homelessness challenges facing Southern California. They also learned communications strategies used by the Cooper-Hewitt Design Museum and the Smithsonian to create museum-quality stories around socially responsible design.

3 Pre-event Engagement Strategies and Crowdsourced Data

A planning committee of eleven people representing faculty from several design programs, at both the undergraduate and graduate level, together with staff from the Kleefeld Contemporary Art Museum met during the fall semester to plan the schedule and organize activities for this two-day event. Since our workshop was not mandatory, one primary objective was to find a topic that was compelling, relatable, and local so that students would be eager to participate. After a short brainstorming session, it was decided to focus on the issue of homelessness, which has affected either directly or indirectly many of the student participants due to the impact of homelessness on cities in Southern California and downtown Los Angeles in particular. The data supporting the relevance of the topic was significant. Online videos, personal stories, news headlines, not to mention startling statistics, all combined to offer a compelling, even heart breaking, topic. When pitching the idea to students, it was confirmed that many of them could relate personally to the topic of homelessness. One student remarked that he had friends who were homeless while another divulged that he had been homeless and was currently living part-time in his van parked near campus. When asked if this was a problem they would like to address and solve creatively, they replied positively without hesitation. This was further validated by the university's own data on homelessness and food insecurity of the student body at CSULB.

Preliminary design thinking activities were conducted for two weeks prior to a campus lecture and workshop event. The strategy for these activities was to create a variety of engagement methods that could be used simultaneously across all levels of students in the department, from sophomore through graduate students, as well as with students and faculty from other disciplines and members of the community that share our common spaces. Crowdsourcing was used as a primary data collection and ideation strategy. Two basic data collection strategies were used. In one, whiteboards were placed in academic hallways and monitored by students who encouraged all people passing through the space to contribute to the data collection by adding new ideas or by responding to ideas already on the boards. This data collection process was able to capture a wide variety of responses by taking place in areas accessed by a diverse array of students, faculty, and community members. The second crowdsourcing strategy was implemented by placing the whiteboards in specific classrooms with subjects including history and theory, industrial design, general design, user experience design, and drawing. In order to facilitate the range of academic subjects, faculty were given topics and encouraged to tailor their methods to fit the academic ability level and knowledge base of their students. This allowed the individual course instructors to facilitate discussion and collect data in keeping with their own disciplinary research approaches and methods.

One data collection session challenged a class of junior industrial design students to break into small groups and ideate on three topics related to homelessness in LA: How might we ensure people's access to safe and affordable housing? How might we address access to safety? How might we address access to food? In groups, students engaged in rapid divergent ideation with the whiteboard. After time ran out, students moved to different boards and expanded upon the ideas already developed or developed new ones.

Students from DESN431A – Senior Industrial Design Studio participated in an extended open discussion, brainstorming, and idea generation session to address homelessness in our community. The session was subdivided in five critical access categories: housing, transportation, food, healthcare, and education. Students were organized in a single discussion group and each category was addressed as an open question or challenge. The initial data and documentation regarding homelessness in the city of Los Angeles came from CNN and Vox [6, 7]. Students analyzed the website documentation and testimonies, discussed the information openly, then they started to brainstorm and to collaborate to generate ideas that were collected on a brainstorming board (Fig. 1). During the brainstorming session some additional new sub-categories were created, such as hygiene within the housing category. Students discovered that the lack of public restrooms is significant in the Greater LA area, and in some cases it forces the homeless population to defecate in alleys or near the river, which contributes to the spread of diseases. This prompted our students to brainstorm design-based solutions such as "temporary-modular" "Lego-type" facilities that could deploy rapidly instead of a formal "brick and mortar" solution that takes months or years to implement. This type of approach would be explored further later during the main workshop activity in which participants created innovative prototypes.

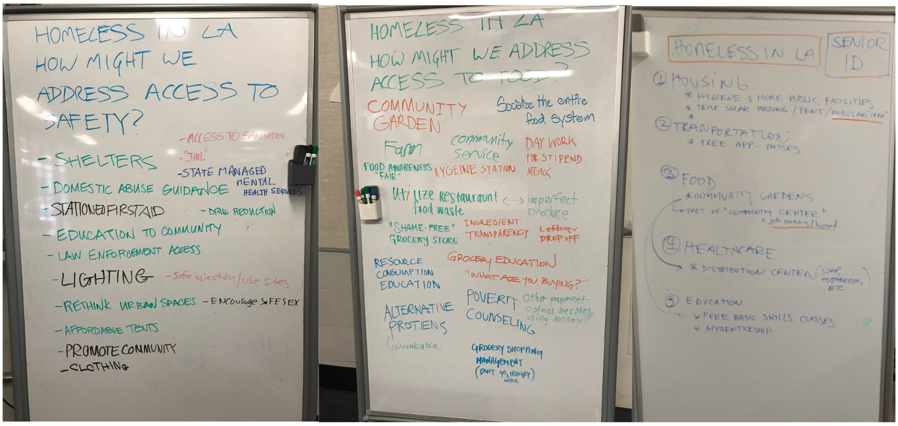

Fig. 1. Data collection from students utilizing portable whiteboards and prompts

In the transportation session students discovered that most homeless people use smartphones, which in principle offers them a way to connect directly with city services such as public transportation and could be used as a way to identify and to find bus routes. The city could even cover the cost of each ride through RFID identification or similar technology. Students were concerned with sustainability and community issues during the food session and proposed community gardens as a way to make local residents participate in the production of healthy food and vegetables not only for themselves but also for those experiencing food insecurity. In the healthcare and education sessions students discussed the need of a local distribution centers where homeless people can receive toothbrushes, soap and other toiletries for free and which could also serve as training centers for basic skills and local apprenticeships.

In addition, the gamification of relevant data acquisition on the topic of homelessness in LA was done via a series of "get the facts" posters displaying a large QR code corresponding to a factual news story on this subject. The fact posters were designed to have a simple heading and a large QR code for students to scan using a cell phone. The posters were displayed on walls prior to the event and were put onto the tables for participants to access during the workshop. On the day of the event the "get the facts" QR codes were also put onto stickers designed by Joshua Ian, a student in the Human Experience Design Interactions graduate program, to have a nostalgic, gaming vibe using a video game visual semantic and reflective adhesive paper. The interesting video game shapes were cut out and put onto the workshop tables for participants to discuss and take home. These became something of a collector's item over the course of the event, with participants trading rare stickers to create sets and to collect their favorites (Fig. 2).

Fig. 2. Gamification elements of the pre-event engagement activities and workshop takeaways

4 The Duncan Anderson Design Lecture Series and Workshop Series

Now in its tenth season, the Duncan Anderson Design Lecture Series is a platform for inviting diverse creatives from many fields to California State University, Long Beach. These speakers, including nationally-recognized designers and architects as well as local entrepreneurs, activists, and filmmakers, interact with students, faculty, the community, and other creative professionals. A coproduction between the Duncan Anderson Endowment and the California State University, Long Beach Industrial Design Program, the lecture series provides intense and focused evenings that consistently leave a lasting imprint on the culture and mindsets of the campus and community at large.

To kick off the tenth season, the Duncan Anderson Design Lecture Series launched a special Workshop Series for the first time to provide participants with lengthy immersions into important and creative topics. While the lecture series is well established and effective some speakers and subjects naturally lent themselves to offering a more immersive and hands-on experience. After first experimenting with offering short workshops following the lecture we discovered that our three-hour class period limited what we could achieve. The solution was to ask our guest to stay over an extra day so that a topic could be introduced on a Thursday night and the follow-up workshop could stand alone on Friday – a day when faculty, students and facilities are available for extra-curricular events.

An interdisciplinary team of faculty from different programs collaborated to organize a coordinated lecture and workshop using UX and access design approaches. Ruki Neuhold-Ravikumar, Interim Associate Provost for Education and Access at the Smithsonian, was invited to present a lecture as part of the Duncan Anderson Design Lecture Series. Her presentation, *Unexpected Creativity – Designing in Technical Sectors,* was followed by a day-long workshop entitled *Homeless in LA: Access Design for the Other 90 Percent* led by Ruki Neuhold-Ravikumar and Meagan Mahaffy from the Copper Hewitt, Smithsonian Design Museum. The workshop focused on the issue of homelessness in our community by posing critical access questions to frame the issue via the roles of access to sustainable food, technology, healthcare, clean water, education, and transportation.

Both events took place in the Duncan Anderson Gallery within the Department of Design at CSULB. The workshop incorporated the data generated by the pre-event engagement activities, which also served to promote environments of awareness, discussion and creative thinking around the topic. Neuhold-Ravikumar and Mahaffy led participants through various design sprints and design thinking activities. They employed gamification in the form of divergent and convergent thinking utilizing a Scattergories format and Mad Libs-style brief generation. Participants also engaged in rapid prototyping sessions with an access design wild card introduced mid-round in the form of new users with a range of abilities (Fig. 3).

Fig. 3. *Homeless in LA: Access Design for the other 90 Percent* rapid prototyping, inclusive design, and access strategies.

5 Analyzing the Event, Experience, and Tools

The pre-event engagement, crowdsourced data collection, lecture, and workshop generated a tremendous amount of data, significant ideation, and numerous prototypes addressing various issues related to homelessness and issues of access. A broad range of students, faculty, and members of the community participated in this educational outreach event. Approximately 200 students from various courses contributed to the pre-event data collection, and 80 individuals attended Neuhold-Ravikumar's lecture. The workshop accommodated 60 participants, with Kleefeld Contemporary Art Museum staff and docents, Osher Lifelong Learning Institute participants, and other interested community members working together with graduate and undergraduate students.

The use of vertical brainstorming boards as a tool to organize and to document student discussions was effective and significant. It allowed students to focus on specific categories but also to keep an eye on the overall picture. These brainstorming boards were later brought to the main workshop activity where they served as a starting point for discussion and also helped the workshop participants to collaborate and to understand the previous research before they worked on their own prototype solutions. Many ideas generated on these boards were later integrated into the prototypes developed during the workshop. Strategically ramping up for two weeks before the event helped to get the word out and build interest and the level of enthusiastic participation in class exercises and whiteboard crowdsourcing interaction only confirmed that we had selected a relevant subject.

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A New Approach for Experience Design Education: Developing Conceptual Framework with Storytelling

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Abstract. This study is to introduce a new approach for the UXD (User Experience Design) pedagogy for graphic design students to expand their critical thinking for user-centered design. A variety of UX/UI (User Experience/User Interface) disciplines has been introduced into design education, but a single class and/or elective course appears to be inadequate to keep up with rapidly changing technologies and services for user experiences. Given the limited time and condition for graphic design students to learn various UX/UI disciplines beside required other studio coursework, this study investigates an effective learning model of UX/UI pedagogy approached by developing the UXD conceptual framework with storytelling in the design thinking process. This study found an impact on students' learning outcomes that demonstrated new paradigm-shifting significant perspectives of the user's experiences beyond visual design.

Keywords: UX design pedagogy · UX/UI conceptual frameworks · UX/UI storytelling

1 Introduction

UX/UI (User Experience/User Interface) design has become an essential learning discipline in various design academic programs. Over the last 10 years, various academic design programs and curriculums have been restructured by a high demand of the industry workforce and environment. Even though hundreds of books have also addressed "User Interface Design," the term of interface has been falling into disfavor [7]. This is because other new buzzwords have been replaced by academic programs and industry working position during this shift with a new term "Experience Design (XD)." However, UX/UI disciplines in design education have not been yet articulated for learning objectives clearly, but many design academic schools offer or look forward to adopt the new interdisciplinary and cross-disciplinary programs on campus. Because of this phenomenon, graphic design students may have great advantages to learn beyond within their disciplines. Nevertheless, this dynamic change needs to be discussed first and then clarified for inclusive and exclusive learning contents to identify a learning objective and outcome. Therefore, this study aims to investigate a comprehensive learning model of UX/UI design method and process which directs design fundamentals for understanding user-centered design precisely and broadly.

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2 UX/UI Design Pedagogy

This study discusses students' learning acquisition in UX/UI discipline through the major graphic design course (GRC 470 Design and Media Studio IV) at the University of Nevada, Las Vegas (UNLV). In the Spring 2019 semester, twenty students enrolled to pursue their first learning experience for UX/UI design. In order to approach the empirical practices, this course began with various case studies where students were able to learn a basic of UX, UI, Visual Hierarchy, User Flow, and user-centered design with products. Despite various case studies for 8 weeks, students were faced with significant challenges for demonstrating problem-solving process due to the situated, complex, and messy nature of the UX/UI work [4]. The most common problems were caused by a lack of understanding of the difference between UX and UI. The common interpretation of the UX and UI terms from many experts were; UX design refers to measuring, analyzing and evaluating user behaviors and human emotions with effective interaction through UI design [1]. The term UX and UI are often used interchangeably, but they should be distinguished between product function and visual elements in UI design [3]. A quote from Rahul Varshney [12], "A great experience starts with UX followed by UI," can be interpreted that UX design is a process of enhancing and improving the usability, ease of use, and pleasure of interactive communication between the user and the product [5]. However, most students had difficulties to understand specific aspects of user experience without accumulated concept development based on the user-centered design. Due to this problem, most topics on UX/UI design for that semester were related to the smartphone apps for contents delivery.

Another issue appeared as a significant limitation of the learning opportunities for graphic design students. Approach for facilitating interaction design between the users and products is not easy to understand for them in terms of a lack of learning experience in product or industrial design fields. In opposition to this situation, students in product design or other majors may have limited opportunities for learning the depth of visual communication in UX/UI design, especially user interface design with a variety of graphic or visual contents and information. Moreover, teaching UX/UI has become a complex interdisciplinary and cross-disciplinary in terms learning objectives between theoretical and practical approaches. Getto et al. [2] also claimed that many of design education are shifting UX/UI core values to UX competencies in order to overcome barriers of producing job ready UX designers. Furthermore, content strategy, information design, and usability as how the product function may or may not interact with users properly and effectively is highly considered rather than developing visual elements in cohesive design value.

3 Adoption of a New Experience Design (XD) Pedagogy

After discovering two major issues from the previous semester, a new design pedagogy was adopted to enhance students' design ability and competencies in UX/UI design. The new course instructions introduced Experience Design (XD) for interactive communication between product functions and user behaviors. Twenty (20) new students were challenged by the new instruction with various learning comprehensive tasks to analyze users and user-centered design, as well as the opportunity to develop a conceptual framework through a storytelling process. There was a total of 10 phases comprised of the progressive learning and practice. Each phase reiterated a specific discussion and constant questions through a small group and individual meeting. Table 1 shows a brief summary of learning objectives and students' learning activity in each phase. Since the design process was broken down into different time lengths but the number of problem-solving and revision tasks accumulated as students moved onto further steps. The official group critique was set in week 12 where students completed the task and visual design outcomes, but the revision process was also required to call small group or individual meeting for the further feedback. According to Laseau's overlapping funnels of design process [10], too much concern for quality too early for an effective usability may result with a negative effect in design learning process. Usability has nothing to do with different interfaces when the users knows how to use a product, but the quality of each user's experience can be different by the result of conscious design during the user's experience.

Table 1. A list of 10 phase in UXD Pedagogy

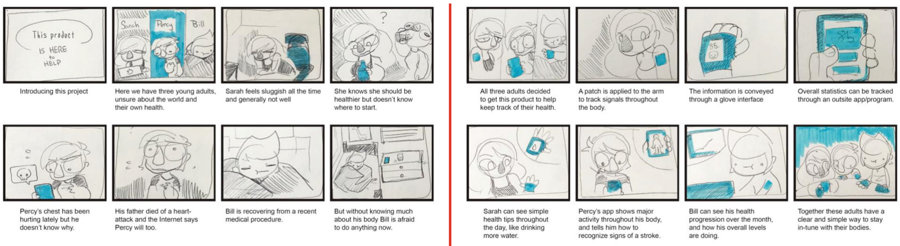
Phase	Learning task	Schedule (Week)	Design concept development
1	Research proposal	W1	Effective healthcare/medical system
2	Storytelling map	W2 ~ 3	Visual narrative explaining user and product interaction
3	Branding	W4	Branding characteristic and consumer communication
4	Product design	W5 ~ 7	A new product function for user' demands and needs in their daily healthcare activity
5	App prototype	W8 ~ 9	Interactive communication between user and device
6	Usability	W10 ~ 11	User study through visual perception and cognition
7	Middle critique	W12	Presentation and two large critiques for peer reviews
8	Revision	W13 ~ 15	Revisit product and app visual design and function
9	Video presentation	W13 ~ 16	Conceptual framework through a short video narrative
10	Poster presentation	W14 ~ 16	Research and Process with a solution

3.1 Pedagogical Initiatives

The new pedagogical initiative was designed to show the effective learning outcomes with a conceptual framework compared by the previous semester. A subject matter, "Develop A New User Experience on the Healthcare/Medical System," assigned students to develop any current or near future products and/or services for the interactive user experiences. The attention to interchanged relationships between user and product, especially the term of "Experience Design," includes an importance of both aesthetics and functionality roles under the consideration of the affordance design [9] and user experience with everyday products [11]. Therefore, this study demonstrated an enhanced funnel of learning to increase students' awareness of the user experience in a variety of aspects of user's environments. Each phase was set with the goal of the successful learning, but the design process was repeated in terms of the revision of the conceptual framework and its development based on storytelling accuracy [6] and [8].

3.2 Development of Conceptual Framework in Storytelling

With a proposed design problem statement for the individual subject matter, each student experimented not only for developing design concept with visual design, but also for analyzing a user and user's working/living environment. Figure 1 is an example to show an outlined situation as the major target audiences are currently faced with a healthcare problem/issue. Students approached the persona research in order to bring attention to other potential users who may have same or similar situations.

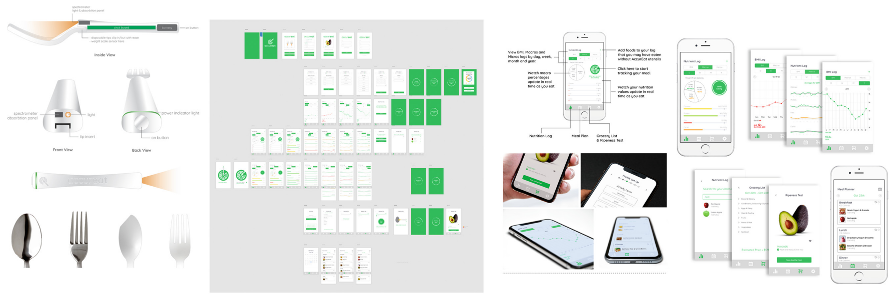


a. Identifying a health issue b. Proposing a new product concept for user(s)

Fig. 1. An example of envelopment for conceptual framework in storytelling, created by Caitlin DeCuir: identifying a health issue/problem with a major target audience (left), and addressing a proposed narrative for the new product design with form and function for helping or assisting user(s) (right)

From the early stage for developing design concept with a storytelling, students collected a variety of feedback and suggestions from peers in the proposal presentation. With successful completion of this task, students spent more time to develop design concept of user-centered interaction between user behaviors and product functions.

Figure 2 is an example that students completed visual design mockup that explained product function and form based on proposed healthcare system. For the development of app design, students were required to measure and analyze various perspectives of users' environment and situation as how they may or may not be comfortable to interact with product functionally and ergonomically. Moreover, prototype app was tested by class peers in order to find any errors and mistakes of visual contents and UI through user experiences. Students were required to give various feedback from their learning experience and this activity is not yet met for the accurate professional usability testing process and measurement, but it brought great attention to students for understanding an importance of expanding critical thinking in user interaction with product and its function.



a. Product Assembly b. User Flow development c. Interactive App design

Fig. 2. An example of product design with visual mockup created by Samantha Meredith: graphic rendering for product assembly with product function (left), user flows and application (middle), and interactive working prototype App design (right)

3.3 Design Examples from Learning Outcomes

The final presentation was comprised of two mediums, 1) poster presentation and 2) video presentation (Fig. 3). The poster presentation addresses the design process and outcome as how the UX concept was developed. It also emphasized the visual design to show how it unifies the product function and visual appearance for being user-friendly. The video presentation focused on delivery method of a narrative for user's experience as how the product interacts with users. The video also demonstrates a virtual or hypothetic product mockup for the major function helping or assisting users through the other digital applications. With all revisions and additional design contents, students demonstrated with research presentation to public target audiences and continued the instructor's website (https://seodesign1.com/xd).

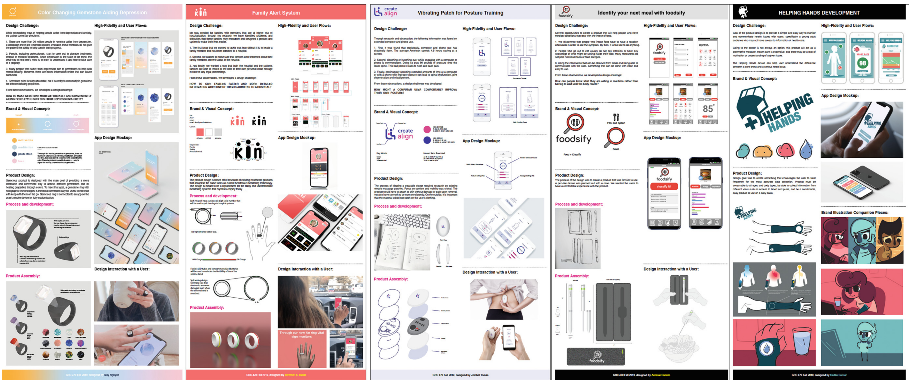


Fig. 3. An example of final poster presentation: created by (ordered from left to right) May Nguyen, Terrence Ozaki, Jomhel Tomas, Andrew Oudom, and Caitlin Decuir

4 Findings and Discussion

This study found significant difference of productive density in learning outcomes between two semesters. Exercises with a case study was not much effective for helping students to expand their critical thinking within development of design concept for user-centered design. However, the new design pedagogy for development of conceptual framework through storytelling process shows that students' learning outcomes to be more effective as a successful learning acquisition where most students appeared with great working efforts and positive learning behaviors. This study also found that gradually gained learning interests through more group discussions and brainstorming is a key for self-directed learning in UX/UI design which students will be acquired to act as UX designers in working environment. This manner is also importantly connected to the designer's ability and design capacity when they begin with analyzing user's needs, measuring design function, and evaluating design value for user-friendly and effective usability of the product and service.

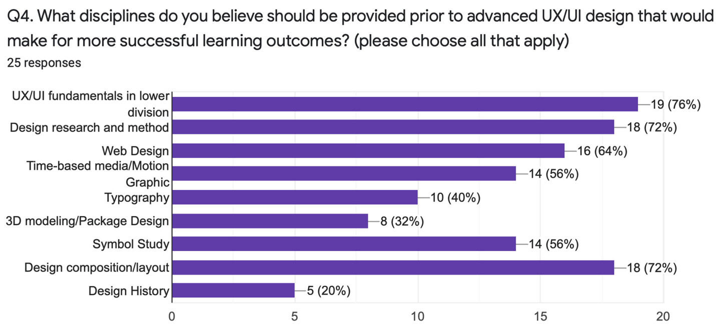


Fig. 4. Survey result of preferred prior disciplines for UX/UI design

Figure 4 shows a result of a survey for preferred disciplines prior to taking UX/UI design. Among 25 participants (5 from Spring 2019 and 20 from Fall 2019), it shows another lower division UX/UI design and design research & method disciplines were highly demanded by students at the end of the semester. Through the exit interview, most students feel that UX/UI learning is different from other visual design studio, but it should be distinguished with other disciplines in terms of importance of understanding how design works for users rather than how users feel about the design. This study also claims significant limitation of demonstrating user testing for user evaluation in design education. Even though development design problems and errors through the usability testing is an essential task for UX/UI design, the academic environment is very limited time and resources to deliver accurate information and practices during a class activity. However, this study found that constant group discussions are extremely helpful for students to expand their critical thinking broadly and effectively through each task. Students also learn more about relationship between product function, user's perceptive behaviors, and interactive communication between users and products. This study concludes that students learning outcomes and their learning acquisition of UX/UI design was more effective and positive with developing conceptual framework with storytelling.

Acknowledgments. The author wishes to acknowledge students who participated in this study. Their working efforts and agreements for using their learning outcomes in this study have contributed great value for improving a new UX/UI design pedagogy in the graphic design program at University of Nevada, Las Vegas.

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Creating Socially Conscious Designers Through the Lens of Empathy

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Abstract. It is a graphic design educator's responsibility that undergraduate students understand the needs and wants of society. Beyond printed matter and digital interfaces, designers have the ability to assist people in remaining active, independent individuals in society. Using several user-experience testing methods including attitudinal and behavioral testing and qualitative research, students completed a social impact project through the lens of empathy. Looking at different perspectives from a wide range of people who might be touched (or not) by their topic, and considering their thoughts as potential insights was essential to a successful project. Through in-depth meetings and design research methods, student teams developed a problem statement related to their chosen topic, which was used for the development of the brand and all of the other design decisions through the project completion.

Keywords: Human centered design · Design education · Empathy

1 Introduction

Art Director and design critic Steven Heller once said, "*Consider the contemporary debate about design's social role and designer's social responsibilities. Today's designers are sometimes blamed for contributing to the wasteful excesses of our globalized consumer society* [1]. Heller's quote is a powerful one, because many external of the design profession do not realize that there is more to design than the logo on your cup or the advertisement on the wall. Design can also be used to improve lives and make the world a healthier place. According to IDEO, "Design can improve the lives of people in poor and vulnerable communities."

Using several user-experience testing methods including attitudinal and behavioral testing and qualitative research, students in an ART 305 Editorial Design course completed a Social Impact project through the lens of empathy. Students began the project by doing a speed dating exercise, where they interviewed one another, identifying their strengths as designers, and passions as individuals. The project topic was left up to the individual student groups–however, some requirements were that the topic needed to identify a need for change (change of view, delivery of message, new ideas), and it needed to be local to the community.

Following the speed dating exercise, they paired with two or three peers who they felt they would work best with, identifying key stakeholders. Using these stakeholders, they created a series of archetype cards based off of the bell curve, looking at two

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extremes keeping in mind that designers need to consider everyone when designing, not just the target audience. Looking at different perspectives from a wide range of people who might be touched (or not) by their topic, and considering their thoughts as potential insights was something that was required for the project to be successful.

After a series of in-depth interviews, research, and classroom critique and discussions, student teams developed a problem statement related to their chosen topic, which was used for the development of the brand and all other design decisions. Students produced and presented final concepts at the end of the course in the form of a printed book.

This paper will focus on the project guidelines, design research methods used, learning outcomes, successes and challenges of group work, and project visuals.

2 Human Centered Design

After seeing the need to introduce human centered design into the undergraduate graphic design classroom in a more in-depth research-oriented setting, a Design for Social Impact project was developed. The project was created to examine how the design industry can play a larger role in the social sector. Through design thinking, students work with the concepts of human-centered design and how this approach can allow them to become more engaged in the community by creating innovative, effective and sustainable solutions to persistent social problems. This project helps students learn the power of collaboration with one another and other organizations and groups.

Students were to step into a more immersive project which required outside research which helped foster the concept of human-centered design. The class utilized IDEO's recommendation on the human-centered design process, which consists of three phases: *1. Inspiration Phase*: where students learn directly from the people they are designing for as they immerse themselves in their lives and come to deeply understand their needs. *2. Ideation Phase*: they make sense of what they learned, identify opportunities for design, and prototype possible solutions. *3. Implementation Phase:* they bring their solution to life, and eventually, to market [2].

3 The Project Brief

The six-week project involved four separate phases of investigation, inquiry, and design. By the time the projects were completed, students were to be experts on the topic.

3.1 Part One: Archetypes

The very first part of the investigation and research phase students were to identify the key stakeholders using a bell curve. When using the bell curve of archetypes, it was stressed that the center is not really the sweet spot. The center is full of average people, and while there are probably a lot of them, they usually do not yield the most insightful feedback or conversation for the investigation they were trying to achieve. The center shouldn't be ignored, because they are the majority, but it is the extreme ends of the curve that yields the most insightful feedback in the design research phase. Why archetypes? Developed by swiss psychiatrist, Carl Jung, the archetype represents the idea of a person, not the person himself. The traits and strengths attributed to the archetype serve as a general description of the overall persona more than as a definition of the traits of a single person. The employ of archetypes is useful tool in story-telling, as the archetype helps a reader to personify an idea without making it personal [3] (Fig. 1).

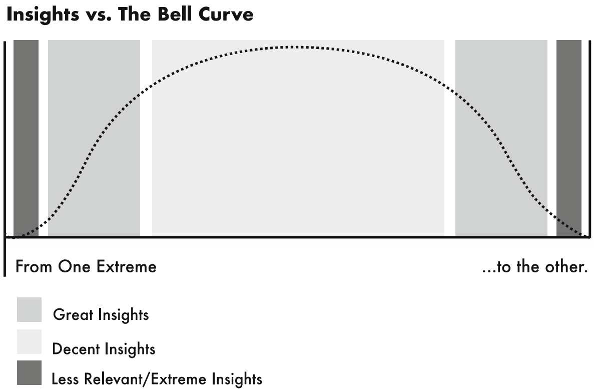

Fig. 1. From one extreme (*darker, less relevant/extreme insights*) or two kernels at *xi* and *xj* (*left and right*) lead to the same summed estimate at *xs*. This shows a figure consisting of a bell curve with two extremes (*less relevant/extreme views*). 'The great insights are those that fit in between the middle, average person, and the extreme views. For the part one deliverable, students were to design and print cards based on stakeholders as identified by the bell curve. Because cards have the ability to live individually, yet still working as part of a set, it gave a unique solution to identifying their personas. The order of cards can be shifted–being added to or taken away, which can affect meaning. Additionally, as a field of information, cards can contain a good bit of data (and art). The format of the cards was up to the student group however, it should have some relevance to their topic and both sides needed to be designed. One side of the card needed to have an image depicting or identifying the archetype. The image didn't need to be a headshot – but it did need to have some type of identifying trait (e.g., imagine a set of cards with pictures of shoes as the identifying trait. Which card would be the Politian, and which would be the cowboy?).

Each card needed to identify at least five specific traits that personify the archetype. Each card needed to have a name of a "handle" (e.g., "Martha" or "the busy mom"). There needed to be two archetype cards that fell outside of the audience spectrum as the extremes and they needed to be differentiated in some way. These would be people very invested in the topic, but have such strong opinions that cannot be swayed another direction. They're passionate about the topic in ways that the average person may not be able to identify with. One topic a group selected was the traveling circus. For this particular group, they identified two extremes on the spectrum as an animal activist involved heavily with PETA and the circus owner. These people would both be passionate about their reasonings, and both have very valuable reasonings behind their beliefs, and it would be very difficult to sway their opinions.

3.2 Part Two: The Research

The research phase required a lot of investigation work. Students were to find journal articles with solid, powerful statistics involving their topic. They were to immerse themselves in the topic by stepping outside the comfort of the classroom and into the community. In addition to the paper, they were to identify, physically meet, and interview local key stakeholders. Combining the information, they gathered from their interviews and articles, they wrote a research paper with their findings.

3.3 Part Three: Through the Lens of ____________

By this stage, students had identified and interviewed key stakeholders, created archetype cards based off of the bell curve, and conducted written research. The third part of the investigation stage was for them to create four additional archetype cards in the lens of empathy. They were to view their topic through the lens of someone from a list provided to them. This helped open their eyes to an entirely different way of approaching the topic. The list is below (Fig. 2):

Environmentalist	Painter	Sculptor	Fortune teller
Politician	Prisoner	Celebrity	Therapist
Businessman	Urban Planner	Social Worker	Waiter
Ethics Professor	The “Public”	Pet	Lawyer
Religious Leader	Folk Singer	Medical Doctor	Rap Artist
Elderly person	Child	Government Employee	Activist
Musician	Pro-Athlete	Handicapped person	Police Officer
Historian	Journalist	Terminally-ill patient	Teacher
Scientist	Homeless person	Farmer	Flight Attendant
Paparazzi	Carpenter	Security Guard	Cab Driver
Mother or Father	Basketball Coach	Sister or Brother	Hair Stylist
Biker	Gang Leader	Janitor	Pastor

Fig. 2. Table of recommended additional archetype personas.

Students were to create a rich dialogue with these people and embody the voice of the subject, and speak on its behalf. They weren’t to personify the archetype through a specific person (e.g., Barrack Obama), and instead keep the subject on an archetypical level. However, they were to “become” the subject to the extent that they could express its insights or experience from the perspective of “I.” (“As a janitor, I feel …”.)

Through this process, they were to consider the intellectual, spiritual, temporal, cultural, ethical, emotional, or physical responses to their topic from each of their archetypes. These should be rich responses, not just one-sentence captions. They could pose the topic to your archetypes in a number of ways (man-on-the-street interview, survey question, dinner-table conversation, etc.). For example, “Q: As a janitor, what makes you feel ___? A: I’ve never thought of it that way. From my perspective.

They were to use the same design as they did for their other archetype cards. On the one side of each card they were to include: “[Your Subject]: through the eyes of ___.” This could be worded in any number of ways, including “_____’s take on ___.” or “What ___ thinks about ___.”

It is after this third phase that students then propose three problems and three differing and unique solutions that they will consider developing.

3.4 Part Four: Design

It is when after phases 1–3 are complete that students then propose three problems and three differing and unique solutions that they develop for their final project. The three designed pieces needed to work together as a graphic design system, yet:

1. One piece must have more than one page (e.g., a brochure, catalog, magazine or website).
2. All three choices should have different formats; there can’t be 2 brochures, 2 websites, 3 books, etc.
3 None of the 3 pieces can have the same exact purpose or contain the same exact information. There shouldn’t be the same copy on a postcard and on a poster. Each deliverable should have a specific role in the system and should carry a different nuance of the message. A postcard might have a more personal message, while a poster might have a more generic one. Or the poster might make people aware of something, and the postcard might supply the nitty-gritty details (and a book might elaborate further and offer history and context).

Through a series of critiques in the classroom, students used the design process (sketching, roughs, comps, finals) to complete the assignment. The research and designs were compiled together in a nice printed book.

4 Outcomes

The project topics varied greatly from group to group–from lack of mental health resources on the college campus, to educating the public about the importance of the bee population and to help with the decline, to an awareness campaign about circuses and animal rights, and local postpartum education for both men and women.

The third phase was absolutely essential for opening students’ eyes and truly understanding the best method for reaching out to the public because it allowed them to view the topic through other people’s thoughts and reasonings.

For example, regarding the importance of the bee population and helping inform the public about their decline: a young child may not have been a prime archetype when considering the people on the bell curve–however, after viewing that topic through the lens of a child during their third phase, the student group found that designing solutions centered around the child as the target audience as a perfect solution. The problems that the student group identified with their particular topic were: lack of awareness, lack of education, and lack of knowledge on how to help once you do see that there is a problem.

The child could learn about the decline in the bee population in school through teachings from their instructor, they could bring home an assignment and stickers that also informs the parents. The stickers could have a link to a website where they could learn more information and order a bee waystation kit. The parents and child together invest in a bee waystation kit to help assist aspiring bee keepers in beginning their journey helping the bee population. The kits included seeds to plants that attract bees. The kits made it easy for the average person to play a very influential role in solving the bee problem (Figs. 3 and 4).

Fig. 3. Archetype card examples from the declining bee population group.

Fig. 4. Sticker designs, packaging for the bee waystation, and an informational website informing the audience about the declining bee population and resources of how to help.

5 Conclusion

In the beginning of the project, students struggled with not immediately drawing conclusions. Before selecting their topics, some of them already had ideas for problems and solutions. They were continuously pushed back into the phase they were currently designing for, and told not to bring those issues up until they were finished with all phases of the research. The way the project was broken up into phases, and only each phase being introduced at a time, really helped students overcome the need to find immediate solutions. It helped slow the pace and allowed students to truly investigate their topic more thoroughly.

For the most part, the completed projects were well developed. Ideally, more time could be spent in the design phase–as the way the project was set up, they only had two and a half weeks to complete the designs and compile them into a finished, printed book.

The Design for Social Impact project allowed the graphic design students to see that their designs can truly change the world–they just have to be patient in the research and investigation phase so that they find that they are truly targeting the right audience by considering the wants and needs of ALL people.

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AI Is the New UX: Emerging Research Innovations in AI, User Experience, and Design as They Apply to Industry, Business, and Education, and Ethics

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Abstract. Emerging applications of artificial intelligence (AI) such as: predictive software integrated into websites like Amazon Prime, autonomous features integrated into automobiles, or smart home technologies such as those found in Alexa or Siri, have an ever-increasing impact on business, industry, research, and higher education. New trends and innovations in the use of AI technology in design, user experience, and behavioral psychology will change how we design for user experiences, how we interact with technology and it will fundamentally change us as humans. Steven Pinker describes the 21st century as the "Conceptual Age." He says that we have progressed from the agriculture Age to the Industrial Age to the Information Age and now to the Conceptual Age. It is characterized by technology and globalization with an emphasis on creators, empathizers, pattern recognizers and meaning makers. This transition leads to the EQ-Based AI areas where those skills are a focus (Pink 2006).

Keywords: Artificial intelligence (AI) · User experience (UX) · User experience research (UxR) · AI-UX Design Model · AI technology · Behavioral psychology and AI · Flow

1 Introduction

AI will play an integral role in the design of most physical and virtual products, services, environments, and communities. The role that AI plays will be part of the interface and interaction of the design and will be coordinated with the physical, spatial, emotional, and social aspects of the designed product or system. There is a critical need for designers to understand how to design and implement the most appropriate AI into their specific situations by working closely with coders and those creating the underlying algorithms. Ethical guidelines will need to be created that ensure the formulas and weights are unbiased, accurate, and inclusive of the intelligence quotient (IQ) and Emotional Intelligence (EQ) components necessary to support the desired end functionality and to respect all human stakeholders. The AI-UX Design Model (AIXD) will be discussed with regard to how it supports these goals for the

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design of physical and virtual products and services using integrated AI as part of the designed user experience. AIXD will examine the roles of cognition, language, creativity, empathy and ethics as nuanced components in both weak and strong AIXD solutions.

2 Definitions

Working Definition of UX. In the discussion of UX, the uniquely human experience is the measure of ultimate effectiveness of the designed system. In his book, Flow: The Psychology of Optimal Experience, Mihaly Csikszentmihalyi notes that human experiences, which he refers to as flow activities, whether they involved competition, chance, or any other dimension of human experience needed to involve a sense of discovery and a creative feeling of transporting the participant into a new reality (Csikszentmihalyi 2008). This UX framework implies that as the challenge of activity increases so do the skills of the participant therefore resulting in a positive "flow" experience.

Working Definition of AI. AI is primarily concerned with making computers mimic intelligent or informed behavior based on a network of stored representations of the world. AI has a 50-year history as a discipline, as Haenlein points out, "…Established as an academic discipline in the 1950s, AI remained an area of relative scientific obscurity and limited practical interest for over half a century. Today, due to the rise of Big Data and improvements in computing power, it has entered the business environment and public conversation" (Haenlein and Kaplan 2019). Specifically, "Artificial intelligence (AI) [is] defined as a system's ability to correctly interpret external data, to learn from such data, and to use those learnings to achieve specific goals and tasks through flexible adaptation" (Kaplan and Haenlein 2019).

The authors wish to introduce the concept that AI is divided into two basic categories, *weak* or narrow AI that focuses on a specific task, and *strong* AI which takes on human characteristics of emotion and cognition. Weak AI is characterized by things such as using data to model expected behaviors such as playing a game against human opponents. Strong AI uses networked combinations of weak AI to build larger and more complex behaviors that can be used to approximate human cognition and emotion. Strong AI is characterized by reactive systems such as those that can play chess and limited memory systems such as autonomous vehicles that learn through observation and recent events or chat bots such as Siri or Alexa. In the future, strong AI will strive to achieve Theory of Mind, the understanding of the personhood of itself and others, and Sentience, self-awareness and self-actualization (Kumar 2019).

3 Cognition

I Think, Therefore I Am: Evolving Definitions of Personhood. From an ethical perspective, these evolving forms of strong AI will bring into question what constitutes personhood and the basic philosophical underpinnings of the "it" versus "thou" statuses. Jaron Lanier says that it is impossible to work with information technology without engaging in social engineering. If the "hive mind" is my audience, says Lanier, who am I? (Lanier 2011). In the realm of ethics, the boundaries of personhood need to be defined. The critical role of humans as identified in a "thou" relationship to non-human machines in the role of "it" is essential to the relative value and significance of human life. To give personhood to strong AI which behave as humans will essentially elevate the status of technology in ways that over emphasize inanimate traits at the distinct disadvantage of uniquely human traits. This fundamental human to machine value equation in the domains of intelligence and creativity is critical to humanity and society.

4 Language

Language as Social Engineering. Language is extremely important with regard to culture and an appreciation of the history and nuances of a society. When our language changes we change. Our words reflect our shared values. An interesting example is the word 'friend.' The definition for 'friend' includes an emotional closeness, trust, and a bond. Friendship was something earned and nurtured. It was both powerful and all-consuming as well as fragile and in need of nurture. It had emotional value and a personal significance. When the social media giant Facebook chose the word Friend to indicate linked nodes in their database of clients, the original meaning of the term lost most of its emotional implications and was reduced to a banal reference to acquaintances or insignificant associates. It blurred the line between a human emotional state and an algorithmic condition. The same is true when we apply the word intelligence to an algorithm-based computer interface. Even the addition of the term "artificial" to the phrase artificial intelligence 'misappropriates' a human emotional condition by applying it to a mathematical case in a condition statement. AI in its many forms is not designed to encompass the same richness and nuanced conditions as the human brain naturally produces. Additionally, the human brain lacks the capacity to compartmentalize and focus thoughts in the utter isolation that is consistent with many forms of artificial intelligence. Therefore, to use the term intelligence in such a broad fashion convolutes the terminology and conflates the assumed capability of machines while significantly devaluing the broader abilities of the human brain. There is an implicit presumption that transactional speed and precision are of a much greater value than a broad, contextually nuanced understanding of emotional associations, intuition, personal or institutional memory, and other criteria.

The use of natural spoken language as an interface for user experience is intuitive and direct. However, a consideration when we create AI that engage with us using language, we create a type of social engineering that will change our human communication and by extension our organic human intelligence. In the age of IoT, people can also be changed by interactions with AI technologies. When we interact with a computer using the same type of language and modalities that we use to interact with humans, people are forced to accept that a computer is in ways human. We have essentially blurred the line of personhood and machines. In addition, when data is collected from a vast array of people using crowdsourcing it suggests that an anonymous crowd is in effect a human organism with a legitimate point of view. According to Jaron Lanier, we should instead seek to inspire individual intelligence beyond what a formula can deliver. Personhood, says Lanier, is a quest, a mystery, and a leap of faith (Lanier 2011).

5 Creativity

AI and the Role of Human Creative Potential. While intelligence is different from creativity in many fundamental ways, the question of what happens when we rely on machine learning as a primary driver for information, communication and innovation. Mark Runco, in his research on creativity, says that all people have creative potential. However, the degree to which this characteristic might apply to AI is unclear; if it applies at all. Creativity, says Runco, is extremely valuable to individuals and to society as a whole. He relates it to productivity, adaptability, and health as it applies to individuals, institutions, and societies. Creativity as a critical driver in society is described in terms of creative performance, creative potential, creative behavior, creative personality, and creative products. However, actual creative performance requires motivation, ego-strength, and in some cases an expert level of domain specific knowledge. It is easy to see how in-depth knowledge might be a characteristic of AI, but it is less clear how the same AI might approximate motivation and ego; two distinctly human traits. Creativity says, Runco, is associated with originality and defined in terms of statistical infrequency. It is related to but not the same as intelligence, but it is more a form of self-expression that engages in both problem finding and problem solving" (Sternberg et al. 2004).

Creative Versus Generative. Creative genius in humans is a process of flow where the designer finds both challenge and frustration as well as intense gratification from the iterative process of generation, creation, evaluation and implementation. Acclaimed graphic designer, Ivan Chermayeff, in discussing visual design is quoted as saying, "If it's still ugly, you just haven't repeated it enough." In a July 2014 interview with "Fast Company," Chermayeff described his creative work as having tremendous volume and executed quickly mostly with cut and torn paper. When the work didn't suit him, rather than try to correct it he would throw it into the garbage can. "I can't sit still no matter where I am. Even if I am lying on the beach in Cape Cod, I'm arranging pebbles in the sand, it's always play. Play is a very good word for my attitude, even towards making a symbol that has to stand for a company–arriving at that symbol is still a form of play" (Dunne 2014). When addressing the creative process in AI, it might be more accurately described as generative rather than creative. Because AI has a distinct advantage in access to a depth of domain specific knowledge, its ability to be incredibly iterative and prolific greatly exceed the human capacity in this area. However, the ability to contextualize the significance of any single iteration is only as good as the connected human stories in the data. Because crowd sourced data suffers from a distinct lack of individuality and idiosyncratic context, the richness of a single human offers greater capacity for societal connectedness and authentic individual experience. The uniquely human traits of a lived experience, ambiguous associations, intuitive thought and illogical or whimsical notions align more closely to creativity than do the vast, yet programmatic iterations of an algorithm driven generative machine process.

6 Empathy

Equality for All Unless… In vetting the qualities of the next AI, decisions will be made with regard to what characteristics will be included, what variables will be used? Runco suggests that a cognitive integration model may be used to create a cognitive creativity model. The model is designed to address an open-ended decision-making situation where the solution must consider cognitive and behavioral variants. He posits that the equation would look something like:

$$\text{Decision} = \text{Factor}\,1(\text{A}) + \text{Factor}\,2(\text{B}) + \text{Factor}\,3(\text{C})\ldots\ \text{Factor}\,\text{N}(\text{Z})$$

In this model the parenthetical variables are the weight or importance that an individual place on each of the considerations in the decision. In a human decision-making scenario, the variables are not necessarily hard data, but often are more emotionally charged and subjective data. For example, a child who is trying to solve a design problem for a science class might consider what they are interested in, what their teacher is likely to reward, how much the proposed idea will impress their friends, and how popular the project might make them upon successful completion. If an AI is posed with the same open-ended problem to solve, the variables and considerations would undoubtedly be more analytical and driven by percentages of concrete data as they relate to desirable outcomes. Both the human child and the AI in this variation on a Turing Test would produce an outcome. And as is common in many realms of creativity discussions; the creative product would be the object of evaluation and discussion rather than the creative potential of the creating entity and the nuanced information coming from a highly relational and connected crowdsourcing (friends, the teacher, the likelihood of impressing peers) and the final more intuition-based criteria riddled with ambiguity, ego, and capriciousness. The question lies in the nature of quality and will the human creator benefit from the type of bias that might tip the scales in favor of a machine produced product? A particularly disturbing reality is that the human brain does not have a metacognitive process of understanding how it solved a problem. Even more complicating is that the human brain is continually learning and creating more and different synaptic connections, as noted by Donald Hebb, a neuroscientist who worked in the field of associative learning, who coined the phrase in 1949, “the neurons that fire together, wire together” (Hebb 2002). Given the fact that our brains are in constant flux and we have no mechanism to reliably identify how a human brain makes cognitive and creative decisions, this will pose significant issues in creating an algorithm to approximate human capabilities. In a very real sense, the room for implicit bias and machine bias are significant issues for concern.

7 Ethics

In 1964, Toynbee identified the following ethical issue, "It is obviously the outstandingly able individual's moral duty to make a return to society by using his unfettered ability in a public-spirited way and not just for selfish purposes. But society, on its side, has a moral duty to ensure that the individual's potential ability is given free play (Toynbee 1962). But will AI be afforded the same rights and tasked with the same responsibilities?

Will an AI be a friend? Will it disagree or be jealous or feel pain or experience loss? Will it have rights or responsibilities? These questions, and more must be investigated. AI as the new UX implies a servitude of machine learning and interaction that ultimately values human experiences over the measures of a machine-based algorithm. In the current definition of UX, the human user is the receiver and the machine intelligence system is the provider. Therefore, the success of the AI must always be evaluated through the lens of a human recipient of the designed UX experience. It is also critical that the AI algorithm incorporates a metric for the value for the traits of human creativity and positive human experience as measured by openness to change, tolerance for ambiguity, divergent thinking, spontaneity, and less than optimal choices. In essence, not only tolerance but an appreciation for imperfection, moodiness, humor, leisure, inefficiency, exploration, and failure will be critical to the success of AI as part of generating uniquely desirable human UX experiences.

8 AI as UXD

The AI-UX Design Model (AIXD) defines the relationship between artificial intelligence and user experience it applies to the design of physical and virtual products and systems. This model provides a framework for understanding and applying AI to business, design, information architecture and user interface design. AIXD examines the applications for artificial intelligence in the form of user experience design. AIXD will be divided into IQ and EQ categories and with four sub categories in each: procedural, analytic, generative, linguistic, and augmentative, avatars, creative, and companion. IQ-Based AI are those functions and applications that are based in cognitive and analytical knowledge. It is described in ways most closely associated with math and language. The IQ-Based AI are associated closely with quantitative analysis and data or information from search functions, mathematical analysis, and crowdsourcing. The EQ-Based AI are closely aligned with qualitative processes involving social and emotional data. Both IQ and EQ-Based data can be found in weak or strong AI applications. They may also be combined in integrated activity sets to add polymathic interrelated nuances to the AI. The ethical and practical considerations of both IQ and EQ-Based AI will be discussed with regard to cognition, emotion, interaction, creation, and generation in the following AIXD categories:

1. **IQ-Based AI (Weak AI)**
   a. **Procedural** - AI this is used for one specific task;
   b. **Analytic** - Data analysis or data retrieval;

   c. **Generative** - AI that processes data for the purpose of generating large quantities of solutions.
   d. **Linguistic** - Language processing programs.
2. **EQ-Based AI (Strong AI)**
   a. **Augmentative** - AI that can augment or enhance human skills or serve as an assistive device or technology.
   b. **Avatars** - AI that can perform activities as a human agent or alter ego such as in video games or online worlds.
   c. **Creative** - AI that creates new solutions from a variety of data sources or influences and is able to adapt solutions to unique or novel situations.
   d. **Companion** - AI that serves in a companion role to humans or other sentient forms of organic life.

The elements of AIXD, cognition, language, creativity, empathy, and ethics, are present to varying degrees in each type of application. For a task specific and limited weak AIXD application the emphasis on information retrieval, speed, accuracy and processing large quantities of data are of highest importance. Ethics are a consideration but are limited to the specific considerations of the task as they relate to harm, perceived harm or risk. The final selection of AIXD properties and functionality will determine the success of the user experience. Future research will include a development of the AIXD categories and their relative properties and applications.

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Mitigating Misinformation: Using Simulations to Examine the Effectiveness of Potential Strategies

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Abstract. When we mitigate misinformation by restricting information flow, we make a trade-off between restricting falsehoods and limiting knowledge. How can we do the most good? This paper introduces popular approaches including social constructionism, linguistics, heuristic, and empiric. Simulation allows researchers to consider information networks of differing size and connectivity. Results indicate that an empiric approach that preferentially limits falsehoods allows researchers to tune this trade off.

Keywords: Human factors · Information accessibility · Decision support systems · Causal inference · Graphical inference · Simulation

1 Introduction

We are moving towards an information-age economy. This creates practical incentives for controlling the flow of information. This paper is motivated awareness of the of emerging misinformation techniques. These techniques undermine our society's ability to succeed financially, politically, and militarily. Provocateurs of such techniques use them to increase the effectiveness of strategies such as advertising, investing, public relations, political campaigns, and even science.

Science has also struggled with misinformation. Journals have recently withdrawn a number of studies including milestone cancer studies from prestigious institutions [6]. By the time we detect misinformation, it may have already exerted damaging inference upon society. Studies on the relationship between vaccines and autism have materially impacted popular perception of inoculation [2]. This increased the spread of diseases. Technology companies have relied upon social consensus and editorial opinion to determine whether content is true [4, 5]. It is a challenge to come up with an approach that is both fast and scientifically uncompromising.

Fortunately, scientists have also begun to study the flow of information so that they can help mitigate the problem. Unfortunately, many of these efforts sacrifice precision for practicality. A popular article in Nature acknowledged the practical need to use non-empiric approaches such as socially constructed or heuristic-based approaches [1]. Highly credible sources have used automated techniques to recirculate inaccurate information. However, researches have also used heuristics to filter nonhuman behaviors regardless of the merit of the content. How might we do better?

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1.1 Misrepresenting Information

Misinformation contains various types. An overall argument could be false as in the case of a fake news article. This falsehood in turn stems from a misrepresentation of facts. Falsehoods can occur unintentionally when the publisher does not evaluate the underlying facts or when they use a flawed form of reasoning. A flawed form of reasoning is any which is incapable of evaluating a fact. While misinformation is unintentional it is practically the same as overt dishonesty. Disinformation purposefully propagates falsehoods in order to solidify alternative narratives. Misrepresentation can either boost or stymy to the flow of information. Boosting occurs if the falsehood increases the ability of an argument to travel through a network. Falsehoods stymy information if they limit its spread.

1.2 Network Structure

A network consists of nodes and edges. Each node is an actor capable of spreading information. An edge connotates that information has spread from one edge to another. The flow of information travels through a network. For example, news websites link to each other. Each site is a node and its links connect the flow of information.

The shape of the network affects the ability of information to travel; networks can serve to amplify or to suppress information flow. An echo chamber is an example of a network whose structure amplifies the flow of information. Firewalls are examples of techniques intended to suppress information flow.

Imagine a network containing a number of nodes, n, and edges, e. If each node were randomly connected to each other, the overall network would be considered **random**. Connectivity would be uniformly distributed based upon the overall density. If probability that any two nodes are connected, p, were low then the network would not be well connected. As p increases, it makes it easier to travel from one node to another. The average path length, l, from one node to another decreases as p increases. The amount of connectivity between a subset of nodes helps explain the presence of communities. The connectivity, c, also increases as p increases. As the relationship between p, l, and c varies based upon the type of network.

Ordered networks are the opposite of a random network. Each node is connected to an exact number of other nodes. The values of p, l, and c are identical for every node. Depending upon these values, the flow of information can be designed to travel quickly or to travel slowly. Information travels quickly when l is low and c is high. Information travels more slowly where l is high and c is low. In this scenario c controls how likely it is that every node in a community has the information. Conversely, l controls the speed of information flowing between communities. A slow network strategy would be the reliance upon word-of-mouth. A fast network could be a broadcast or an announcement where many are reached at a given time. Information can still travel quickly even in a slow network if l is low. Information can go viral using word of mouth as long as it targets more influential nodes.

Real-world networks are neither purely random nor purely ordered. A network that begins as a random set of connections will over time develop more common paths based upon typical usage. This evolution causes a transition to occur. What was initially random becomes increasingly ordered [2]. The more common paths become increasingly utilized due to their ability to lower the overall average travel distance that is required to go from one node to another. Thus, a tipping point occurs. As a critical level of order emerges l rapidly decreases and the prevalence of certain paths quickly escalates. Paradoxically, it is nearly impossible to detect the presence of such a tipping point at the local level. The flow of information within each community is virtually unchanged in these **small-world** networks.

1.3 Challenges

Studying a network also requires understanding the domain. Due to the nonlinear sensitivity of networks to factors such as p, l, and c, even minute differences in measurement technique can cause drastically different results. Measurement varies across instruments and between observers. Careful interpretation of results as well as repeated validation of techniques will help minimize these differences. Thus, approaches to mitigating information must be measurable and repeatable.

An added level of rigor is required for an approach to be considered causal. Such approaches are externally grounded and internally representative [8]. Grounded occurs when the entities studied are defined by consistent constraints such as set of physical dimensions or of attributes that define the properties of an object. Representative approaches encode some key element of the scenario into the problem space.

No matter the approach utilized, truth can only be established when it is possible to operationalize a statement. Subjective statements that could either be true or not depending upon perspective cannot qualify as misinformation. Arguments not supported by objective statements contain no operational support.

1.4 Approaches

There are various philosophies used throughout science and industry to evaluate arguments. Each epistemology has its own technique for evaluating evidence. It is not practical to establish verisimilitude. Instead, use facts to prove statements are false.

While an approach that examine an overall argument is unlikely to be successful, it is possible to examine the verisimilitude of certain facts. An argument contains many statements. Each statement can contain multiple implications. Finding a number of facts to support an implication may not be enough to establish its credibility. Finding even a single contradictory fact is enough to discredit an implication. Thus, there is no strict boundary on the number of ways to show that an argument could be true but there is a small number of falsehoods necessary to prove it false. This paper considers several common approaches that are repeatable, measurable, and contain an internally consistent epistemology.

Social Constructivism. A socially constructed fact is one that has achieved consensus within a group. What defines a group and consensus can vary depending upon implementation. Most broadly facts are true if they a majority of the population agree with them. Other techniques might consider the consensus of an expert panel. If there are more than two choices, consensus might connotate the single most popular choice.

Thus, truth is an aggregation of the characteristics of individuals in the group. As the group changes or as opinions change, the verisimilitude can change. Once established, the narrative can continue to construct truths relative to these new facts.

This approach works well for scenarios that are actually socially constructed. For example, surveys work well for predicting the success of political candidates if such candidates are elected using popular consent. The value of a stock is related to the popular perception of its buyers and sellers. This approach struggles when facts are not socially determined. Popular consensus can do little to change externally grounded truths. Even if a majority do not want it to rain, it may still happen.

A recent example of the application of this approach occurred when Facebook created a social credibility tool. The idea was that users could flag various sources of information based upon their perception of its trustworthiness. If enough users were concerned it would then show warning messages to would be viewers. In extreme circumstances this technique prevented users from publishing certain information. While mitigating misinformation is an admirable goal, we need to consider the extent to which the approach targets normal information.

Linguistic. Language is constructed to give the users an internal ability to describe an external world. Language both constrains and enables thought. Examining the structure of an argument along with the words present allow for a repeatable, measurable approach to examining facts. The hermeneutics of an argument considers whether the language used to describe something can change the associated implications. Word choice can affect whether a fact is considered false. If an argument contains certain words, there is an increased probability it is false.

Since this approach constructs truth relative to the language contained, it cannot be causal and is instead a correlational approach. Language may contain evidence of misrepresentation but language itself does not cause misrepresentation. The structure and meaning of language can vary across users and across time. In order for this approach to work, it needs to be updated more quickly than language changes. All inferences are relative to the linguistic and social context. Generalizing requires first examining the linguistic similarity between environments. Finally, this approach must consider whether disinformation is targeting the meaning of words. Some recent examples of this approach involve automated tools that flag social media posts based upon whether they contain certain words [1].

Axiomatic or Heuristic. This approach uses basic building blocks to examine the construction of more complex truths. These axioms and heuristics form the basis of for Mathematics proofs and Legal briefs. Axioms are fundamental truths are always true. Heuristics describe things that are usually true. Heuristics can be easy to deploy and can work quite well in practice. For example, the reasonable person heuristic is a common legal standard. Another example could be filtering automated behaviors based upon whether the behavior occurs more quickly than is humanly possible.

If an axiom is called to question, then all subsequent constructed truths must be reconsidered. Thus, axioms are both difficult to deploy and fragile. For example, an argument that was published by a robot is not necessarily false. If built upon heuristics, this approach can be surprised by new forms of evidence. Thus, it must be constantly ted. An example of this approach comes from [1] where they deployed an automatedup-process to examine the speed of publishing. da-

Rational Empiricism. This epistemology requires that facts be obtained through repeatable experimentation. The ability of these inferences to generalize to non-experimental conditions depends upon how well the experiment represents the underlying scenario. Leaps in reasoning should be as small as is feasible. Logical positivism is a stricter subclass. Generalization requires deductive reasoning and experimentation requires direct observation.

This technique is causal since it is both grounded and representative. Repeated observations are a great way to combat the natural variation in observers and instruments. Deductive inferencing allows the creation of causal networks. However, empiricism requires effort. This costs more time and money than may be practical in a given circumstance. Truths are also constrained to the scope and integrity of the underlying experiments. Recent examples of this approach include using direct observation to gather evidence and assess the root cause of several Tesla crashes [9]. The study found that the fires were falsely attributed.

2 Method

To compare each method, consider a simple laboratory set-up where an arbitrary number of nodes are initially randomly connected. This set-up allows for variation in initial network size and average connectivity. The flow of information prior to performing any intervention on this random network then serves as a control for each configuration. The extent information can flow through the network depends upon the proportion of nodes that become interconnected. Call this f. If a network of 100 nodes has a largest community containing 10 nodes, then $f = 0.1$. Information can travel further as the network becomes more interconnected. In addition to preventing misinformation, consider whether the approach would have hindered normal information flow. Assess the impact by examining the size of f.

I used simulation to assess the effectiveness of these approaches. To set-up this experiment, I used size combinations ($n = 10, 100, 1000$) and densities ($p = 1/(n*10), 2/(n*10), \cdots 30/(n*10)$). Since the socially constructed approach examines what information is most popular filters, it filtered nodes whose connectivity was less than average. The empiric approach filtered all false nodes with a 95% probability and true nodes with a 5% probability. I hypothesized that the rational empiric approach would have the most favorable decrease in misinformation and the most negligible impact on normal information.

3 Results

Across networks of exponentially increasing size, there is a precipitous increase in interconnectivity as network connectivity allows each node connects more than 2 nodes (see Fig. 1). The social consensus technique mitigates the flow of false and normal information. The empiric approach preferentially mitigates the flow of false information (see Fig. 2).

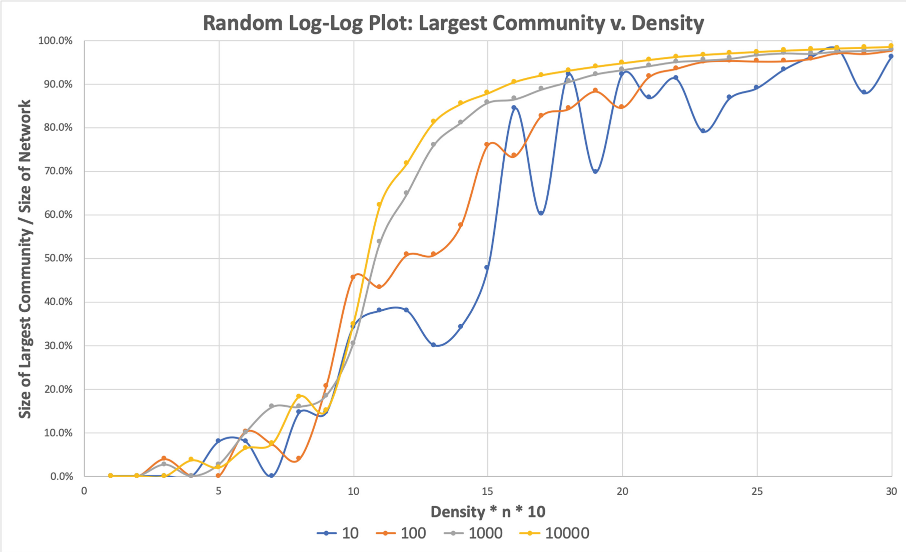

Fig. 1. The size of the largest community compared to the size of the network (y-axis) illustrates the proportion of network across which information can spread, f. Density governs the rate of connectivity, c. Normalizing by size (n) and density (x-axis), f approaches 1.0 as c approaches 3 (30 on this chart). This holds true for across various sized networks: 10 (blue), 100 (orange), 1,000 (grey), and 10,000 (yellow).

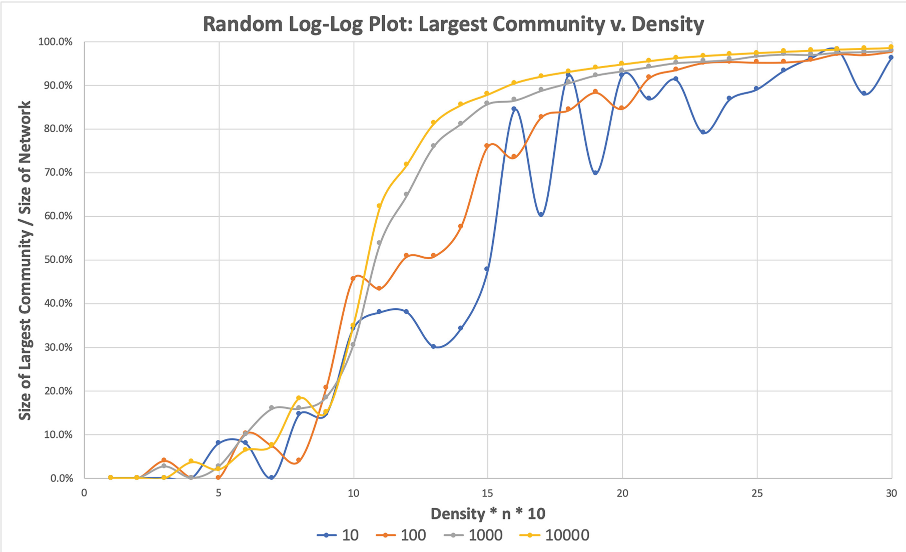

Fig. 2. As c increases (x-axis), f drastically increases (y-axis). This relationship using 1,000 node random network (blue) serves as a control. The consensus-true approach (orange) impedes information flow regardless of whether it is true. The empiric-true (yellow) has limited impact on information flow while the empiric-false (grey) technique heavily mitigates flow.

4 Conclusions

There is a linear relationship between network c and f. This hold true across networks of various sizes. Once c ~ 2.5, f exceeds 0.8. By the time c = 3, f approaches 1. Thus, each publisher only needs to recirculate information from a few sources in order for information to become ubiquitous.

The methods presented in this paper cannot be used to determine whether something is definitively true. The empirical method is preferentially proficient at determining whether something is likely to be false. The nonlinear relationship between density and interconnectivity elevates the importance of being proactive. Damage in a network can occur quite quickly. In order for this mitigation technique to be effective, publishers should proactively apply misinformation mitigation techniques.

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Picking Apart the Black Box: Sociotechnical Contours of Accessibility in AI/ML Software Engineering

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Abstract. This paper considers everyday software engineering (SE) work practices in applied artificial intelligence (AI) and machine learning (ML) development projects. As contemporary AI/ML systems become increasingly embedded into a wide array of everyday digital services, a number of concerns emerge over the opaque and "black box" constitution of these technical capabilities. How do software developers come to understand complex AI/ML capabilities and how do they explain their inner-workings to others? This paper empirically investigates these questions by drawing on an ethnographic study of AI/ML research and development at a large, global technology and services company, highlighting the situated, careful labor involved in configuring access around AI/ML systems and services. By rendering these situated practices visible, this paper contributes important provocations for current discourses on AI explainability (XAI) and interpretability: rather than a quality or component of a model, system, or interface, access emerges through ongoing, unfolding, and effortful sociotechnical encounters.

Keywords: Accessibility · XAI · Software engineering · Work practices · Accessibility · Sociotechnical systems

1 Introduction

This paper considers the topic of access in contemporary, data-driven service systems. What does it mean to have "access" to services that leverage artificial intelligence (AI) and machine learning (ML)? Who has access, what does it involve, and what are its contours? We investigate these questions through ethnographic study of the everyday software engineering (SE) work practices in applied AI/ML development projects at a large, global technology and services company. Our findings uncover the situated and careful labor involved in configuring access around AI/ML systems and services. Accessibility requires work – it is not self-evident, nor is it a fixed quality or component of a machine or interface. Instead, SE teams must work to create shared understandings of these complex technologies. Coherence of AI/ML must be configured amongst SE teams themselves (within-team sensemaking that renders AI accessible and meaningful to the dev practices within which it is embedded), but also configured amongst the SE teams and others who hold a stake in the service. These stakeholders involve, *inter alia*, technical executives and strategists, service offering

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managers, product owners, designers, sellers, customers, end users, and so on. Each brings a unique point-of-view to the AI/ML services as hand, as well as their own diverse sets of technical literacies and aptitudes. The work of gaining "access" to the data-driven, model-based technologies that undergird AI/ML services is a different proposition for various people who are differently positioned within the broader constellation of the AI/ML service ecosystem.

What do we mean by accessibility, when we use that term? A common invocation of the term comes in relation to interfaces on the Internet, which are governed by accessibility standards created and maintained by the World Wide Web Consortium (W3C) [5]. It also arises in relation to the fields of assistive technology and inclusive design, which are driven by the goal of improving the lives of people with disabilities by ensuring everyday technologies met basic standards of usability by diverse users (e.g., those who use screen readers or mobility devices) [4]. To understand accessibility at a conceptual level requires inquiry into the notion of "access" – what does it mean to have access (or not) to a particular environment or experience? There is, of course, access in the immediate and obvious sense – *am I allowed here?* But the question of access has deeper considerations, which are key foci of inquiry in the field of disability studies. In disability studies, access is conceptualized as an interpretive relation between actors in time and space: "Access is a way to orient to, and even come to wonder about, who, what, where, and when we find ourselves to be in social space" [8:3]. (In)Access, then, emerges from *in situ*, situated practices through which we come to understand ourselves, others, and our environment as embodied, sociotechnical configurations. These configurations shape agency and action by enabling and constraining perceptions of what is or might be possible – or impossible. Thus, "dis"-ability is not a fixed quality of a person or body, but instead emerges in specific sociotechnical encounters that make certain experiences possible, while foreclosing others [6, 7]. *I may be allowed here, and I may find myself here, but what can I do here? Can I meaningfully participate in this space, do I have agency here?*

Contemporary AI/ML demands we ask questions about (in)access. The AI/ML boom of recent years has been precipitated by "Big Data," an explosive growth in the volume, velocity, and variety of data in the past decade. Alongside this growth in data, there have been advances in increased computational processing capabilities (in the form of graphical processing units or GPUs) which are available in distributed arrangements (i.e., via cloud computing). These entwined technology trends have rekindled widespread fascination and hope for the possibilities of artificial, machine intelligence to transform human experience and action, galvanizing social change. Yet contemporary AI/ML systems – which, at their core, are comprised of immensely complex, multi-dimensional statistical models often referred to as "black boxes" – raise questions of human interpretability, sensemaking, and coherence. Who has access to AI/ML models? Who can meaningfully participate in AI/ML ecosystems, who has agency there?

Concerns over human interpretability and sensemaking of AI/ML models have fueled a rapidly growing foci within the AI/ML research community called "eXplainable AI" (XAI) [1, 3]. Despite the technical advances in this space, scholars have called attention to a gap between XAI techniques and methods as developed within the research community and situated settings of applied AI/ML end-use [9]. This paper follows this line of inquiry, interested in understanding how developers come to understand AI/ML models in their everyday work practices and how they explain them to other stakeholders in the broader AI/ML services ecosystem. This paper draws on an ethnographic study of AI/ML research and development at a large, global high-tech company. This study began in 2017 and is ongoing; it involves an examination of the everyday work practices of machine learning (ML) developers, as well as several projects developing/implementing AI/ML models in enterprise services. This paper examines how access emerges within two scenes from the day-to-day work of ML developers – one focuses on processes of debugging and error analysis (*tinkering with models*) and another focuses on developers' service encounters with others, including product owners, designers, sellers, and customers (*explaining models to others*). In both scenes, we see how AI/ML systems and services are rendered accessible through careful, sociotechnical configurations – of people, practices, data, code, screens, visualizations, concepts, abstractions, processes, outcomes, explanations, and so on. In examining these configurations, this paper aims to highlight the situated and careful labor involved in creating access around AI/ML services, raising provocations for our conceptualizations of AI explainability and interpretability.

2 Ethnographic Setting and Methods

This paper draws on ongoing ethnographic fieldwork at a large, global technology and services corporation headquartered in North America (referred to as "TechCorp" or "the company"). The overarching focus of this long-term study is understanding the "work of AI" – that is, the various forms of everyday human work and labor practices involved in applied, enterprise AI projects. This ethnographic project is exploratory and purposively broad, including those who work on building applied AI systems (i.e., SE practices), those who manage, productize, and otherwise "package" applied AI systems (i.e., business/management practices), and those who interact with AI systems as part of their everyday work (i.e., practices of use and interaction with enterprise AI systems). This ethnographic endeavor began in Fall 2017 and includes several sources of qualitative data, including semi-structured interviews (both formal and informal), participant observations, and artifact analysis.

This paper draws on analyses of four projects from this broader investigation: two long term (>12 months) projects; and two shorter term (<6 months) projects. The two long-term projects focused on building a software/system service, while the short-term projects were exploratory in nature. Details on each are provided in Table 1. All proper names (including the names of informants and projects) are pseudonyms.

Data were analyzed inductively, following techniques similar to those in constructivist grounded theory [2]. Given this paper's focuses on questions of accessibility, analysis was driven by the following questions: How do various actors create shared understandings of how AI/ML systems and services work? What are the conditions of these sensemaking encounters and what are their consequences?

Table 1 Describes the four projects from the larger ethnographic study.

Project pseudonym and description	Time period	Sources of data
Alpha – software development project building an intelligent decision-support system to support the design work of IT architects, who design IT infrastructures	Dec. 2017–Aug. 2019	Semi-structured interviews and usability testing (with members of the user community of IT architects) and participant observation of technical development work on this project; also design and execution of a user feedback program to facilitate exchange between user community and technical team (72 informants)
Beta – exploratory interview study of ML developers' experiences and work practices and design evaluation of an interface	June 2018–Aug. 2018	Semi-structured interviews and participatory design of an interface for a novel, open-source AI/ML toolkit (13 informants)
Gamma – software development project building a system to support the model improvement practices of data scientists	Oct. 2018–Sept. 2019	Semi-structured interviews and participant observations of model improvement practices; participatory design of a system to support those practices (8 informants)
Delta – exploratory interview study of those who work on natural language processing (NLP) projects	July 2019–Sept. 2019	Semi-structured interviews (30 informants)

3 Sociotechnical Contours of Accessibility in Everyday AI/ML Software Engineering

Our findings center on two themes: *tinkering with models* and *explaining models to others*. We elaborate on each below.

3.1 Tinkering with Models

ML development involves ongoing tinkering, testing, debugging, and re-running of models, an iterative work practice that is experimental and information rich [10]. Through these situated practices, SE teams work to render models penetrable, developing enough coherence that enables their development work to proceed. While developers may go into a project with a high-level understanding of different AI/ML algorithms and modeling techniques, such as artificial neural networks (ANNs), generative adversarial networks (GANs), or decision trees, they engage in active sense-making to understand how that algorithm acts upon and transforms the particular dataset at hand in a given project. Expectations help to guide everyday practice, piquing interest and information-seeking when expectations are violated: "*It's a natural thing we as people do*," Ethan, a developer, said. "*When we are surprised, that's when we need some type of interpretation or explanation. If we see or experience what we are expecting, then we just continue on without making much note.*" When model outputs differ from expected behavior, SE teams will debug, using various techniques to construct coherence of the model's actions. "*Explainability stuff, XAI, it's really for debugging*," Siddhartha, a developer stated. "*The explanations that they give are still very specialized, heatmaps of the model's internal workings and so forth. It's useful for developers, but I can't see how an end user would find it helpful.*" Similarly, Suzanna, a developer, was careful to note distinctions between how the SE team talks about models and how they talk about them with non-developer stakeholders: "*So when it's just us, like those of us on the data science team, we'll talk really low-level details, you know, hyperparameters and stuff, when we are debugging and running experiments and testing, brainstorming,*" she recounted, "*But we talk at a much, much higher-level when we report back to others on the broader team, otherwise their eyes will just glaze over.*" She went on to clarify: "*It's not that they are dumb, not at all. Just that they have a different frame, a business frame, and the low-level details make no sense for that frame. For us, we live and breathe low-level, for them it's all about the business.*" In both Siddhartha's and Suzanna's accounts, we can see an awareness that different people engage with AI models differently across the model's broader service ecosystem. XAI explanations and low-level details help provide access to the model's internality for some, but not others – the model is not explained *per se*, but rather explained *for a particular audience* (i.e., ML developers).

3.2 Explaining Models to Others

SE teams develop an intimate and highly-skilled understanding of AI/ML models through their everyday tinkering and experimentation; they also work to translate these knowledges in ways that help various stakeholders understand the models in the context of a specific services engagement. Many talked of doing so through the use of collateral, such as PowerPoint decks that depict workflow diagrams and other abstractions of the ML pipeline. "*It always requires some creativity to explain specialized things to non-specialized people*," Devyn, a developer stated. "*From my experience and observations in meetings, even just saying we used a 'deep learning neural network' is often too much detail for conversations with the product side*," Rex, a developer said. Explaining AI/ML models to different stakeholders requires iterative calibration to get descriptions "just right," at a level that is both meaningful and productive, as Joni, a developer, shared. She talked of a health informatics project collaborating with medical researchers: "*In initial meetings, we explained to the MDs, we tried to present 'How the model works' through model diagrams and equations*," she recounted. "*But that was too much for them, so we adjusted our approach.*" In later meetings, the dev team shifted their focus to talk about the model in terms of the domain and what it was doing on specific input data like electronic health records (EHR) text: "*Shifting things to explain it in terms of 'How the model can help you' that was important. Then the focus of our meetings became performance on specific domain* *cases, so looking at specific inputs/outputs from their domain*." Keeping model discussions grounded in the project's industrial domain was emphasized by many developers across the projects. This requires a shared understanding of a project's overarching business problem, how it will be codified and represented in an AI/ML model, and if/how the resulting AI/ML service will transform the business process. For example, Chandrasekhar, a developer, was working on a project building an AI/ML service to support knowledge discovery in the pharmaceutical domain. He talked of how the SE team had to take care in explaining how the AI/ML approach differed from the business-as-usual process (a manual, hand-curated process). "*We have to really work with clients to understand the differences,"* he said, "*the AI service is much faster than the manual process, which is a key benefit, but it also has limitations in that there isn't a human verifying everything along the way*."

Many times, the client will come and ask for a pre-trained model, as Dafna, a developer, shared: "*So what happens is clients will come to us or to other companies that do this, and they will say 'Hey, let me take your model as is,' and you know, it doesn't work with their data, or it doesn't work very well with their data*." Bootstrapping off a pre-trained model and then building a customized model tailored to the client's data on top requires ongoing iteration and collaboration between developers and the client, often working closing with subject-matter experts (SMEs). "*They have their own ideas on how the models do or should work*," Dafna reflected, "*but they're also my end users…I have to figure out how to make changes to the models based on their feedback*." She continued: "*I may not fully understand the domain, but I have to work with them to understand it, and understand the feedback they are giving, and what it means for the model."* This iterative, situated learning is reciprocal: "*The SMEs help me understand their domain, and then I also have to translate the model, the technical stuff, so they can understand enough of how it all works, to help give feedback to improve it*." Thus, access is emergent – both for developers, as well as the SMEs and end users they interact with. Through close, collaborative partnership, access emerges as each slowly gains entry to and develops fluency in the other's professional arena, their respective logics of action, and ways of knowing.

While we can see how various kinds of access emerge through high-touch service encounters like the ones described here, open questions remain on the "scalability" of such encounters. Consider the Alpha project, which was building a decision-support tool for the IT infrastructure design domain. The system had various AI/ML capabilities (such as NLP and optimization matching) and was envisioned to be used across a global user community of IT architects. As the project moved through Agile phases of Early Adopter, many on the dev team were continually called to provide "walk throughs," helping explain the inner-workings in real time as users navigated the tool. Yet as the project moved closer to General Availability, the demand for these types of walkthroughs grew, as did questions on the sustainability of this approach. Ultimately, various kinds of collateral were created by the dev team (PowerPoint decks and demo videos) to help address the need for user training, though uncertainty remained over their ability to remain "evergreen" in the face of Agile's continual improvement, as well as the dynamic and evolving cycles of feedback and adaptation that fuel AI/ML.

4 Conclusions

What makes an AI/ML system (in)accessible? This paper has empirically investigated this question by drawing on an ethnographic study of AI/ML research and development at a large, global technology and services company, highlighting the situated, careful labor involved in configuring access around AI/ML systems and services. By rendering these situated practices visible, this paper contributes important provocations for current discourses on AI explainability (XAI) and interpretability: rather than a quality or component of a model, system, or interface, access emerges through situated and effortful sociotechnical practices. Access is not something we make, but rather something we make *possible* – it is something that is ongoing and unfolding, not a promise, but instead an opportunity that must be relentlessly worked towards and continuously reconfigured through everyday situated action.

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Challenges and Opportunities for Designing Smart Service with Artificial Intelligence

Typology-Based Analysis of Artificial Intelligence in Service Companies

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Abstract. Artificial intelligence is currently one of the most discussed topics in service companies. With the help of current data from an empirical study among German companies, experiences and effects of artificial intelligence were examined. As an approach for analysis, a typology of service companies has been derived on the basis of work-related characteristics and then used to analyze the role of artificial intelligence. The result of the analysis shows different strategies in using artificial intelligence depending on the type of service.

Keywords: Service typology · Artificial intelligence · Knowledge intensity · Standardization · Empirical study

1 Introduction

The possibilities of artificial intelligence (AI) are currently the subject of much discussion [1–4]. Politicians like to make competitive comparisons between the leading industrial nations, researchers celebrate new initiatives and projects, and talk show guests outline colorful future scenarios of autonomous applications. However, it is often overlooked that artificial intelligence is not a new phenomenon but has already found its way into the practice of many companies [5].

In particular, service companies are increasingly taking advantage of artificial intelligence - especially at the direct interface between companies and their customers. For example, incoming written enquiries are automatically classified and processed with the help of text analysis methods, expert systems make independent decisions about customer concerns and so-called chat bots communicate automatically with users [6].

For the majority of companies, the question now arises where the use of artificial intelligence makes sense and is even necessary for competition. Investments in artificial intelligence are still associated with considerable costs, and in particular the adaptation and training of systems with valid data causes high expenditures [7]. The question of the acceptance of AI systems for customers and employees is also unsolved for many companies. In the end, AI applications are required in practice, which on the one hand increase productivity in the companies, but on the other hand do not lead to a loss of trust among the people concerned [8].

To investigate the use of artificial intelligence in service companies in the following, the original data from a recent company survey in Germany has been used [9].

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A total of 195 service providers from various industries participated in this study. 69% of the respondents were small and medium-sized enterprises and 31% came from large companies.

2 Derivation of a Service Typology

Looking at the services sector as a whole, a high degree of heterogeneity in the services offered can be observed. In order to be able to take this heterogeneity into account, it is necessary to carry out appropriate structuring of the particular service in question. The classification into different sectors seems to be an obvious criterion for the analysis at first. On closer examination, however, it becomes apparent that this criterion is not particularly meaningful, as certain markets in the services sector are increasingly merging with each other. It is also true that one and the same service is often provided by companies from different industries [10].

Therefore, it does not seem reasonable to consider a differentiation according to different industries for the purpose of this analysis. Rather, it seems more promising to consider a differentiation according to the type of services, whereby the industry in which the service provider is active is irrelevant. In the literature, there is a substantial number of typologies for the service sector [11], but firstly, very few have been empirically tested and secondly, most of these typologies have not been developed in the context of work-related criteria. Therefore, a new approach for typologization is needed.

The first step was to identify suitable criteria for the typologization. Before the study was conducted, an expert workshop was held for this purpose and the specifics of work in service companies were discussed. Finally, the experts recommended six criteria that were to form the basis for the typologization (Table 1).

Table 1. Criteria for typologization

DL	Degree of division of labor
PS	Degree of process standardization
FA	Degree of freedom of action for employees
IC	Degree of interaction with customers
IE	Degree of interaction between employees
CW	Degree of complexity of work

Once the data on the typology criteria had been collected, the next step was to perform a correlation analysis (see Table 2). Here it is interesting to determine the extent to which the criteria chosen by the experts are independent or mutually dependent.

It can be stated that there is generally low to medium correlation within the criteria examined. The highest values are reached with +0.469 (between interaction with customers and interaction between employees), +0.404 (between interaction between employees and complexity of work), and +0.348 (between freedom of action for employees and complexity of work).

Although the correlations are not very high, the criteria in this format are not used to create the service types. The use of these criteria would result in certain aspects being assigned a disproportionately strong influence. For example, freedom of action for employees, interaction with customers, interaction between employees and complexity of work appear to have a closer correlation and to be mutually dependent to a certain extent. Taking all these criteria into the next steps of the analysis would have a disproportionately strong impact on the shared influence on which this is based.

Table 2. Correlation of the criteria for a typology

	DL	PS	FA	IC	IE	CW
DL	1	0.311**	−0.142	−0.030	0.011	0.026
PS		1	−0.133	0.044	0.023	−0.129
FA			1	0.241**	0.348**	0.289**
IC				1	0.469**	0.212**
IE					1	0.404**
CW						1

Pearson correlation
** Significant at the 0.01 level

In order to reduce the shared influences of the typologization criteria, a factor analysis was carried out. This resulted in the original six criteria being reduced to a smaller number of independent factors, albeit with some loss of information as the complete variance can no longer be explained. In order to be able to analyze the correlation between the original criteria and the two factors ascertained, the factor loadings were examined (Table 3).

Table 3. Results of the factor analysis

	Factor 1	Factor 2
DL	−0.016	0.789
PS	−0.041	0.797
FA	0.617	−0.263
IC	0.680	0.027
IE	0.823	0.114
CW	0.677	−0.060
Interpretation	*Knowledge intensity*	*Standardization*

Principal Component Analysis
Varimax with Kaiser Normalization
Eigenvalue > 1

The greatest challenge in carrying out the factor analysis is undoubtedly interpreting the new factors. With the case in hand, it is interesting to note that the first factor has a strong correlation with the criteria freedom of action for employees, interaction with customers, interaction between employees and complexity of work. It seems that this factor primarily characterizes complex services where interaction plays an important role. For the purpose of this analysis, the first factor should be referred to below as knowledge intensity. The second factor is characterized by especially high factor loadings for the criteria division of labor and process standardization. For the purpose of simplicity, this factor will be referred to below as standardization.

As a result of the factor analysis, it should be noted that the six criteria mentioned at the outset have been reduced to two predominantly independent factors: notably, "knowledge intensity" and "standardization." These serve to characterize the services examined as part of the empirical study and to summarize them as appropriate types according to the things they have in common.

The hierarchical cluster analysis in accordance with the Ward method was chosen for the classification of service types, which means that the above factors are used to set up clusters of companies that demonstrate a very high degree of similarity in the services they offer. Once the cluster analysis has been carried out, the increases in the sum of squared errors give the number of four clusters as the most favorable result. Here, as with the factor analysis carried out above, the question of an appropriate interpretation of the specific clusters also arises. To help with this, the mean values of factors can be used for the respective clusters, i.e. the mean value is calculated and analyzed for both factors in each cluster.

Table 4. Mean values of factors for each cluster

	Cluster 1	Cluster 2	Cluster 3	Cluster 4
Factor 1 ("knowledge intensity")	−0.455	0.254	−0.958	1.077
Factor 2 ("standardization")	0.089	1.270	−1.311	−0.510

Ward's method

Using the factor analysis and the cluster analysis, it is now possible to derive the desired typology. To this end, both factors determined are used as dimensions for the typology, and the four clusters are then allocated according to the interpretation in Table 4. The following figure shows a visualization of the typology.

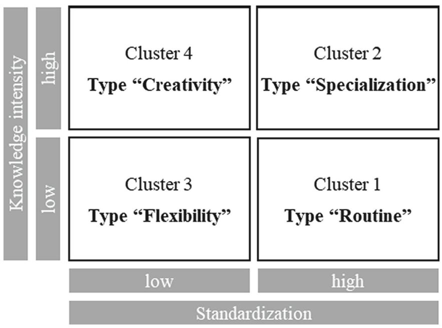

Fig. 1. Empirically-derived typology

The intermediate result is that it was possible to derive a service typology by means of a widespread empirical study using a factor analysis and a cluster analysis, which largely reflects the assessments made in practice. Consequently, four typical types of services can be identified, which can be termed as “Routine”, “Specialization”, “Flexibility” and “Creativity” (Fig. 1).

3 Service Types and Artificial Intelligence

The service typology now serves as a starting point for the analysis of the study results. In the survey, the question was investigated to what extent companies already have experience with artificial intelligence (Fig. 2). The results show that there are only a few companies that do not currently deal with Artificial Intelligence - especially for companies of the “Creativity” and “Specialization” types, the values are very low (13% resp. 17%). One exception, however, are companies of the “routine” type, where 47% have not yet dealt with artificial intelligence.

Another interesting question is to what extent applications of artificial intelligence are already being used in practice. Here it can be seen that the types “Creativity” and “Specialisation” achieve the highest values.

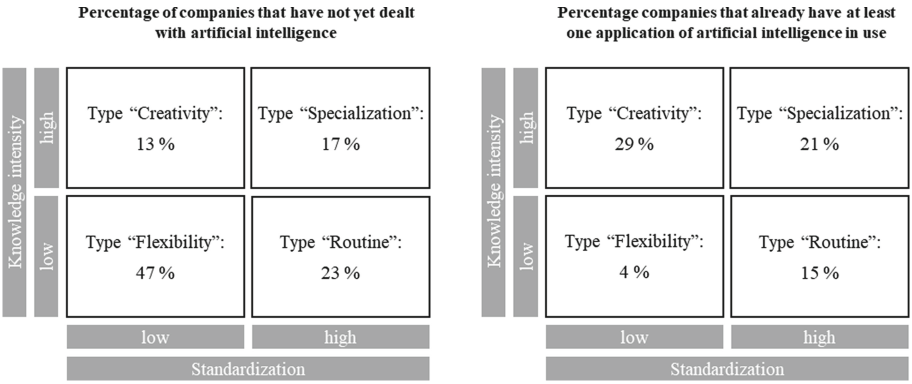

Fig. 2. Use of artificial intelligence in practice

A similar picture emerges in the responses regarding the present and future significance of artificial intelligence. On a scale of 1 (“very low”) to 5 (“very high”), the types “creativity” and “specialization” again achieve the highest average values (Fig. 3).

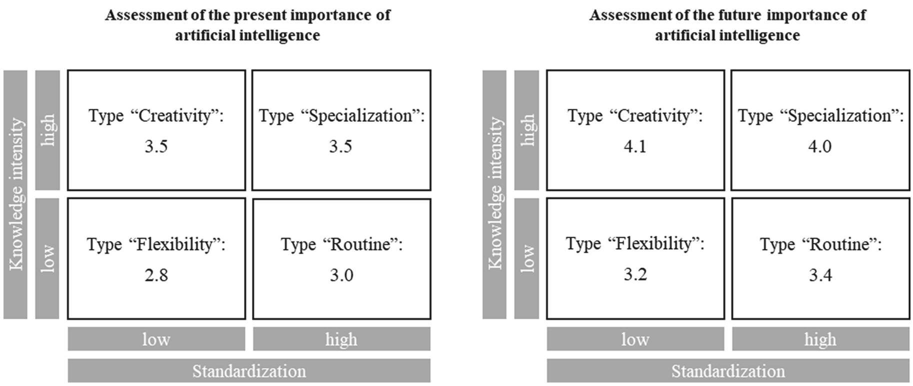

Fig. 3. Present and future importance of artificial intelligence

Overall, it can be seen that both the occupation with artificial intelligence and the importance attached to this topic is significantly higher for the two service types "Creativity" and "Specialization" than for the other types. Both service types are characterized by a high level of knowledge intensity - from the practitioner's point of view, this is where the highest application potentials for artificial intelligence arise.

4 Conclusion and Outlook

The purpose of this paper was to examine the relationship between different types of services and the role of artificial intelligence. A survey on the use of artificial intelligence in practice, in which 195 German service companies participated, provided the empirical basis for the analysis. The respondents classified their services according to six criteria, which were developed in an expert workshop prior to the survey. Empirical data showed some dependencies between the six criteria, and a factor analysis was used to derive independent criteria for the subsequent typologization. Finally, four different types of services were identified by means of cluster analysis and used for further analysis.

The results of the analysis show that artificial intelligence is already used today, especially in the field of knowledge-intensive services, where it is considered to be of the greatest importance for the future. This suggests that companies see artificial intelligence primarily as a way of improving areas that have so far tended to elude systematic optimization approaches. In particular, interaction-intensive and complex services are seen as a rewarding field for artificial intelligence.

The study was limited to the type of service. Nevertheless, it can be assumed that there are other implications that have a major impact on the use of artificial intelligence by service providers. For example, factors such as company size, technical know-how or innovation culture. Future studies should examine the detailed implications for the role of artificial intelligence and the strategy for implementing appropriate solutions.

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Artificial Intelligence as Driver for Business Model Innovation in Smart Service Systems

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Abstract. Artificial Intelligence drives business model innovation. In this context, our paper examines major amendments of business model elements (value proposition, value creation and value capture) due to artificial intelligence implementation into products and services. Based on a literature review changes like enhanced autonomous and adaptive value proposition, intense use of data and stronger collaboration in ecosystems as well as adapted revenue models are identified, analyzed and presented in this paper.

Keywords: Artificial intelligence · Business model · Smart Service Systems · Business Model Innovation

1 Introduction to Artificial Intelligence as Driver for Business Model Innovation in Smart Service Systems

The advancing digitalization and especially the increasing equipment of physical objects with sensors and communication capabilities is transforming business models across all industries and areas of life [1]. Data collected in the Internet of Things (IoT) allows drawing comprehensive conclusions regarding the condition, usage and application-specific context of physical products and thus allows to offer individualized solutions as well as to automate service provision processes. Artificial intelligence (AI) technologies play a central role for deploying potentials of so-called Smart Service Systems [2]. For example, AI is used to independently extract information required for individualization from large amounts of partially unstructured data or different sensors that need to be fused automatically. Moreover, the application of AI enables a more automated or even autonomous provision of smart services, for example via physical or digital robots. The superiority of AI over conventional analysis methods lies in its ability to independently process and structure large amounts of data. The main reasons for the growing importance of AI include the availability of large amounts of data, which result from the increasing networking of physical products. They are an essential basis for the use of AI, as well as the decreasing price for the computing power required for data processing. However, implementing AI in products and services requires new

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business models that, for example, support data acquisition and trade at customers´ sites or charging highly individualized and immaterial solutions.

A business model describes the value companies provide to their customers and partners (‘value proposition’), how this value is generated by combining different resources and activities (‘value creation’) and how provided value can be monetarized by the company in return (‘value capture’) [3]. Applying AI affects traditional business models in manifold ways: Regarding the ‘value proposition’ of more effective and individualized products and services, smart service providers need to think about how the value added can be translated into revenue through new, individual pricing schemes. Moreover, the use of AI fundamentally changes the way target groups are identified and analyzed as well as how value is delivered to them. Regarding ‘value creation’, comprehensive data become a central resource and thus gain in importance in exchange relationships between partners and customers (‘value capture’). Since, new resources and competencies are required for using AI that are currently not core competences in many companies, value creation is often made available in an ecosystem and in a collaborative way. In particular, digital platforms play a central role in combining and organizing them.

Above stated examples show that AI can be seen as a driver for Business Model Innovation in Smart Service Systems. In our paper, we discuss selected prerequisites, effects and strategic options of AI and their impact on business models in more detail. Therefore, scientific contributions and studies are analyzed for deriving new insights from a business model perspective as well as practical examples are stated (Fig. 1).

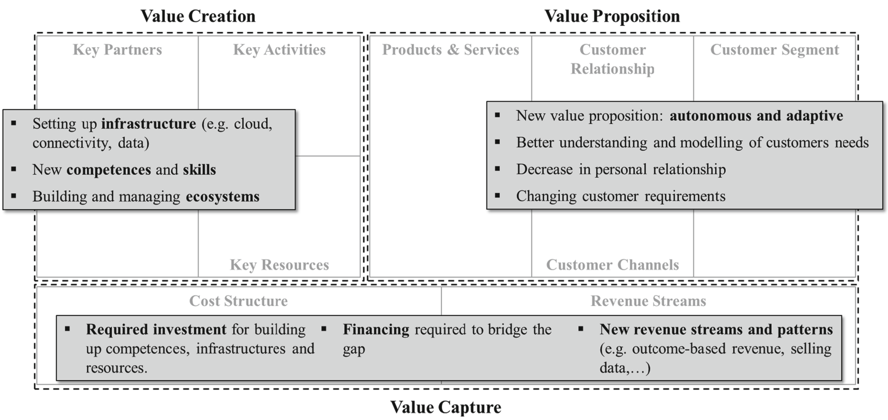


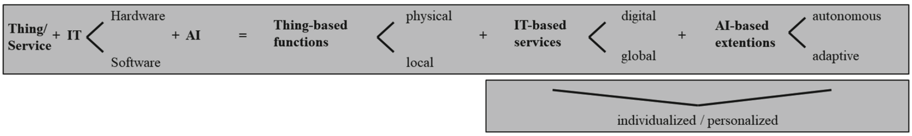
Fig. 1. Overview of business models components that are affected by implementing AI into products and services (Source: own illustration, based on [4]).

2 Changes in the Value Proposition: Traditional, Digital and AI-Based Offers

[5] examines the role of IT in business models and concludes that IT plays a major role in many disruptive business model patterns and case studies. When taking a closer look at digital products or services, [5] describes the product-service-logic in the IoT. The basis of this logic is a combination of a thing or a service and IT, hard- and/or software. When breaking down functions of a product and/or service, thing-based and IT-based functions are differentiated. In this context, thing-based functions locally provide the physical value and IT-based functions allow the provisioning of their services digitally and globally accessible.

However, AI-based functions are an additional category of functions, which are added to smart products and services. [6] claim that AI is appealing due to its self-organizing (autonomous) and self-learning (adaptive) nature, and thus, addresses many different application fields within the given context. Many research activities strengthen this argumentation [7–10].

Thus, when examining AI-based products and services, the above-mentioned product-service-logic must be extended to a product-service-AI-logic. This logic considers AI-based extensions as a further element, which adds autonomous and adaptive behavior to products and services. For example, the products, which gather sensor-based usage data in order to provide hints to improve product handling to their users, act highly autonomous and adaptive (Fig. 2).



Things/Services	Enhanced things/ services with IT/AI	Thing-based functions	IT-based services	AI-based extentions
Watch	Smart watch	▪ Time	▪ Performance determination through measurement data acquisition and GPS route recording	▪ Performance data evaluation / fitness tests ▪ Provide training advice
Socks	Fitness-socks	▪ Warmth ▪ Running comfort	▪ Development platform for textile electronics ▪ Bluetooth connectivity ▪ Sensor data acquisition	▪ Improvement of bad running habits by evaluating the weight distribution and its effects
Lathe	Automatic lathe	▪ Production process turning	▪ Optimization of production planning through connected machines and systems	▪ Optimization of maintenance through predictive maintenance ▪ Data-based operating instructions
Insurance broker	Robo advisor	▪ Classical insurance sales	▪ Digital insurance sales via the insurance websites (digital contract assistant)	▪ AI-based recommendation of policyholders based on their profiles

Fig. 2. Product-service-AI-logic and examples how to interpret the different functions added by thing/service, IT and AI (Source: own illustration, based on [5]).

Personalization of products and services is a transversal issue. This way, a supplier is able to differentiate his offers from competitors. Neglecting simpler personalization methods of things, such as putting a name on a device, the more sophisticated options of personalization start with digital services. Based on roles and rights concepts, personal information may be applied to a product or service, such as mentioned in the context of self-regulated e-learning systems in [11]. When applying AI as an approach for personalization, a product or service is able to personalize autonomously and adaptively. E.g. [12] introduces the automatic content personalization through semi-supervised learning, whereas [13] shows a personalization approach in service-oriented systems by using the Markov Chain Model and the Bayesian Inference. Many other similar approaches exist which allow a dynamic personalization based on AI. Moreover, AI can be applied to gain new customer insights and thus allows adaption of the value proposition to customers in a more effective and efficient way. One example, as presented by [14], is applying text-mining techniques in market research, in order to extract customer information from large amounts of data (e.g. customer feedback or service technician reports) as well as to measure and manage customer experience [14]. By extracting and structuring information automatically, companies can measure and manage customer experience in a superior way and thus provide a higher value [14]. Another interesting application field covers service robots, in terms of system-based autonomous and adaptable interfaces that deliver services to customers [1]. Replacing personal interaction by robots, however, will also affect the type and depth of customer relationships and consequently the value proposition.

3 Changes in Value Creation Through AI Application

Value creation, which comprises activities, resources and competencies required to realize the value proposition, is also influenced by the integration of AI into products and services. On the one hand, AI-specific knowledge and skills regarding data acquisition, analysis and visualization as well as developing data models and algorithms are required [15]. On the other hand, domain-specific knowledge and application knowledge remain central prerequisites for successfully integrating AI, since data needs to be interpreted in a certain context [16]. Consequently, T-shaped competence profiles that include deep knowledge in one domain (e.g. developing physical products) and general knowledge of other domains (e.g. data science, programming etc.) are gaining further importance [17]. Moreover, the establishment, integration and operation of IT-infrastructures to implement AI-based value propositions play increasingly important roles, since most AI applications require high computing power. The selection and design of the underlying technical infrastructures, e.g. in the form of cloud, on-premise or edge solutions, thus represents an important strategic decision [15]. In order to be able to decide on the appropriate variants for concrete implementation, companies should take requirements regarding scalability, reliability and availability, data security, protection and costs into account. In addition to the technical infrastructures, available data stocks also play a central role in adding value to products or services. The more data from different sources are available to integrate into data models, the higher chances are that it represents reality and thus support meaningful decisions and actions [16]. Moreover, aspects such as quantity, quality or formatting of available data influence the possibility of developing or using AI applications.

Especially small and medium-sized enterprises (SME lack required competences and infrastructures becomes apparent. In order to integrate AI into products and service, cooperating with external partners that provide data or missing skills and resources becomes even more important. Whether companies should build up AI competences themselves or integrate partners in their innovation ecosystems becomes a central question for SME. Decision criteria may include required innovation speed (e.g. regarding developments of competitors or changing customer requirements) as well as the need for stability of applications or importance of AI to the overall value proposition in the smart service system. Figure 3 illustrates this decision paradigm.

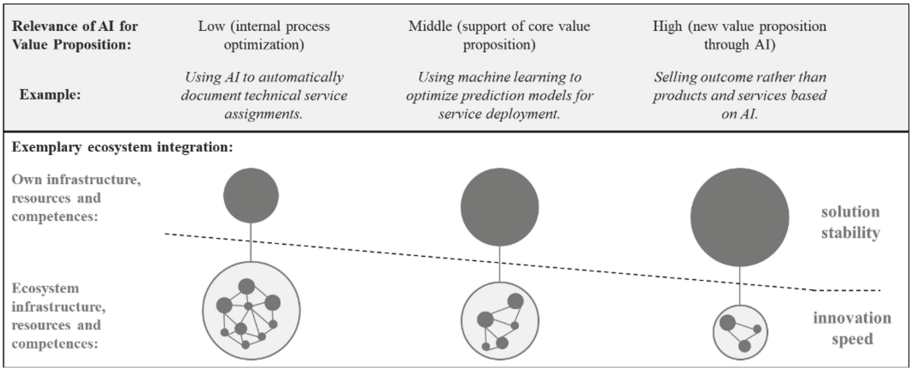


Fig. 3. Exemplary integration of ecosystem resources into value creation, based on importance of AI for the value proposition (source: own illustration, based on [18]).

Consequently, AI-based business models are often developed and managed in ecosystems including actors with complementary competencies. Skills such as compilation, organization of value exchange and partner management in business ecosystems become increasingly central competences in value creation [19]. Digital platforms, which coordinate value exchange between internal and external partners, thus play a major role in providing value in AI-based smart service systems. Via these platforms, data, activities as well as service modules can be exchanged, enabling service adaption across company boarders [16].

4 Needed Amendments to Value Capture Mechanisms

Companies also need to find out whether customers appreciate and are willing to pay for the benefits created by AI. Following business logic, willingness to pay needs to exceed necessary investment costs for developing models, setting up infrastructures and developing competences. Regarding monetization, traditional price determination mechanisms reach their limits when it comes to autonomous and adaptive systems. Firstly, data, algorithms and digital services have marginal costs of almost zero, which is why they can be scaled up at nearly no cost. Consequently, calculating prices on basis of individual costs becomes more and more difficult. Secondly, it is difficult to calculate prices based on value, since value (e.g. automatic adaption to context) often only unfolds during the product usage phase and thus is hard to estimate in advance [20]. Thirdly, individual pricing based on unfolded potential requires a rather opaque, complex simulation of value exchange. In order to find suitable pricing models and revenue streams, companies can rely on well-known revenue patterns [21]. Table 1 illustrates an overview of possible revenue models for monetization of AI-based products or services.

Table 1. Exemplary patterns for AI-based Business Models (referring to [15, 22]).

Pattern	Description
Razor and blade	Core products and services are sold rather cheap in order to spread them as platforms for continuous use of AI applications and related revenue streams (e.g. automatic machine adjustments to context)
Pay for performance	Based on automatic evaluation of manifold field data, product performance are quantified precisely and thus invoiced (e.g. subscription to performed machine hours). Consequently, it leads to a risk shift from customer to provider and a price premium
Data as currency	Raw, anonymized or consolidated data as main or side product from integrating AI into products and services can be monetarized directly or indirectly to customers (e.g. selling anonymized data to related industries)
Free/freemium	In order to access valuable data for AI models, certain parts of products or services are offered free to customers (e.g. selling condition monitoring hardware for free to learn from generated data)
Direct to customer	Autonomous products using AI allow direct interaction with end customers instead of through intermediaries, such as service providers or retailers
AI as a service	Intellectual property-based services or AI models allow external marketing of internal know-how in order to create new revenue streams
Platform as a service	Applying a product or service platform enables multilateral exchange between companies and can be extended to other areas and lead to new revenues for using the platform services

As indicated, the implementation of AI often leads to a continuous but smaller payment stream, compared to selling goods at a high price (e.g. in a pay for performance model). This change in revenue mechanics represents a major challenge, especially for SME. On the one hand, large investments have to be made. On the other hand, high revenues for selling products initially break away in the short. They might be balanced by smaller but recurring payments but might lead to a financing gap in the short term [20]. Furthermore, potential creditors might feel overburdened in evaluating the value of AI to products and services and thus lack to provide necessary financial investments.

5 Conclusion

Our paper introduced some essential changes in business models due to implementation of AI in products and services. Based on literature analysis it provides a basis for further and more detailed research in this domain: Exemplary research tasks are:

– Developing a better understanding of new functions and services added by AI in innovative products and related business models.
– Examining how those functions are implemented and organized in terms of involved IT, human resources, competences, and data sources.
– Provide successful transformation paths, regarding financial structures and their change to service models.

The answers on those questions allow organizations to setup sustainable business models and plan the economically successful application of AI in the future.

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Validating and Improving the Smart Servicescape Wheel: A Qualitative Video Analysis

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Abstract. We previously proposed a conceptual framework of a smart servicescape wheel (SSW) in order to delineate the broad continuum of environmental constraints in smart homes for health care services (SHHSs) [1]. This framework was established through expert analysis and an extensive literature review, and its structure and applicability must be validated. Accordingly, in this study, we aimed to qualitatively verify the SSW framework and improve it in order to improve its applicability. Thirty scenario-portraying movie clips on SHHSs were collected from the official YouTube™ channels of ICT companies. The categories of the SSW were prepared for an analytic framework. We analyzed the movie clips using framework analysis and validated the SSW's applicability along with some improvement points. Moreover, the results implied the opportunity for new service ideations and additional dimensions of constraint layers such as service interactions.

Keywords: Smart servicescape wheel · Ecological approach · Smart home healthcare services · Video analysis · Framework validation

1 Introduction

The radical improvements to the Internet of Things and artificial intelligence technologies have stimulated the expansion of smart services. As smart services become more intelligent, they will become more intangible and pervasive. Accordingly, users are inclined to perceive the service quality and service experience more from environments, namely the "servicescape" [2]. Furthermore, smart services are generally considered as "complex adaptive systems" [3] in which complex combinations of "smart servicescape" [4, 5] components can produce diverse and unanticipated service experiences.

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However, most mainstream research on service engineering for smart services mainly focus on service functionalities and interactions rather than on the constraints in service developments. Therefore, it would be valuable to understand complicated service experiences by determining the extensive environmental constraints and their diverse combination patterns, namely through an "ecological approach" [6, 7].

In a prior study, we proposed the conceptual framework of a "smart servicescape wheel" (SSW) to delineate the broad continuum of environmental constraints in smart homes for health care services (SHHSs) [1]. This conceptual framework was theoretically established through expert analysis and an extensive literature review, making it necessary to validate its structure and applicability and to determine any limitations.

Along with this background, this study aims to qualitatively verify the SSW framework and to improve it in order to improve its applicability. This article begins by highlighting the service environments in creating service experiences and the ecological approach to SHHSs. Then, the SSW developed in the prior study is briefly described. This is followed by a qualitative video analysis to validate the SSW describing the framework analysis and the results. The discussion and conclusion sections provide an interpretation of the results and further research opportunities.

2 Smart Servicescape Wheel

2.1 Ecological Perspective to SHHSs

The Importance of Service Environments in Service Experience Creation. Service management research has underlined the importance of service environments in conjunction with service experiences because the service is provided in such environments [8]. The service environment—namely, the "servicescape" [2]—is the physical and social environment where the service interactions occur, and it can affect how customers experience and perceive a service [2, 9].

The servicescape is fundamental when creating a service experience because it can stimulate and restrict usage behaviors. Accordingly, it can influence the service user's emotional response, perception of the service's quality, satisfaction with the service experience, and continuous intention of service usage [10–12].

Regarding healthcare services, patients usually have difficulties with evaluating the technical quality of professional medical services [13]. Instead, their perception of healthcare services is apt to be influenced by the functional quality associated with the physical environment—the servicescape [14, 15]. Likewise, users tend to perceive the quality of a smart service experience from the smart service environment—namely, the "smart servicescape" [4, 5]. Therefore, the servicescape is important to the experience of both smart services and healthcare services.

Ecological Approach to a Complex Adaptive System. The smart servicescape of SHHSs can also be accentuated, from the perspective of the ecological approach, to a complex adaptive system. Rouse defined a complex adaptive system as a dynamic system consisting of intelligent and independent agents whose behavioral patterns are not designed by the system but emerge by themselves [3, 16]. SHHSs can be regarded as a complex adaptive system because of (1) their diversified stakeholders and intelligent agents and (2) continuous customization according to users' behavioral patterns in their private home circumstances, which can be hardly controlled by service providers.

The ecological approach basically requires an analysis of environmental constraints to understand the real and variable contexts in which actual behaviors occur, namely the behavior-shaping constraints [7, 17]. This approach is appropriate for understanding the service experiences in SHHSs because analyzing the environmental constraints—the smart servicescape—can allow one to comprehend the complex combinations of contextual and environmental factors and diverse behavioral patterns [18–21].

2.2 Smart Servicescape Wheel

In our prior research, we established a conceptual framework of a smart servicescape wheel (SSW) based on the ecological approach, to illustrate broad environmental constraints in SHHSs [1] (see Fig. 1).

The SSW was systematically composed of three sectors: the perceptible "physical scape" and "social scape" and the imperceptible "datascape". The physical scape contains hardware components, environmental cues, and human states; the social scape embraces service relationships and social relationships; and the datascape comprises computing intelligence, databases, and communication networks. Moreover, each section of the SSW was segmented and described at the functional or component level.

As this framework was theoretical, it could require empirical studies with actual use cases to evaluate its applicability and to identify any limitations.

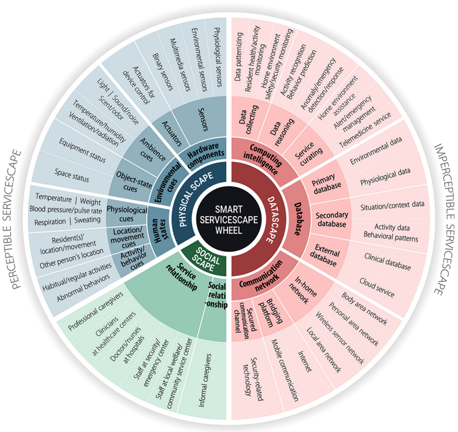

Fig. 1. Smart servicescape wheel for smart homes for health care services [1]

3 A Qualitative Video Analysis to Validate the SSW

3.1 Research Method

Video Analysis of 30 Scenario Movies from YouTube™. Due to limitations in collecting real use cases from well-equipped SHHS environments, YouTube™ videos were utilized for preliminary observation of user experiences. We collected 30 scenario-portraying video clips on SHHSs by searching with the keywords such as "smart (or 'intelligent') healthcare (or 'home')", "home healthcare," and "mhealth." Those released by the official channels of notable ICT corporations (e.g., IBM, Microsoft, Intel, Amazon, Samsung, and LG) were selected.

Framework Analysis. The SSW categories were prepared for an analytic framework. Based on the SSW, we analyzed the movie clips according to a framework analysis method. First, we separately watched the 30 video clips and counted the number of clips illustrating each element of the SSW. For example, if a certain element was shown multiple times in one movie, we counted it once. Then, we held a workshop to review the elements for which the researchers provided different frequencies and compared the differences one by one to arrive at consensus. Moreover, we also identified the co-occurrences or sequential flows of certain elements in the scenarios.

3.2 Results for the Validation and Improvement of the SSW

Frequencies and Co-occurrences. As listed in Table 1, environmental cues were shown less often in the videos because the scenarios focused relatively more on smart healthcare services in home environments than on the smart home services with environmental controls. Moreover, as shown in Fig. 2, a large portion of the healthcare service scenarios presented the co-occurrence of pertinent elements such as physiological cues, physiological sensors, physiological databases, and health status monitoring and were finally connected to telemedicine services in the service curating. Meanwhile, in several scenarios on home assistance and home safety management, the other co-occurring elements included environmental cues, location/movement cues, activity/behavior cues, situation/context data, activity data/behavioral patterns, and activity recognition/behavior prediction, which were finally associated with home environment assistance in the service curating.

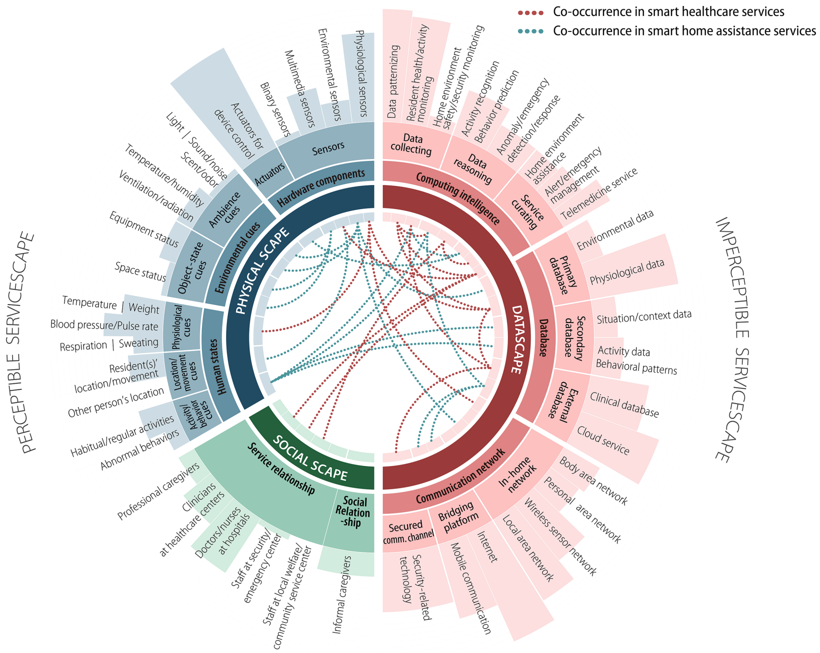

Fig. 2. Frequencies and co-occurrence analysis result of the SSW

Table 1. Video analysis results (frequency: the number of video clips representing each element)

Smart servicescape categories				Smart servicescape elements	Freq.	% (/30)
Perceptible servicescape	Physical scape	Hardware components	Sensors	Physiological sensors	23	76.7
				Environmental sensors	6	20.0
				Multimedia sensors	10	33.3
				Binary sensors	2	6.7
			Actuators	Actuators for device control	29	96.7
		Environmental cues	Ambience cues	Light	1	3.3
				Sound/noise	1	3.3
				Scent/odor	0	0.0
				Temperature/humidity	3	10.0
				Ventilation/radiation	2	6.7
			Object-State cues	Equipment status	5	16.7
				Space status	1	3.3
		Human states	Physiological cues	Body temperature	5	16.7
				Weight	6	20.0
				Blood pressure/pulse rate/glucose	15	50.0
				Respiration/sweating	7	23.3
				* *Others*	*12*	*40.0*
			Location/movement cues	Resident's location	2	6.7
				Resident's movement	7	23.3
				Other person's location	0	0.0
			Activity/behavior cues	Habitual/regular activities	8	26.7
				Abnormal behaviors	4	13.3

(*continued*)

Table 1. (*continued*)

Smart servicescape categories				Smart servicescape elements	Freq.	% (/30)
	Social scape	Service relationship		Professional caregivers	4	13.3
				Clinicians at healthcare centers	8	26.7
				Doctors/nurses at hospitals	16	53.3
				Staff at security/emergency centers	2	6.7
				Staff at local welfare service centers	0	0.0
		Social relationship		Informal caregivers	6	20.0
Imperceptible servicescape	Datascape	Computing intelligence	Data collecting	Data patternizing	29	96.7
				Resident health/activity monitoring	27	90.0
				Home environment/security monitoring	3	10.0
			Data reasoning	Activity recognition/behavior prediction	11	36.7
				Anomaly/emergency detection	7	23.3
			Service curating	Home environment assistance	7	23.3
				Alert/emergency management	8	26.7
				Telemedicine service	14	46.7
				** Others*	*15*	*50.0*
		Database	Primary database	Physiological data	23	76.7
				Environmental data	6	20.0
				** Multimedia data*	*10*	*33.3*
				** Human communication data*	*10*	*33.3*
				** Others*	*5*	*16.7*
			Secondary database	Situation/context data	6	20.0
				Activity data/behavioral patterns	7	23.3
			External database	Clinical database	15	50.0
				Cloud service	21	70.0
		Communication network	In-home network	Body area network	10	33.3
				Personal area network	8	26.7
				Wireless sensor network	18	60.0
				Local area network	24	80.0
			Bridging platform	Internet	30	100.0
				Mobile communication	19	63.3
			Secured comm. channel	Security-related technology	15	50.0

Note. The elements in italics with an asterisk (*) were newly added to the analytic framework during the analysis.

Necessity of New Elements for Subdivision. First, the actuators within the physical scape needed to be subdivided to distinguish the agent and recipient of the actuation process. For instance, the actuation can be specified as occurring from human to device, from device to human, between humans, or between devices. This can imply an additional constraint layer from the perspective of interactions.

Second, the physiological cues marked *others* in Table 1 needed to be more segmented. Today's high-end technologies allow physiological recognition to be widespread among smart services. Moreover, biometric authentication and security-related technologies are inevitable in smart healthcare services. Therefore, fingerprint, iris, voice, and face image cues can be added to the existing physiological cues. Hence, the primary data in databases also needed to be specified as voice or image data, in addition to multimedia data and human communication data, as newly marked in Table 1.

Third, the service curating in the datascape also required more subsections. The scenario videos showed various SHHSs in addition to the existing telemedicine, alert-management, and home-assistance services. Quotidian health-management services can be supplemented, which support exercise and fitness, nutrition-relevant behaviors, medication adherence, relaxation by body care, matching with off-line care services, etc.

Inversely, the communication network elements must be simplified. Due to the recent radical advancement of IoT technologies, the sub-elements of networks were usually simultaneously associated, from the perspective of service experiences.

4 Discussion and Conclusion

During the qualitative video analysis of 30 scenario movie clips on the SHHS, we validated and improved the SSW in several ways. First, we empirically validated that most of the SHHS scenarios were demonstrated well by the SSW's elements. Therefore, the SSW's applicability as a framework for service environmental constraints and system composition was preliminarily verified. We had validated the SSW in the medical services of hospital environments in out prior study [20], and this study applied the SSW to smart home environments. This implies that the SSW can be actually utilized in service development to establish the requirements for SHHS design.

Second, new service opportunities can be explored by analyzing the reason for the SSW elements that were little occupied in the scenarios. This might have occurred because the companies' promotional scenarios may have not sufficiently highlighted smart home management, which has already been largely investigated. Nevertheless, new service ideas can emerge through association with unconsidered elements.

Third, as noted in the specification of actuators, the validation of SSW implies an additional layer of service interactions. Various types of direct or ambient interactions among humans or devices can be defined to determine diverse service experiences.

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Service Science and Knowledge Science

Value-Dominant Logic: An Evolving Quantum Theory of Economics

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Abstract. Marketing logic is an important element of economic theory. As the science of economics evolves towards a deeper understanding of subjective value, marketing logic must evolve with it. Value is identified as an experience that lies entirely within the customer domain. Service providers can not create value, or even co-create it. Value is recognized as a creation of the individual customer, entirely within their own service system. The unit of analysis is the individual customer and the individual experience. The paper draws a parallel with quantum physics, where "the rules are different" [1]. Marketing logic and uncertainty must be reconstructed to deal with value uncertainty, and marketing itself can be re-defined.

Keywords: Value · Value-Dominant Logic · Economics

1 The History of Marketing Logic

In the January 2004 issue of The Journal Of Marketing, Stephen L. Vargo and Robert F. Lusch published *Evolving To A New Dominant Logic For Marketing* [2] and subsequently further developed the new logic in many different works, including two complementary papers by the same authors [3]. The theory outlined in those papers is that marketing was grounded in the goods-dominant logic of Adam Smith-era economics, and the exchange of goods for money. The authors argued for the replacement of this logic with Service-Dominant Logic (S-DL) and a substitution of a service-for-service exchange for the goods-for-money exchange. Goods are defined as distribution mechanisms for service provision.

A fundamental premise of Service-Dominant Logic in these works is that value is co-created by multiple actors, including the beneficiary. The emphasis that goods are desired not for their own sake, but for the services they are able to deliver, was not original. It dates back at least to Carl Menger's Principles Of Economics [4], originally published in 1871. Vargo and Lusch's contribution was more centered on (1) the service design method (that services are designed with customer feedback, a process that the authors christened "co-creation"; (2) that, as a consequence, services marketing has a special intensified focus on the customer, or customer-centricity; and (3) that customer relationship management therefore assumes greater importance for services marketing than for traditional product-based business brands.

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2 Further Evolution

Economic science has continued to grapple with how value is created, and the role of entrepreneurs, firms, organizations and institutions in that process. Value is a subjective experience of the customer. Only a customer can recognize his or her own wants, needs and desires. Customers express this recognition through the notion of uneasiness or dissatisfaction with respect to specific aspects of their own situation. They seek services produced by others to address their unease.

From a pure subjective logic, value is an experience only the individual interacting with a particular service or bundle of services can have. This individual emotional state cannot be fully and perfectly replicated or repeated. Value is personal, tacit, and dependent upon the individual's state of mind and the environment in which he/she is inserted at that particular time.

Therefore, while it is common terminology to say that entrepreneurs or firms or service providers create or co-create value, such a use of language is misleading. The logic of value means it cannot be created by an external force. The service provider can only propose value based on the best understanding of what is causing the customer's unease and the technical skill to develop possible solutions. Value will only be actually perceived, and therefore created, by the customer himself or herself.

3 Economic Theory and Marketing Logic: Quantum Economics

In the structure of systems, as laid out by Stephen Jay Kline, hierarchy is a necessary concept, as it "describes much (perhaps most) of the structure of many kinds of systems of importance" [5]. In system hierarchies, the variables, parameters, behaviors and the appropriate "rules" all typically vary between one level and the others in hierarchical structures [6].

Austrian economics, pioneered by Carl Menger, studies economic systems at a quantum level. Austrian economics employs methodological individualism, studying the actions and deducing the motivations of individual actors, in their roles both as producer and consumer, and observes individual transactions between producers and consumers. An economic system is an order brought about by the mutual adjustment of individuals in a market [7].

If marketing logic is to apply to service systems, the unit of analysis must be at the individual level – the quantum level in economics. As in quantum mechanics, at this level the world is not deterministic, and value cannot be objective. This economic world should be viewed as uncertain and randomly probabilistic.

4 Value Uncertainty

Wants are subjectively felt by consumers as a corollary of felt uneasiness: that there is something in the current situation that is lacking for them. This may initially be quite inarticulate – as in a vague feeling that "things could be better" – and may later result in the individual forming a hypothesis regarding what kind of new consumption experience might address their felt unease. Sometimes consumers are unable to diagnose their own problems and rely on the entrepreneur to exercise the role of diagnostic entrepreneur instead [8]. Entrepreneurial diagnosis is a cognitive skill possessed by the entrepreneur.

It is the consumer's continuous, wide-ranging desire for improvement in one's own life condition that pushes entrepreneurs to go beyond what is immediately doable under present market conditions – what Bylund (2016) calls the 'specialization deadlock' [9] – thereby driving innovation, economic growth and the overall advance of civilization.

Consumers organize a plethora of wants in a subjective ordinal ranking that they change and rearrange subconsciously at all times and according to their individual circumstances [10].

All of this subjective complexity means that objective observers, including entrepreneurs and marketers, cannot expect to perfectly identify individuals' needs or wants, nor measure the rankings that those individuals are allocating to their wants at any point in time or in any particular context.

5 Value in Experience: Only Those Who Ultimately Consume Create Value

It follows that customers and consumers, the individuals that ultimately use the solutions to their unease proposed by entrepreneurs, are the creators of value. They do so in a multi-stage process that combines emotion, search for possible solutions, judgement and action. Having identified an uneasiness to address, they evaluate available options for consumption on the basis of their perceived relative potential to solve the felt problem. Evaluation is a subjective process of answering the question "is it worth it?" – is the expenditure of scarce resources likely to yield a benefit that is greater than the cost? The consumer has the option of using their existing resources to solve the problem or deferring expenditure and accepting the uneasiness for the current time period. The evaluation process is complex, individual and subjective. The individual's benefit will include emotional as well as more functional benefits.

(It is important to stress that this analysis is valid for marketing logic in both B2B and B2C business systems. Individuals will be making the choices in the name of companies in B2B settings. Menger [5] established that the value of non-consumable products earlier in the value chain than goods or services for end-consumption (what he called "higher order goods") is derived from the value that the final product/service will have for the consumer).

The value experience per se occurs only through an act of consumption, by which is meant the direct use of some means to satisfy the felt unease. The individual creates a subjective value expectation before the acquisition, and then, to judge the value of the solution, compares the actual experience with the expected experience. Satisfaction occurs when the experience is equal to or better than the expectation. Experiences will have impact in future transactions, because they will, in some way, shift the consumer's expectations.

There is no co-creation role for the service provider. The service provider makes a value proposition and aims thereby to facilitate the consumer's experience by giving him/her a potential solution. At that point, the value experience is entirely in the customer's or consumer's domain. The customer allows the entry of the value proposition into their own system, i.e. their life with all its subjectivity and complexity and overlapping and interacting sub-systems. It is here that value is created in the user experience.

6 Foundational Premises of Value-Dominant Logic

In homage to Vargo and Lusch's original contributions, which were a seismic shift in the world of marketing and in business more broadly, we propose to outline the evolution of the Value-Dominant Logic (V-DL) utilizing a similar presentation format. The tectonic plates of strategic marketing still have quite a lot of movement in them and the subjective value foundations given by the Austrian School of Economics are the starting point of a second large shift in (1) the understanding of how value is created and (2) the role of entrepreneurs and organizations in that process. We thus take a vanguard position in this development, seeking to bring clarity to the field while indicating what types of powerful tools this new framework – and the coming shift – will make available.

To do so, we propose the following 10 foundational premises of VDL [11]:

- FP1: Value is a subjective experience of the consumer. This is the singular foundation of V-DL (in the parlance of Vargo and Lusch, it is axiomatic for our theory), from which all other premises follow [12].
- FP2: Only consumers can subjectively recognize their own wants, needs, and desires2. They express this recognition through the notion of uneasiness with respect to specific aspects of their own situation [13].
- FP3: Only those individuals who ultimately consume create value [5].
- FP4: To realize value, consumers exchange services for experiences with perceived value.
- FP5: Entrepreneurs profit (make money) by facilitating value to consumers.
- FP6: The purpose of entrepreneurship is the facilitation of value, from which it captures revenue [14]. (This is a corollary of FP1 as seen from the point of view of the value proposer, the entrepreneur).
- FP7: Empathy is the key to unlocking understanding of a consumer's felt uneasiness.
- FP8: Value facilitation is a combination of understanding consumers' uneasiness and technical knowledge joined in a value proposition.
- FP9: There will always be producer uncertainty because there is value uncertainty in the consumer's mind.
- FP10: Consumers rank their value experiences, but value itself is not quantifiable.

7 Implications: The New Marketing Logic

Up to this point, marketing logic has been objective. Value has been described as "created" or "co-created", implying objectivity of value. Under quantum economic logic governing the uncertain individual experience, this objectivity no longer holds. When there is uncertainty in the customer's mind, there will also be producer uncertainty, and the emergence of value from interactions and even transactions is not predictable. Value is not quantifiable.

The logic remaining for marketing is to attempt to qualify to fit in to the customer's own service system, and to wait for an invitation to do so. Pre-existing marketing concepts such as audience targeting, positioning, communication of benefits, engagement, loyalty, and many more must be abandoned.

8 A New Definition for Marketing

From time to time, The American Marketing Association publishes an updated definition of marketing for their members, and some research programs have attempted their own redefinitions [15]. We contribute to this tradition with our own redefinition based on the marketing logic of quantum economics.

Marketing is customer value focused human action that permeates the entire firm and all its processes. Marketing makes promises to customers through value propositions and facilitates fulfillment of the individual expectations stimulated by those promises, by supporting the customer's own value creation activities in their own context.

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The Impact of Chatbots on Customer Service Performance

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Abstract. The advent of chatbots in customer service solutions received increasing attention by research and practice throughout the last years. However, the relevant dimensions and features for service quality and service performance for chatbots remain quite unclear. Therefore, this research develops and tests a conceptual model for customer service quality and customer service performance in the context of chatbots. Additionally, the impact of the developed service dimensions on different customer relationship metrics is measured across different service channels (hotline versus chatbots). Findings of six independent studies indicate a strong main effect of the conceptualized service dimensions on customer satisfaction, service costs, intention to service reusage, word-of-mouth, and customer loyalty. However, different service dimensions are relevant for chatbots compared to a traditional service hotline.

Keywords: Chatbots · Customer service · Service quality · Service performance

1 Introduction

The introduction of chatbots in customer service interactions received increasing attention throughout the last years. However, the impact of chatbot usage on customer service perceptions and relevant metrics in the customer service environment remains quite unclear [1]. Chatbots might lead to innovative solutions for customer self-service and a drop of service costs. Yet, firms also need to develop further insights about the impact of service usage on metrics like customer satisfaction, loyalty, and the intention to reuse service applications.

Measurement frameworks for the impact of service chatbots on customer relationship metrics are rare [2]. In particular, it is not evident which service dimensions and precise features are relevant for the evaluation of service quality in the context of a chatbot and how they affect different performance metrics like customer satisfaction or customer loyalty. Therefore, this paper develops a measurement model for the service quality of chatbots and provides evidence for the performance impact of different service dimensions on relevant cost and customer relationship metrics. Moreover, the service dimensions and performance impact of chatbots is compared with traditional service channels deployed in the context of a customer service hotline.

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Accordingly, this paper focuses on the following three research questions: (1) *How is the construct of customer service quality conceptually defined in the context of chatbots?* (2) *How does the perception of service quality affect relevant cost and customer relationship metrics?* and (3) *What differences exist with respect to service dimensions and performance impact of chatbots compared to a service hotline?*

Six studies set out to work on these research questions. The first four studies follow mainstream scale development and validation procedures to develop a fundamental set of items for the construct of perceived service quality in the context of chatbots. The fifth study defines a measurement model for perceived service quality. The sixth study deploys the measurement model in a real service context characterized by a service chatbot based on IBM cloud solutions and a B2B service hotline. This corresponding study measures the causal impact of service quality on customer relationship performance in the two service channels (chatbot versus hotline) among a sample of 480 customers for business-to-business (B2B) solutions. The findings lead to four general dimensions for service quality in the context of chatbots. Moreover, results of causal analysis indicate a strong main effect of different service dimensions on service costs and customer satisfaction. However, different service dimensions are relevant for chatbots compared to a traditional service hotline and the customer-related performance differs between both channels.

2 Theoretical Foundation

The theoretical foundation for the evaluation of chatbots in the context of customer services refers mainly to information systems (IS) and marketing research. A relevant research stream in IS deals with *virtual assistants* [1–5]. A virtual assistant is a software service which applies the potentials of artificial intelligence in order to perform different tasks for users. Virtual assistants are being increasingly developed by firms to provide better experiences for customers and to manage interactions on issues relating to the offerings of the firm [1]. Some of the common services executed by virtual assistants include, responding to queries of customers, acting as a guide, leading customers to relevant topics on a website, or guiding them during their buying journey on an online shop. A virtual assistant is not only there to answer questions. Such services also focus on conversations and copy human behavior. The users should perceive that they are interacting with a real human.

One of the familiar approaches for the implementation of virtual assistants refers to *chatbots*. Chatbots, also known as conversional interfaces, are software driven services that can respond to natural language and try to hold a user interaction in a way that imitates a human service agent. Chatbots communicate with customers through various interfaces ranging from a simple text to speech recognition [6]. Such virtual assistants are getting a lot of attention from business firms, as they might help in improving customer service quality and reduce the costs in the customer service department by automation. However, measurement frameworks for the impact of service chatbots on customer perceptions are rare.

A recent research by Trivedi [7] claims that the success of chatbots in a customer service context is generally driven by information quality, system quality, and service quality. The objective quality of the chatbot impacts on the *perceived service quality* of the user during service usage [8]. Relevant dimensions for perceived service quality in customer service interactions are explored in marketing research. Orsingher et al. [9] suggest that customers' perceptions of service quality include three distinct dimensions of justice: procedural, interactional and distributive justice. Procedural justice refers to how the customer perceives the procedure behind the decision making and service resolution. A procedurally good service process is easy to access, enables the customer to have control in its disposition, is flexible and concludes in an appropriate and timely manner. Interactional justice refers to the communication between the customer and the service agent during the complaint handling process. Features as empathy, politeness, trust, and treatment are relevant when dealing with service issues. Distributive justice refers to the customer's perception of the firm's efforts to solve the service problem. In the context of services and complaint handling, an implicit promise of fairness is salient, and justice is critical to the consumers' perceptions.

How firms manage customer service issues is an important indicator of their customer centricity and overall service quality [10]. While poor service handling can amplify a negative evaluation of the overall service, excellent handling can boost customer service and customer loyalty [8]. To provide superior customer service, firms operate multiple channels, including traditional service channels (e.g. stores), call center hotlines and digital channels (e.g. social media, chatbots). However, firms need to expand their knowledge on relevant service dimensions and features for each service channel in order to define a proper service mix.

3 Methodology

This paper adopts psychometric scale development and validation procedures which were already performed in related research projects [11, 12]. The research process is grounded on a construct working definition for *perceived service quality*. The definition represents perceptions of users with respect to relevant service dimensions of a chatbot. The first stage of the research process involves four qualitative studies to define a pool of items for *service quality*. The second stage applies quantitative research methods to define the dimensional structure and to refine scales for service quality.

3.1 Study 1: Feature Description

Study 1 identifies features *technology vendors* use to describe the service quality and performance impact of chatbots. Websites, white papers, and external publications from technology vendors commonly contain features that describe the service quality and performance impact of chatbots. The data input incorporates reports and websites of 20 technology vendors listed in a recent market guide for virtual customer assistants published by *Gartner* [6]. During analysis data input reached theoretical saturation [13]. Therefore, the marginal return on examining more vendors diminished. In total, the process yielded 26 vendor-related features for service quality and 14 features for performance. The research process was supported by an analysis of the available scientific literature on chatbots in a customer service context [1–3, 5, 7]. Finally, feature descriptions and scientific publications yielded 29 features for service quality and 17 features for performance.

3.2 Study 2: Expert Interviews

Study 1 focuses on vendors' actual perception of chatbots, but the findings do not indicate how such perceptions correspond to the view of *subject matter experts*. Therefore, we undertook semi-structured expert interviews with eight executives responsible for chatbot implementation projects in German, Austrian, and Swiss firms. We selected the executives with respect to the industry of their firms and their role in managing chatbot implementation projects. Finally, we created at a sample of eight different industries (i.e., automotive, manufacturing, banking, insurance, retail, pharmaceutical, consulting, and utilities). The main purpose of the interviews was to describe the relevant metrics (features) for service quality performance in practical chatbot projects. After interpreting the results, we added 16 additional features for service quality (in total 45) and 8 features for performance (in total 25) to the pool.

3.3 Study 3: Supplementation of Features

Study 3 incorporates an extended sample. Here, 143 respondents of an international professional education program worked on an online survey. The respondents of the education program (average age: 33.4; male: 54%; female: 46%) described relevant features for service quality and performance from a user perspective in a survey that included an open-ended questionnaire [14]. Study 3 compiled another 22 features for service quality (in total 67) and 11 features for performance (in total 36).

3.4 Study 4: Item Reduction

Studies 1–3 yielded 103 features in total. Thus, we implemented several routines to reduce the initial item set. First of all, we eliminated items which are not used in common language [15]. Therefore, two researchers rated the frequency of each word in daily language (1 = very rarely, 7 = very frequently), and two researchers rated the appropriateness of features in describing chatbots (1 = not qualified at all, 7 = very qualified). Additionally, experts rated face and content validity [15, 16]. Two executives from technology vendors rated item appropriateness based on the concept of virtual assistants. Mean scores for each step (i.e., for appropriateness of use, to describe a chatbot, and to measure customer service performance) provided a screening mechanism. The resulting pool of items retained only items with an average evaluation value of at least 5 across each expert group. For further validation an academic scholar familiar with the development and implementation of chatbots compared the complete and reduced list of items. This led to a final list of 36 features for service quality and 22 features for performance.

3.5 Study 5: Identification of Service Quality Dimensions

Study 5 identifies the potential factor structure of service quality and service performance in a reflective measurement model by applying calibration procedures. In total, 253 respondents of professional education programs (average age: 35.6; male: 58%; female: 42%) participated in a survey titled "*Chatbots in Customer Service*". Respondents made experimental use of six implemented service chatbots and described their experience based on the following questions: "We are interested in your general experience while using the different chatbots. To what extent do the following items describe your expectations regarding service quality while using the chatbots?" Items were evaluated with 7-point Likert-type scales (1 = does not apply, 7 = totally applies).

Principal component analysis (PCA) followed by oblimin rotation allows examination of dimensionality and suggests items for deletion. A four-factor solution was the most appropriate according to a variety of commonly applied criteria. Through a meta-description for each dimension, the following four facets of perceived service quality evolved: (1) *customer effort*, (2) *procedural justice*, (3) *interactional justice*, and (4) *quality of service solution*. Overall, this led to a four-factor structure in the conceptualization of perceived service quality with 16 different features (items).

3.6 Study 6: Model Evaluation

Study 6 aims to develop and test a causal model with the four derived service dimensions (based on study 5) and typical performance dimensions (based on the features defined in study 4) for customer services. The study tested the formulated hypotheses using data derived with the customer services department of a German B2B manufacturer. The customers of this manufacturer already received services through different channels. Therefore, we decided to use two different samples for our research, one from a traditional channel (hotline: sample A) and one from the chatbot deployed as web service in online shop (chatbot: sample B). The chatbot is based on an IBM Watson Assistant solution and provides information for customers on the price and shipping time of a specific product. This was also an important service issue deployed by the hotline. Thus, it was possible to interview customers immediately after a service experience in two different channels. In sample A, customers were invited by email to take part in the service survey immediately after a hotline contact. In sample B, customers received a comparable invitation directly as a pop-up in the user interface of the chatbot. All interviews were conducted online. Thereby, we arrived at a sample of 480 customers for business-to-business (B2B) solutions in Germany, Austria, and Switzerland (240 in sample A, 240 in sample B).

After the measurement models were deemed to be acceptable, we used partial least squares structural equation modelling (PLS SEM) with the software Smart PLS to test various path models between the four service dimensions and relevant performance constructs. We tested the models stand alone on each single sample (hotline versus chatbot). Furthermore, we applied an established multigroup method to analyze the differences between both samples according to our research model.

4 Results and Discussion

The final model is outlined in Fig. 1. The four dimensions for service quality impact on customer satisfaction and service costs. This means that firms need to develop chatbots with low customer effort, high procedural and interactional justice and a high quality of the service solution, if they are to enhance customer satisfaction and decrease service costs. The four dimensions of service quality explain 71.7% of the variance in customer satisfaction (total sample, n = 480). A test of different models suggests that a *full mediation model* leads to optimal results, indicating that customer satisfaction is fully mediating the impact of perceived service quality on different customer relationship metrics. This is also corresponding with existing marketing research [8, 10].

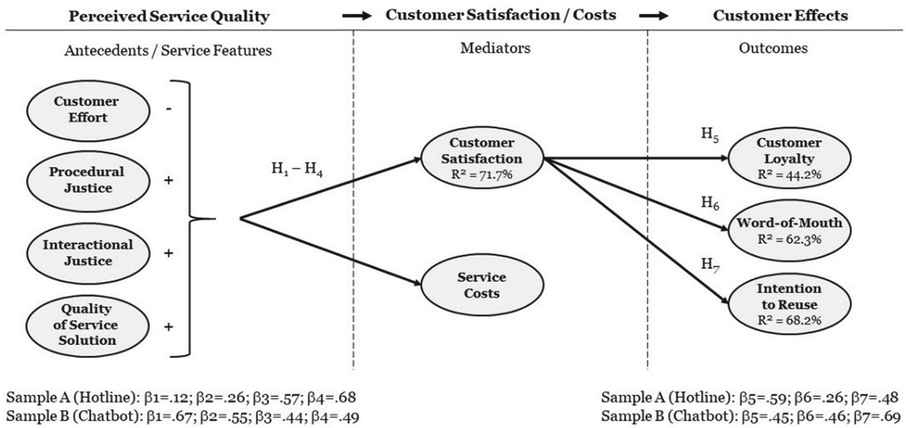

Fig. 1. Research model

All seven main effects were supported in both samples. Additionally, data from multigroup (chatbot versus hotline sample) analysis provides relevant insights with respect to channel differences, e.g. customer satisfaction at a hotline is mainly driven by interactional justice (.57) and the quality of the service solution (.68), whereas on a chatbot customer effort (.67) and procedural justice (.55) are of higher importance. Moreover, the performance impact of chatbots is different compared to a traditional hotline. Chatbots impact stronger on word-of-mouth (.46) and intention to reuse (.69), whereas customer satisfaction derived by a hotline is affecting stronger on customer loyalty (.59).

In a nutshell, as the results indicate, the service quality of chatbots contains four dimensions and 16 features along customer effort, procedural justice, interactional justice, and quality of service solution. The findings indicate a strong main effect of service quality on customer satisfaction and service costs. Moreover, customer satisfaction is mediating the effect on further performance measures. Different service dimensions are relevant for chatbots compared to a traditional service hotline. The most important service dimensions in a chatbot context relate to the reduction of customer efforts and procedural justice. Additionally, the customer-related performance difference between chatbots and a service hotline is considerable, indicating that chatbots offer a seminal extension for the service environment in B2B markets.

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Can Humans Learn from AI? A Fundamental Question in Knowledge Science in the AI Era

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Abstract. The paper discusses four research questions on the human side of AI (Artificial Intelligence) technology one by one, from an S-D logic perspective. The main question is "Can humans learn from AI?", and the three subsidiary questions are "Can AI be a legitimate actor?", "Can humans work comfortably with AI just as they do with humans?", and "Can humans perform better with support from AI?". We conjecture that the answers to all the questions are YES. Specifically, we conjecture that the key for human experts to learn from AI is to develop adequate boundary objects between AI and human experts. Tacit knowledge creation drives the knowledge integration between AI judgement and human expert judgement.

Keywords: Artificial intelligence · Collaboration between AI and humans · Tacit knowledge creation · Boundary objects

1 Introduction

Artificial intelligence (AI) is becoming ubiquitous and will soon play indispensable roles in our society. In particular, it will become a formidable rival to human experts in various fields. AI will provide products/services prediction capability [1]. In the short run, it will offer the prediction power to help human judgement, but in the end—when the predictions of AI become more precise than those of humans—it will make the final judgement on behalf of humans. AI will become an autonomous entity behaving as if it were a human; at least, looking from the outside.

In some sense, AI can learn from humans, i.e., learning through big data that humans generate daily. How about the reverse? Can humans learn from AI? We decompose this question into three subsidiary questions and then we make answers to these questions. We bring up these questions as fundamental questions in Knowledge Science in the AI era.

What AI can do is very different from what humans can do in nature. Suppose you are a young researcher. AI has an exhaustive search capability and can in a second identify various kinds of literature that are worthwhile for you to read. You can save time and use the time saved to do creative tasks. This sounds great, but is it good for you in the end? Is there any risk for you to lose the chance of competency development associated with doing of good literature review? You could instead continue doing conventional literature searches by yourself without AI, but then you may miss an

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opportunity to get a job because your performance might not be as good as that of your colleagues who accept unthinkingly the benefits of AI. We can solve this dilemma. If you are able to learn from AI, you can achieve competency development with the help of AI, and simultaneously get the benefits of power of AI to achieve high performance.

We divide the main research question, “Can humans learn from AI?”, into three subsidiary research questions: SRQ1, “Can AI be a *legitimate* actor?”; SRQ2, “Can humans work *comfortably* with AI as they do with humans?”; SRQ3, “Can humans perform *better* with support from AI?”.

S-D Logic [2] calls all the kinds of stakeholders in service eco-systems actors. In service eco-systems, actors exchange services with one another. Companies that offer or sell services are actors. Customers who receive or purchase services are actors. Platformers who intermediate service exchanges are actors. Miscellaneous people indirectly related to those service exchanges are also actors. Everyone who participates in service eco-systems is an actor. An actor possesses resource at hand to strengthen its ability for service exchange. It draws on tools, special kinds of resources, to augment its flesh-and-blood ability. For example, with an electronic calculator we can do arithmetic calculations accurately and quickly. SRQ1 poses a fundamental question whether AI becomes a legitimate actor in service eco-system or not, specifically, when AI becomes an autonomous entity.

Next, we pose SRQ2 as a further question. In theory, service exchange possibly happens in all possible combinations of two actors. Practically, however, it does not. It happens only between actors who want it to happen. In practice, we choose appropriate partners for service exchange to make up for insufficient resources because we alone cannot have all the necessary resources (e.g., tools, money, knowledge, skills). Then, can AI be a good partner of us to make up the resource shortage? Are there any obstacles that prevent us from having a good relationship with AI? What conditions are necessary to work comfortably with AI? These are the essence behind SRQ2.

Even when the answer to SRQ2 is YES, there is a possibility that humans cannot perform better with strong support from AI. This is SRQ3. Humans are creatures and their performance cannot increase as rapidly as AI. It is a matter of time before AI will overwhelm humans where AI does better than humans. If humans cannot perform better even with support from AI, then there is a possibility that the professional jobs for humans will disappear.

Finally, based on the discussion about all the SRQs, we make an answer to the main question. We conjecture that humans can learn from AI by inserting adequate *boundary objects* between of AI and humans. The idea of boundary objects was introduced by Star [3, 4] in 1989. In practical use, they connect different “communities of practice” by reducing the gap of the different practices. AI will create its own communities of practice. Therefore, we expect that it is significant to develop adequate boundary objects that bridges AI and humans. As a corollary to this, loss of professional jobs can be prevented by developing adequate boundary objects between AI and humans.

In the remaining sections, we discuss the four research questions one by one.

2 Can AI be a Legitimate Actor?

This question can be re-phrased as “is AI a tool or an actor?” You might say that AI is a just tool because people can purchase it. However, these days, AI is offered as a service by platformers over Internet. In this setting, the service looks like an exchange between the platformer and the beneficiary actor. However, when we zoom in the platformer, the service looks like an exchange between AI and the beneficiary actor directly (Fig. 1). For example, Uber offers an application matching Uber drivers and passengers, where the drivers are managed not by human managers but by an algorithm [5].

In the near future, autonomous AI will be able to take the initiative to start service exchange. For example, when autonomous driverless cars under the management of Uber algorithms become ubiquitous and help us change our location from where we are to where we need to be, why can we not say they are actors offering their competence for our benefit [6]?

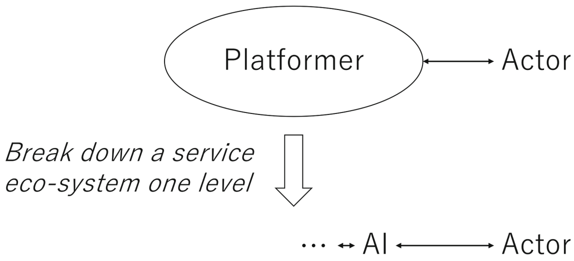

Fig. 1. Conventionally, AI is a part of a surrounding service eco-system and not considered a legitimate actor (*upper service exchange*). The surrounding service eco-system is an upper level actor, e.g., a platformer like Uber. However, it can be seen as a legitimate actor (*lower service exchange)* when the service eco-system is broken down one level. This becomes more apparent when the AI comes to the service front as an autonomous entity, e.g., autonomous driverless cars managed by Uber’s algorithms.

3 Can Humans Work Comfortably with AI Just as They Do with Humans?

Why can humans produce innovative results through collaboration? One possible answer is *shared intentionality* [7]. Shared intentionality distinguishes humans and other creatures, such as chimpanzees. Even 1- and 2-year-old humans show behaviors different from those of chimpanzees. They show “joint attention instead of joint attention, cooperative communication instead of social manipulation, collaboration instead of group activity, and instructed learning instead of social learning” [7]. In essence, humans can care for each other and, consequently, they work together comfortably.

At this moment, it seems safe to assume that AI cannot have shared intentionality. AI cannot have joint attention, cooperative communication, and collaboration with humans, and instructed learning from humans. We conjecture here that *psychological safety* [8] can be a substitute for shared intentionality between AI and humans (Fig. 2).

The importance of the concept psychological safety has become known through Google's project Aristotle [8]. The atmosphere in which one can say anything fosters creative minds and promises productive outcomes. It is difficult to have psychological safety with people who have a sense of competition with each other. It thus seems easy to develop psychological safety with AI because it has no appetite for competition with humans. We therefore conjecture that humans can collaborate with AI on the ground of psychological safety, just like with humans.

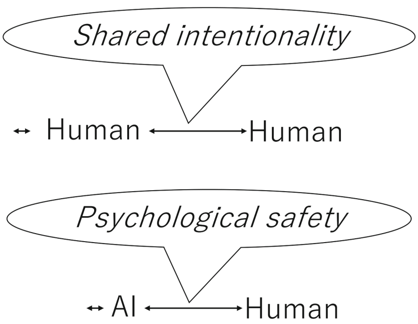

Fig. 2. Humans can work together comfortably because they have shared intentionality as their nature (*upper service exchange*). We conjecture that AI and humans can share psychological safety and work together (*lower service exchange*).

4 Can Humans Perform Better with Support from AI?

Humans heavily rely on others' knowledge [9]. Moreover, humans have not only individual intelligence but also collective intelligence [10]. A team of humans may show performance worse than the sum of their individual performances, but another team of humans can perform better than the sum of its individual performances. One of the conditions for collective intelligence is the psychological safety explained in the previous section.

Then, is it possible that a team of AI and humans can show performance than the sum of their individual performances? One example of productive collaboration between AI and humans is the form of chess that grandmaster Garry Kasparov named "Advanced Chess" [11]. In Advanced Chess, AI and humans merge their move judgment. A good collaborative team of AI and humans performs better than AI alone or a poor collaborative team of AI and humans. We infer from this that humans can perform better with support from AI in various social settings.

5 Can Humans Learn from AI?

Tacit knowledge creation between humans is one important mode of organizational learning [12]. If humans can learn from the "behavior" of AI through tacit knowledge creation, just like apprentices learn skills from their masters, we can make an affirmative answer to the main question of the paper.

We conjecture that humans can learn from the behavior of AI by inserting between AI and humans boundary objects that display the difference between AI and human expert judgement (Fig. 3).

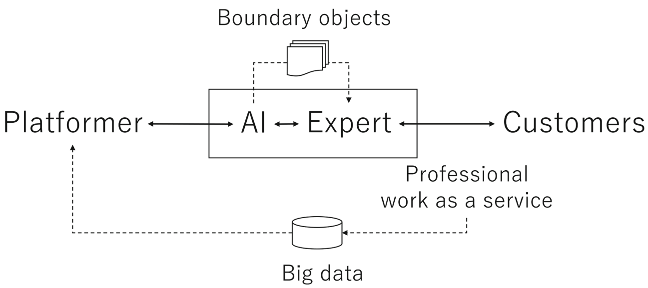

Fig. 3. In some sense, AI can learn from human experts, i.e., learning through big data generated through professional work (*lower dotted arrows*). Our interest is the reverse. We conjecture that human experts can learn from AI while they are working with AI if there are well-designed boundary objects between AI and human experts (*upper dotted arrows*).

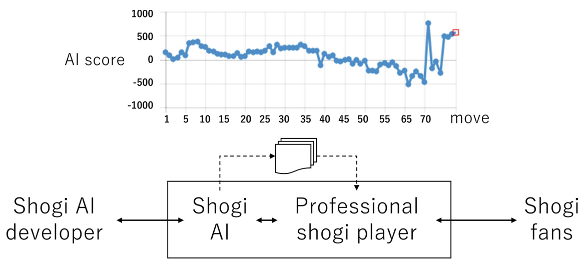

Fig. 4. Professional shogi (Japanese chess) players can learn through a situational judgement trend graph (*move-AI score graph*) produced by shogi AI. Professional shogi players can update their move strategy when they find a difference between their judgment and AI judgement.

Professional shogi (Japanese chess) players can acquire new strategic moves of pieces through monitoring an "evaluation score" generated by AI after each move (Fig. 4). Human professional shogi plays can improve their "situational judgement of a shogi board" by analyzing the gap between their own move evaluation and AI's move evaluation score.

In conclusion, we conjecture that developing adequate boundary objects between AI and humans is the key element for AI and humans to live side-by-side in our society.

6 Summary

In this paper we focused on a positive side of artificial intelligence rather than a negative side, such as disappearing jobs. We made a series of conjectures. (1) AI can be a legitimate actor in the framework of S-D logic. (2) Humans can work comfortably with AI just as they do with humans. (3) Humans can perform better with support from AI. (4) Humans can learn from AI through well-designed boundary objects between AI and humans, which enable filling of the gap between AI judgement and human expert judgement.

In conclusion, we think that an adequately designed boundary object that displays AI judgement will be the key to making a combination of AI and human experts productive. This productivity is made possible by the process of tacit knowledge creation, where human experts update their expert knowledge by integrating AI judgement into their own judgement. As a corollary to this, we further conjecture that so-called explainable AI is unnecessary even though it is said that the explainable AI is needed to convince human experts to work with AI.

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Intelligence Augmentation (IA) in Complex Decision Making: A New View of the *vSa* Concept of Relevance

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Abstract. Recent literature from the stream of the Viable Systems Approach (*vSa*) highlighs the need to shift from the concept of Artificial Intelligence (AI) to that of Intelligence Augmentation (IA) in complex decision making. IA is defined as an intelligence given by the integration and interaction between *wise* people and AI entities. More specifically, in the interpretative framework of the *vSa* Information Variety Model (IVM), IA qualifies the ability to approach a problem by changing the system's Information Variety. To understand how this process occurs and its latent effects, it is useful to refer to the new interpretation of the *vSa* concept of *relevance*. Using this concept and the IVM, the paper illustrates how IA addresses the complexity of decision-making at the same time highlighting how interaction with AI determines a transformation of the structure and process of human thinking capability and how technology is becoming ever more critical for humans.

Keywords: Complex-decision making · Viable Systems Approach · Artificial Intelligence · Intelligence Augmentation · Relevance · Wise systems

1 Introduction

In the context of managerial literature, recent studies show that the focus of research and management has moved from the smartness of organizations (structural endowment of technology) to the ability of decision makers to implement and use intelligent algorithms capable of supporting decision-making processes and thus enhancing the performance of 'intelligent' organizational systems (systems endowment of technology) [1–3].

These studies lead to a systems qualification of the concept of intelligence, based on the interpretation of the interaction between humans and machines viewed no longer as a simple amplification of cognitive ability (greater elaboration capability) but as a

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'collaborative' integration of cognitive processes, that is 'Intelligence Augmentation' (IA). In summary, interaction with artificial intelligence changes the way people mature their rational and emotional intelligence: for example, compared to peers ten years ago, digital natives experience technology as an essential and indispensable component in many processes of their life. An important implication of this change is that the way in which humans interact with technology is much more relevant than the technology itself.

The *vSA* studies on Information Variety and Systems Relevance allow us to explain this new interpretation of the human-machine interaction in terms of Intelligence Augmentation (IA). In essence, interaction with machines determines a transformation of the structure and process of human thinking enhancing cognitive processes and making them wiser rather than simply smarter systems.

The 'wise' system concept is developed in the theoretical context of Service Science [4] that introduces wise service systems as systems "that connect to human values and positively impact future generation of people" [5]. Reconceived from a *vSA* perspective, the process of knowledge creation of a *wise* service system is enhanced by Intelligence Augmentation (IA) [5–7]. As it will be clarified in the following sections, to understand the role of wise systems in interaction with technology, the concept of *relevance*, developed in the interpretive framework of the *vSA* is of great help: viable systems interact in their living context by establishing relationships with other systems entities (suprasystems) that own the resources necessary to their viable functioning; in this process, the concept of relevance qualifies the capability of the suprasystem to 'condition' the survival prospects of the viable system considered.

The work is organized as follows: the next sessions will recall the concepts of IA and the Information Variety Model (IVM) that already exist in literature [1, 2] and clarify the *vSA* innovative representation of systems' knowledge endowment. Then, the *vSA* concept of relevance, together with other key *vSA* concepts, will be used to explain the IA-based knowledge variation process that supports complex decision making. A final section will discuss the main implications of the proposed view, highlighting how technology is becoming ever more critique for humans, challenging their role in cognitive processes and making it relevant to understand how to put them back at the centre of knowledge creation against the emergence of a potential new species of 'algorithm-dependent' humans.

2 Intelligence Augmentation in Complex Decision Making

Managerial studies of decision support systems have traditionally been based on the model developed in 1971 by Gorry and Scott Morton [8], who used Anthony's management categories [9] and the taxonomy of Simon's decision types [10] to explain the usefulness of intelligent systems. This approach, although valid today, must be reinterpreted due to the technological and logical evolution and the ever-greater complexity of the systems and organizational dynamics.

The extensive and increasing use of Artificial Intelligence (AI) makes it necessary, in particular, to understand its effects on humans. According to the concept of Intelligence Augmentation (IA), one of the main effects is an enhanced human capacity in the use of technology that qualifies the notion of wiser systems [3, 11].

2.1 Intelligence and Wisdom in Decision Making

In this regard, it is useful to recall the concepts of intelligence and wisdom [5, 11]. According to the *vSA*, intelligence can be seen as the ability of a system to survive in a context while maintaining its identity and producing in it and with-it value [5, 6]. In this sense, intelligence qualifies a potential of systems viability, which, referring to the space-time dimension in which technology evolves, represents a necessary, although not sufficient, condition to create *consonance*. The creation of consonance guarantees the systems themselves and society, as an articulated set of systems, a harmonious co-evolution. Wisdom ('Phroneris' - Aristotle), on the other hand, is a prerogative of the system capable of 'experiencing' change by generating *resonance* in the context, i.e. supporting, in time and space, production processes of widespread and shared value. In this sense, wisdom presupposes the generation of a collective intelligence capable of balancing individual and collective interests [5, 6].

In this broader perspective, the intelligence of wise systems is qualified not so much by the competence of solving a problem but by the ability to circumscribe it. In essence, wisdom gives intelligence the vision ability of a large whole of elements with differentiated relevance with respect to the best resolution possibilities of the problem itself: the system is capable of envisioning not so much greater but better solution options. It is in this sense that the concept of wisdom intervenes to qualify IA by enhancing not so much the ability to manage and process information but the ability to conceive better resolution possibilities in a wider view.

This means going beyond the 'solving' dimension of the problem to support the complexity of 'decision making' which requires a 'meta' interpretative positioning with respect to the specificity of the problem in order to read the link between individual and collective perspectives and conceive resolution possibilities capable of harmonizing them in the whole.

2.2 The Information Variety Model (IVM)

As affirmed, to understand the dynamics of IA, it is useful to refer to the Information Variety Model (IVM) [12], by virtue of which IA qualifies the ability to circumscribe a problem and, therefore, to approach a possible solution by appropriately leveraging the various elements of the system's variety, namely:

i) value categories;
ii) interpretative schemes;
iii) information units.

In short, according to this model, being intelligent means deciding not much on the basis of data and information but on the basis of schemes and values that are the elements that make the knowledge endowment an intelligence able to take the best decision in specific circumstances [1]. In this perspective, an intelligent human interaction with technology (IA) qualifies an interpretative approach to the problem that, thanks to the action of the schemes and value categories in a collaborative environment, opens up a range of resolution options with greater potential for resonance in the context. The use of the interpretative schemes and value categories progressively make the human-machine system wiser in the decision-making processes, thus generating (IA). It follows that, in a complex decision-making context:

– the choice adopted depends on the role played by the interpretative schemes (that determine the interpretative address);
– a new idea/ possible solution is strongly influenced by certain value categories (that determine the acceptance of the choice).

In essence, each level of the IVM qualifies different kind of knowledge approaches useful in different problematic contexts: the information units are relevant in optimization algorithms of problem solving and are enhanced by AI (smartness); the interpretative schemes and value categories are relevant in complex decision making (intelligence and wisdom) and are enhanced by IA [13]. Choice depends on the level of consonance developed in the context by the decision maker, i.e. the capacity of alignment/attraction achieved by the system by expressing its rational but also emotional character [14]. If the rational side directs more towards optimization approaches (which mainly benefit from AI), the emotional side mainly directs towards harmonizing the choices (which mainly benefit from IA). It is thus possible to understand why people should develop more emotional and social intelligence than rational intelligence to create a wise decision system based on a virtuous integration of humans and machines [2].

3 The Role of the *vSA* Relevance in Complex Decision Making

3.1 A Novel View of the *vSA* Concept of Relevance

Managerial decision-making processes are conditioned by the relevance of the suprasystems interpreted as systems that project their own expectations, constraints and rules on other systems [15].

As highlighted, decision makers act on the basis not only of the rational sphere of intelligence, but also of the emotional one which is subject to state changes in time and space, above all because of the varying viability conditions (detected pressures).

In literature, *relevance* has been defined as a criterion of assessment and selection of suprasystems, made by the decision maker in order to establish effective relationship and endow the governed system with the resources necessary to its functioning. It is a latent variable which cannot be observed directly, and which can be measured through two elements: the critical bearing of resources and the influence exercisable [14, 15].

As mentioned, the determination of the degree of relevance is the result of a value judgment formulated by the decision maker with reference to the capabilities and probabilities of a suprasystem to be indispensable and to condition the development of an inter-systemic relationship and the pursuit of goals. The correct interpretation, by the decision maker, of the interactional potentials resulting from the establishment of a relationship with a suprasystem can be a source of value creation and competitive advantage and, therefore, can improve the survival chances of the system. For this reason, the determination of the 'attraction capacity' exercisable by each suprasystem constitutes a fundamental moment in defining the choices to be made. The subjective and contextual nature of the relevance, connected to the process of perception by the decision maker, does not imply that there is no possibility of measuring it. In fact, it is possible to rely on the criticality and influence characteristics of relevance. By virtue of these two characters, it is possible to distinguish a relevance that is influent (systemic) and a relevance that is structural (critical). Structural or critical relevance refers to those components unquestionably necessary to carry out a process in different contexts: for example, the hand is a structurally critical component in the game of tennis, writing, eating and so on. The systemic relevance of influence, on the other hand, concerns components that condition specific processes and actions: for example, a book is a systemically influent component in the process of 'expanding one's culture'.

3.2 The Relevance Explanation of IA in Managerial Decisions

From a managerial view point, what has been discussed so far is disruptive: while the conditions of viability of a system generally depend on the strategy and the adequacy of its goals, what is mostly important is the decision maker's ability to manage the degree of consonance at the various interaction levels in the context[1]. This is important because the suprasystems' relevance varies depending on the degree of consonance developed in the iteration processes. The consonance is measured by the speed of change of the system's Information Variety (IV) as an effect of the dynamic of interaction with the suprasystem. Hence, this IV variation speed depends on the relevance of the suprasystems that acts as an obstacle to the change of the system: the more the consonance grows the more the relevance changes (dependence inertia). In other words, while the influent relevance refers to a certain space-time context, the critical relevance is widespread in time and space. It must be said, however, that if the influence is confirmed over time, it can become critical, as it is recurrent and necessary.

From a managerial viewpoint, as anticipated in Sect. 2, the consonance concerns the ability to align with the other systems following their own evolutionary trajectories and is always emotional. In the case of technology, the growth in consonance with it that has been recorded over time, means that technology itself, from an influent suprasystem, becomes increasingly critical as the algorithms that are defined with it

[1] To understand the *vSA*, it is important to remind that it is an approach based on metaphors and analogies that are useful for understanding business phenomena. So to better understand the concepts of relevance and consonance, in systems terms, we refer to some analogies with Newtonian science in which relevance is the equivalent of mass. We know that mass in physics is distinguished in gravitational mass and inertial mass. Physical mass is the obstacle to change just as relevance is the obstacle to change: when we have relevant suprasystems, it is as if we had constraints on action just as inertial mass is a constraint in physics. But while in Newtonian physisc the mass is uniquely determined and therefore cannot vary, in Einstain's relativistic physics the mass can vary and varies due to the speed that, in viable systems, is the equivalent of consonance. By analogy, the more the consonance grows the more the relevance changes even if it is influent. This means that if the suprasystem is influent and has become super consonant, that is, an excess of consonance occurs, then the suprasystem becomes pathological and therefore becomes influent from critical. In management, this explains why a successful entrepreneur at one time may not be successful in another.

permeate and condition all the processes of socio-technical systems and communities. In this sense, relevance refers to a systemic process dynamic; sometimes, however, it assumes a structural character when it becomes critical in the context regardless of the process in progress. By this means, relevance can be read not only as capacity of pressure but also as capacity of attraction, which can be influent and critical, as clarified. For example, if a service system is conditioned by a suprasystem that is critical, it loses degrees of freedom in taking choices: hence, the suprasystem's relevance becomes critical and not only influent [14, 15].

In the case of technology, it is clear that while at the beginning it is at most influent in the various processes of man, over time, by virtue of the dynamics highlighted, if and as the consonance grows, its relevance changes from influent to critical. As technology enters all humans' processes until it becomes indispensable, its relevance becomes critical. Suffice it to think at the omni presence of smartphones in the life of young people (and not only). The growing consonance of man with technology means that decisions are increasingly influenced by the technology whose attractiveness grows inexorably. A further element that is important to note here is that what attracts is not the technology itself (i.e. the smartphone) but the algorithm, that is the function that the smartphone manages when interacting with humans (that is the video game, the social network, etc.). Accordingly, decision is (systemically) conditioned by algorithms, increasingly developed thanks to technological progress, and not by the technology infrastructure. Therefore, as technological evolution spreads and develops consonance in the viable context of humans, it becomes ever more critical as the managed algorithms permeate the decision systems becoming indispensable in the process. By interpreting the role of technology in this way, one understands how the IA deriving from human-machine integration, on the one hand, implies a *differentiator* of human cognitive processes, on the other hand, it raises the relevance of the technology suprasystem by transforming it from an influential resource to a critical one.

4 Discussion and Conclusion

Sharing what has been proposed, the managerial decision results increasingly conditioned by the technology 'suprasystem' which, due to its pervasiveness, becomes progressively critical. Another important element becomes apparent in this perspective: the power of the technology's 'owner'. The owner becomes the subject who, due to a new wider/deeper Information Variety, can be more consonant with the algorithm/process and manage the power/decision-making moment. In other words, IA is substantiated not in the technological structure, but in the algorithm present in it, which differentiates its operation by reason of a so-called process owner. In this sense, IA characterizes more the *wise* systems (capable of managing in an overall and equifinal way), that the *smart* systems (able to solve problems and not necessarily for collective benefits) or even the *intelligent* ones (mainly able to understand).

Therefore, it can be argued that, especially in a complex context of fast technological evolution, decisions are made on the basis of algorithms. The new generations will be increasingly conditioned by the highlighted critical nature of the technology relevance, i.e. by the process algorithms that are implemented with it. Generally, those who manage the technology simply provide the algorithm and not program its effects. For example, the algorithm could be a data mining based on the neural network which then learns from the user and behaves like him, but certainly it will not be the user to decide but the algorithm that behaves like the user, who will end up invoking the algorithm to ask him what to do when he is in trouble.

In conclusion, the new IA conceptualization, as explained through the new view of the concept of *relevance*, represents a collaborative and integrated intelligence that allows the business system to evolve from a smart system to a wise system by integrating the action of the rational component with the emotional one, hence putting back humans at the centre of the process [1–3, 5, 6, 13, 16–20, 21].

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A Framework for a Practical Nurse Scheduling Approach: A Case of Operating Room of a Hospital in Thailand

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Abstract. Nurse Schedule Problem (NSP) is the assignment of nurses to fulfill hospitals operational goal and regulations. The major aim of NSP is to minimize the total cost, maximizing nurse's satisfaction, or maintain balanced distribution among preferable assignments and workloads. This paper is the preliminary research in development of NSP for a case of an operating room at a private hospital in Pathumthani, Thailand. An interview with the head nurse was conducted to capture insights and emerging issues that the head nurse wants to resolve. Then, a framework is proposed as a guideline for the development stochastic optimization model to tackle uncertainties in patients' arrival and surgery duration which are the main concerns. This paper aims to serve as a fundamental stage for a further case based NSP development research.

Keywords: Job satisfaction · Nurse scheduling problem · Healthcare management · Scheduling

1 Introduction

Nurse and medical staff are usually required to perform their duties over excessively long and irregular work hours. Certain shift assignment criteria are normally in place to ensure their workplace well-being and good work-life balance. However, in practice, nurses are still at high risk of receiving the cumulative effects of sleep disorders [1] and carrying excessive fatigue [2]. Working under shift work conditions, nurses are constantly subjected to work time alteration. Many find it difficult to maintain a proper work-life balance under a shift rotation scheme [3]. A robust and agreeable shift-scheduling for nurses is required to obtain smooth and optimized operations while providing nursing staffs with favorable working conditions. In the research field of the

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nurse scheduling problem (NSP), previous studies have addressed potentially important nurse scheduling parameters and developed optimization-based decision-making tools. A number of nurse scheduling techniques and mathematical problem-solving approaches have been proposed. However, there is still a lack of empirical evidence about the effectiveness and the practicality of the pro-posed techniques. Based on our literature review, case study research is still underemphasized in nurse scheduling literature. This present study is the first step of wider research aimed to conduct a case study research to bridge the gap between theory and practice in nurse scheduling. The data regarding the current nurse scheduling of an operating room in a hospital located in Pathum Thani, Thailand, are collected and summarized in the following sections. A research framework that identifies the important scheduling parameters of the operating room case study and the main components of future scheduling approach is provided.

2 Literature Review

The research on NSP has been well-documented in both operational research and health-care system management literature. NSP is different from other scheduling problems due to its highly constrained nature. In hospitals, numerous requirements and regulations need to be considered for human resource planning and scheduling of staff. NSP is classified as NP-hard problem [4], due to the potentially large number of decision variables and constraints. Optimization, heuristics and hybrid problem-solving approaches have been used by previous NSP studies. The problem can be formulated as single- or multiple- operational objectives that involve the minimization of nurse staffing cost [5] and [6] or the maximization of nurse satisfaction [7] and [8]. Optimization-based NSP can be formulated as goal programming by minimizing the undesirable deviation from target value such as workload [9], targeted nurse-patient ratio, favorable and unfavorable shifts, and rest days [10]. In the case with a large number of constraints, NSP can be formulated as a constraint satisfaction problem as in [11] and [12], which aims to satisfy all hard constraints and minimize violation of soft constraints. All of the hard constraints are related to regulations and coverage requirements which cannot be violated. Soft constraints are related to preferences and balanced distribution. These soft constraints can be violated with penalties. The use of optimization techniques can help reach optimality. However, due to the complex nature of NSP, optimization potentially requires tremendous computation efforts, while a feasible solution is not guaranteed. Therefore, the application of problem-specific heuristics [13], and metaheuristics such as genetic algorithm [14] and simulated annealing [15] approaches in solving NSP has become more favored for its capability of generating good solutions with less solving time.

In order to develop a nurse scheduling approach with improved practicality, issues in real case studies such as uncertainties should be taken into account, given the dynamic nature of hospital settings. However, the NSP with uncertain parameters has not been receiving much attention in the literature. In [16] the fuzzy integer programming approach is applied to address the fuzzy environment of nurse coverage and preferences. Similarly, [17] developed a stochastic optimization technique to deal with uncertainties regarding demand and preferences. [18] consider uncertainties in patients' arrival and their duration of stay using a stochastic optimization technique. [19] developed stochastic programming coupled with genetic algorithm for NSP with uncertain patient census and nurse absenteeism. To this end, there are still remaining research gaps. First, the way operation uncertainties are identified and managed can be improved. Second, the implementation of conceptual scheduling models can be validated by case study analysis. The details of our nurse scheduling case study are given in the next section.

3 A Case Study and Proposed Framework

The case study of this research is a hospital in Pathumthani, Thailand. The hospital is the main private hospital in the area that receives patients with national standard medical rights including universal coverage and social security. The designated department is the surgery department, where nurses are employed 24 h. An interview survey with the head nurse who is in charge of nurse scheduling was conducted to gain insights into problems emerging in the department.

The hospital has 3 working shifts, morning from 8 AM to 4 PM, Evening from 4 PM to 12 AM, and nightshift from 12 AM to 8 AM. The morning shift is the most crowded, and three teams of medical staff are scheduled, while the other shifts are assigned with only one team. In each medical team, there is a medical doctor, a nurse, an anesthetist nurse, and two nursing staff, where the head nurse ensures that there is a mix between experienced and non-experienced staff in each team. The total regular work hours of nurses are regulated at a maximum of 48 h per week or 6 shifts per week. Whereas overtime hours are counted when the working shifts exceed 22 shifts per month, and the overtime hours cannot exceed 36 h per week, which accounts for 18 shifts per month.

The current scheduling method is manually handled by the head nurse for at least one month in advance. One of the major problems they have currently encountered is the shortage of full-time nurses, in order to supply for demand coverage, they need to hire part-time nurses. The uncertainties in patient arrival and variation in the duration of surgery, which sometimes can be unexpectedly extended affect nurses' work hours and their satisfaction. Additionally, although the head nurse claimed she did her best in trying to distribute the shifts and weekend day-offs, manually handling these would be challenging to obtain a satisfactory outcome for all nurses, also, there is still no consideration of nurses' preference in the current schedule. The following framework for nurse scheduling has been proposed to provide better visualization in the plan to develop nurse schedules for managerial and the head nurse, the illustration is shown in Fig. 1.

The input of the model includes hospital regulations on the allowable number of shifts and workhours in a certain period of time. In order to cope with uncertainties more efficiently, the analysis of historical data of patients' arrival rate, and the estimated surgery time required for similar cases can be done through the prediction of patterns. Last, the nurse database should be electronically stored, the data should include years of experiences, preferences, and requested vacation, and automatically feed into the model as inputs. Since there is only a limited number of nurses in the case study, optimization can be applied for obtaining optimal schedules. The stochastic optimization model provides an estimated monthly schedule for nurses based on historical data. However, once the emergency occurs, part-time nurses are still available on-call. The robustness of the model is verified based on the feasibility in not violating any of the hard constraints regulated by the hospital. At the same time, the model should be able to satisfy soft constraints, which are related to preferences and fairness, as much as possible.

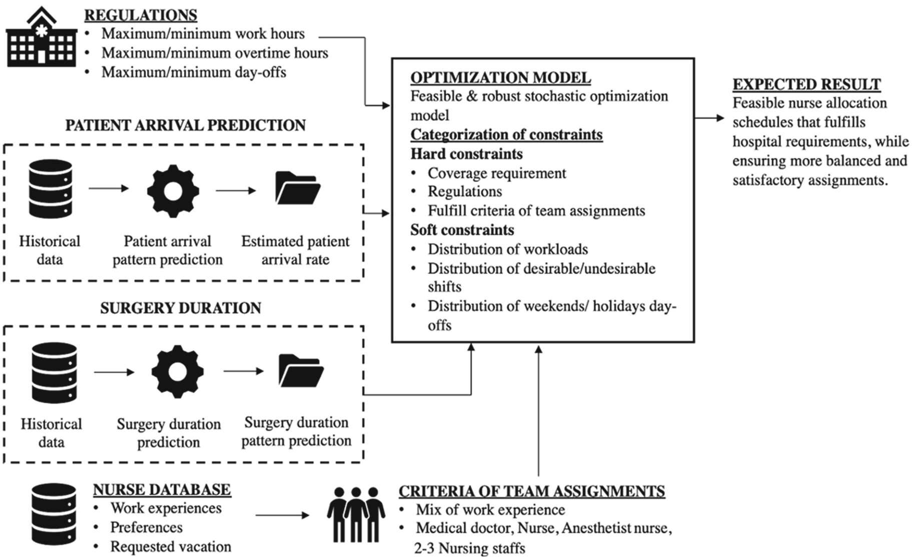

Fig. 1. The proposed framework of the nurse scheduling model.

4 Conclusion

The problem of nurse shortage and the requirements for nurses to work during unusual hours is the cause of fatigue, job stress, and dissatisfaction among nurses. In general, the scheduling of nurses is a hard and time-consuming task for the head nurse and can be even more challenging when trying to include the aspects of satisfaction and fairness in addition to fulfilling nurse's coverage and regulations. Because of these reasons, NSP has been receiving much attention in the literature in an effort to improve nurses' well-being through more efficient nurse schedules, however, only a handful of research considering the dynamic nature of hospital settings, for example, variations in patients' arrival and duration of stay. This results in the proposed model from the literature not practical for implementation in the real case.

This paper proposed an NSP optimization framework for a case study of an operating room at a private hospital in Pathumthani, Thailand. An interview with the head nurse who is responsible for nurse scheduling was conducted. So far, the nurse scheduling is manually handled by the head nurse one month in advance, where the fairness of the assignment is somewhat considered but not optimized, also, the preferences of nurses, as well as their satisfaction, have not been taken into account. The major concerns are the high variation in patient's arrival, as well as the duration used in each surgery, which is often delayed. These variations sometimes cause understaffing and overloading for the nurses working during peak hours resulting in stress and dissatisfaction. Note that it also results in lower hospital performance considering patients waiting time and service level. The stochastic optimization framework is proposed as a guideline for the development of models to tackle uncertainties emerge in the case, as well as improving efficiency and robustness of current nurse scheduling method in terms of nurse coverage and enhancement of overall nurses' satisfaction.

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Analysis and Feedback of Movement in Manual Assembly Process

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Abstract. A manual assembly has an important role in the manufacturing of products with small lot sizes and high variation. Becoming skilled manual labor requires knowledge transfers offered by human experts through a training process. To reduce the dependency of human experts, this paper introduces a framework called "Virtual Trainer" that incorporates the current state of the art marker-less RGB human pose estimation, activity detection for assembly step recognition, and training feedback through a multi-media presentation includes score evaluation and semantic description of trainee performance. Furthermore, the detailed transcript of each step and 3-D visualization compares to ideal movements also presented. The experimental design for evaluating the effectiveness and hypothesis is given.

Keywords: Action recognition · Motion evaluation · Manual assembly · Feedback · Training

1 Introduction

Becoming skilled in manual labor requires a training process. Manual laborers have an important role in the assembly process in the manufacturing of products where the final product is going to be assembled manually. The observation of a training process, and interviews of experts, trainees, and managers from a manufacturing plant, an expert is an experienced and skilled manual labor in an assembly line who has the following qualities. First, the expert can perform various assembly tasks in the assembly line correctly under the required completion time. Second, the expert can supervise by observing and providing feedback to another operator who requires some assistance or being less experienced. Lastly, the expert is capable of verbally step by step instruct the assembly steps while performing them. A trainee is an inexperienced operator under training, who requires supervision from an expert. An operator can be transferred to an assembly line within the manufacturing plant. The role of an operator can be switched between an expert and a trainee based on the experience of the operator with the

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designated assembly line. A manual assembly training is a one on one training process, an expert is going to be responsible for training one operator. In the beginning, an expert provides demonstrations of operation steps, while a trainee observes and learns. Then the trainee performs the assembly under the supervision of the expert. The expert continuously evaluates the trainee and provides detailed feedback. For a trainee, to independently work in an assembly station, the training process must repeat until an individual can perform the assembly step correctly with expected quality under the required completion time. Each trainee is going to require a different training time due to differences in experiences, and their ability to learn. Inspired by the traditional training perceived by the perspective of a trainee, first, carefully observe, listen to instruction, and remember an expert's demonstration of an assembly step. Second, performs a trial assembly by following the demonstration and mimicking every step of the expert. Lastly, the trainee receives and responses to the feedback of the expert and improves the assembly skill until becoming mastered in the assembly step.

This paper is focusing on developing an augmented feedback framework for the virtual training system called Virtual Trainer and designing an experiment to evaluates the framework with by mimics the one on one training environment of a manual assembly task. The development of such a system faces the following challenges. First, how to encode the activities in the physical world to the virtual world. Second, how to compare and analyze the encoded data. Lastly, how to provide the feedbacks that are effective for the process. From the identified challenges, the system aims to introduce a framework to incorporate human pose estimation techniques, assembly step recognition, assembly step analyzer, and feedback through a multi-media presentation. The detailed description is going to be provided in the later section.

2 Literature Review

The framework aimed to provide feedbacks by visualizing detected movement compares to a reference together with a semantic description of the movement for correction of movement. This section identified related research and techniques that are going to be evaluated, later applied for constructing the framework.

2.1 Motion Recognition and Analysis

The motion recognition and analysis served as a prerequisite as it is going to encode the perceived activity from physical space to the virtual space. Human pose estimation is a task to estimate the positions of body joints in two or three-dimensional spaces [3, 10]. The markerless RGB human pose estimation is one of the active research topics under the field of computer vision. To perform motion analysis, most of the related research employs the techniques of calculating the difference of human joints distances and time from designated templates [8].

2.2 Feedbacks in Motor Training

Much research has been done in applying augmented feedback in motor learning to sports, rehabilitation, and dance. To the best of the authors' knowledge, past research that applies feedback to facilitate virtual training in the manual assembly has not been reported in the literature. Also, most of the research in the domain of assistance and training in manual assembly was focused on applying augmented reality or virtual reality as a presentation medium [5, 9, 12]. There are various types of feedback for motor learning namely visual, auditory, and haptic as described in the review of [11]. A visual feedback can be presented in the abstract as a graph and score as in [6] or natural visualization as a 3-D model reference [2]. An additional type of motor training augmented feedback called semantic feedback was recently developed in [8]. A baseball trainer uses the system proposed by [6], to quickly identify the problematic coordination of the movement of trainees by abstract visualization of feedback using the time series plot of velocity on the x-axis and y-axis together with corresponding key events transcript. A proposal system of [2] virtually constructs the dance training environment using motion capture technology. The system provides feedback to the trainee as a 3-D visualization of the body movement template superimposed to the motion-captured of the trainee.

3 Methodology

For the Virtual Trainer, the system is partitioned into three subsystems representing the separation of responsibilities into a trainee as a user of the system, and the system itself as present in Fig. 1. The activity flows of the system are as follows. First, the trainee studies the provided material includes video clips with annotation, 3D animations of each assembly step, and electronics copy of detailed assembly instruction. Then, the trainee performs a trial assembly, in parallel, the Virtual Trainer recognize and record each assembly activities being performed. The system compares the movement recordings with the expert's template. Once the trainee completes the trail assembly, the system generates feedback for the trainee for further investigation that leads to an improvement in the next iteration of training. The details for each step are going to be elaborated in the follow subsections.

3.1 Step Analyzer

In the proposed framework, Step Analyzer uses the technique that is less intrusive to the operator by using a markerless computer vision-based technique. It can be implemented in the manufacturing plants with less modification of installed hardware, and assembly space. It consists of two main tasks as follows.

Human Pose Estimation. Human pose estimation is a task to estimate the positions of body joints in two or three-dimensional spaces. It can be performed automatically using techniques in computer visions. This paper chooses to apply RGB markerless deep learning in the computer vision technique because an observed factory already installed an RGB camera to inspect the activity of an operator on each assembly station. The paper selected a bottom-up approach based on Part Affinity Fields to perform the estimation [1]. To the best of the authors' knowledge, the chosen technique currently performs best on the standard dataset and is suitable for the partial occlusion on the human body.

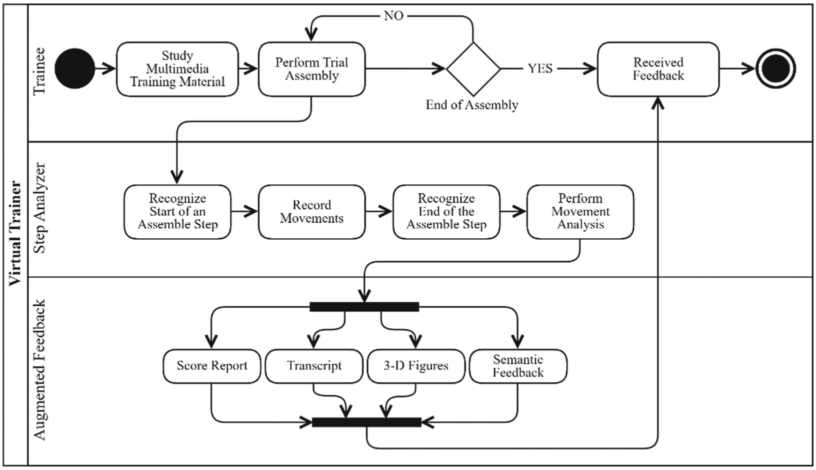

Fig. 1. A diagram shows three separated subsystems; the first lane at the top is an operator in training activity, the second and the third lane is the underlying systems.

Activity Recognition. Activity Recognition uses time-series coordinate data of estimated body joints from human pose estimation as an input to the model to recognize assembly activity. According to [7], activity recognition is a low-level process to recognize the current activity from the set of all possible activities. The steps in a manual assembly are strictly sequential. To recognize a step, detecting step transition activities includes pick and place activities is going to be applied. According to [4] it is possible to detect picking an assembly part or tool from its designated locations on the assembly station by detecting changes of visual features in the designated area. For this paper, instead of applying computer vision techniques, it uses 2-D coordinates location information of tools and parts together with the location of the operator's hand from the pose estimation to detect key activities as an indicator of the beginning of a step.

3.2 Analysis of Movement and Feedback

The Virtual Trainer provides terminal feedback to the trainee once after the trail assembly session as visualize in Fig. 2. The feedback consists of an analysis of each assembly step includes time and accuracy scores, transcript, 3-D pose figures, and semantic summary.

Time and Accuracy Scores. The framework uses the time taken on each step and the movement accuracy of an operator to calculate scores. An assembly line has an ideal time for each step specified by an expert. A full score is going to be given if the operator can achieve the step under the ideal time, otherwise, it will be gradually decreased. Next is the movement accuracy score, it is calculated based on the euclidean distance of joints deviates from the ideal movements and posture from the template as additive inverse. These two scores are going to be reported separately.

Transcript. A transcript is an abstract visualization as a bar plot of the time taken on each assembly step compares to the ideal time.

3-D Comparative Figures. A 3-D comparative figure is a natural visualization of 3-D movements in human form and the posture of the trainee represented compares side by side to the standard template. The trainee can use this visualization to compares themselves with an expert template to correct the movements and posture.

Semantic Summary. A semantic summary is generated by comparing the movement and posture of the trainee to the template. It aims to provide textual feedback mainly on posture errors and unnecessary movements of the trainee on each assembly step.

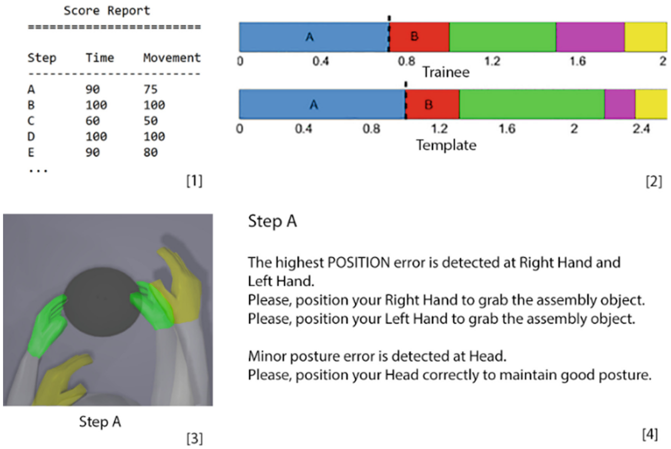

Fig. 2. Visualization of feedbacks provided by Virtual Trainer consists of [1] Scores report of each step, [2] Transcript of time compares to ideal, [3] 3-D comparison figure, [4] Semantic summary of a step.

4 Experimental Design

To evaluate the hypothesis that Virtual Trainer reduces the amount of human expert dependency in manual assembly training. The experiment separate participant into two groups, the control group receives conventional training from an expert, and the group trained with Virtual Trainer. Each participant in both groups is going to be evaluated with a trial assembly to determine an experience level. The hypothesis is accepted if all the participants in the test group can perform manual assembly without having to consult the human expert. The experiment also records the time used in success training iteration, and the amount of error on each failed iteration.

5 Conclusion

This paper proposes a framework called Virtual Trainer, it offers a preliminary design of a virtual training system with augmented feedback that mimics the traditional training process. It composes of analysis part that incorporates deep learning in computer vision human pose estimation technique under RGB camera, then locations of body joints are being processed to identify the assembly step and analyzed with a template to provide various forms of augmented feedback. To examine the possibility to apply the system for manual assembly training, the experimental design is proposed. The experiment divides participants into two groups, the control group and the group train with Virtual Trainer.

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Towards an Application of Remote Sensing Technology for Decision Making During Natural Disaster

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Abstract. A large number of remote sensing technologies for disaster management have been made, they still need a time to be accepted in disaster management framework of local governments. Before considering the application, it is necessary to discuss the practicality of remote sensing techniques in the existing disaster management frameworks. Towards the application of remote sensing technologies for decision making during natural disasters, this study addresses the following research questions; Which decision making of local governments can the remote sensing technology assist during natural disasters? And, what kind of remote sensing technologies can be applied? To solve these research questions, this study analyzed the regional disaster response plans of local governments in Japan, and discussed the practicality of the remote sensing technologies to the decision makings of disaster management operations.

Keywords: Remote sensing · Emergency response · Decision making

1 Introduction

In recent years, natural disasters have occurred frequently in Japan, such as the 2011 Tohoku earthquake and tsunami, the 2016 Kumamoto earthquake, the 2018 Japan floods. These disasters caused severe damages to extensive parts of Japan and breakdown of information network and road networks that resulted in the isolated situation of affected areas. This situation has led to difficulties of damage assessment of extensive affected areas, which resulted in the delay of decision making in disaster response. Therefore, there was a strong demand on establishing a scheme to figure out extensive damage within a short time without visiting affected areas. Remote sensing technology is promising for solving this problem. Remote sensing technology with satellite, airborne, and unmanned aerial vehicle (UAV) made it possible to observe affected areas without visiting within a short time.

The recent development of sensors and spread of machine learning applications have accelerated the development of remote sensing technique that can be applied for disaster management. Until now, various kinds of techniques have been developed in assessing damages on buildings, infrastructures, vegetation and in detecting hazards from tsunami, floods and landslides. In satellite/airborne remote sensing research fields,

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methods to apply synthetic aperture radar (SAR) have been studied for detecting areas inundated by tsunami and flood disaster, estimating the number of damaged buildings due to earthquake and tsunami, detecting landslide areas and identifying bridge damages (e.g. [1–3]). Regarding the UAV application researches, a number of human detection techniques have been developed (e.g. [4]). In onsite remote sensing, methods to classify building damage level with a handy photo of each building have been developed based on deep learning technique (e.g. [5, 6]).

Even though a large number of efforts have been made, they still need a time to be accepted in disaster management framework of local governments. Before considering the application, we need to identify "When", "Where" and "How" we can apply the remote sensing techniques in the existing disaster management frameworks. Towards the application of remote sensing technologies for decision making during natural disasters, this study addresses the following research questions; Which decision making of local governments can the remote sensing technology assist during natural disasters? And, what kind of remote sensing technologies can be applied? To solve these research questions, this study analyzed the disaster response activities of local governments in Japan and discussed the practicality of the remote sensing technologies to the decision makings of disaster management operations.

2 Method

We analyzed disaster response operations of Nomi City located in Ishikawa Prefecture, Japan. For the investigation, we sort out disaster response activities from the disaster prevention plan and extracted the decision makings that remote sensing technologies can assist soon after the disaster.

2.1 Topographic Conditions and Historical Disaster of Nomi City

Nomi City faces the Japan sea in the western part, has the Tedori river alluvial fan in the central part, and the eastern part has the verdant hills connected to the Hakusan mountainous areas. Nomi City is 84.14 km^2, consisting 42% of forest, 22% of agricultural lands and 14% of residential lands. The 1934 Tedori River flood disaster is most famous disaster in Nomi City. At this time, a large amount of snowmelt and heavy rain exceeding 400 mm caused collapse of sediment, which flowed down to downstream of rivers as debris. As a result, almost the entire basin from the upstream to the estuary was flooded. As for the damage at this time, 172 houses were washed away, 586 houses were flooded, 97 were died, and 15 were missing.

2.2 Analysis of Regional Disaster Prevention Plan

In Japan, based on the lessons learned from the Isewan typhoon, also known as the Typhoon Vera, in 1959, the basic act on disaster management was enacted in order not to repeat the same damage. In the Isewan typhoon, insufficient information transmission, inadequate awareness of danger zones, and inadequate disaster prevention systems were understood as issues. To overcome these issues, the basic act on disaster management clarified responsibilities of disaster management on local governments. Based on this, local governments have prepared regional disaster prevention plans for disaster prevention phase, emergency response phase, disaster recovery phase and reconstruction phase. Disaster response operations are clarified using a regional disaster prevention plans issued by the Nomi City. The regional disaster prevention plans currently used in the city was created in fiscal 2006 and has been revised several times since the 2011 Tohoku earthquake and tsunami. Nomi City's regional disaster prevention plan consists of 5 parts, "Part 1 General Disaster Countermeasures", "Part 2 Earthquake Disaster Countermeasures", "Part 3 Tsunami Disaster Countermeasures", "Part 4 Accident Disaster Countermeasures", and "Additional documents". Section 3 of each volume describes emergency response operations. Remote sensing is very effective in damage assessment of emergency response operations, therefore we analyzed mainly the work of the emergency response plan in Sect. 3. As an example, the sections of the emergency plan of "Part 1 General Disaster Countermeasures".

Among this plan of emergency response activities, representative tasks and decision makings that are related to wide area decision makings and remote sensing technologies can contribute, were selected and summarized as follow. All might not be covered, and further discussion is needed in terms of the relation with extensive decision makings; (1) Early warning, (2) Request supports from other stakeholder, such as SDF and other cities, (3) Identification of danger zone, (4) Explore isolated people, (5) Decide areas for emergent rescue, (6) Secure emergent road network, (7) Deploying snow removal team, (8) Identification of isolated areas, (9) Decide the quantities of supplies, (10) Individual building damage inspection, (11) Estimating debris, (12) First aid of infrastructures.

Next, I summarized representative hazards that can be observed by remote sensing technology, and typical surface objects that Nomi City will try to assess the damage soon after the disaster occurrence. (1) Hazards that can be observed by remote sensing technology; (a) Flood, (b) Tsunami, (c) Volcano, (d) Snow, (e) Fire, (f) Land slide, (2) Typical surface objects that Nomi City will assess the damage during disaster, (a) People, (b) Building, (c) Road, (d) Embankment, (e) Railway, (f) Park, (g) River, (h) Coast.

2.3 Discussing the Relationship with Remote Sensing Technologies

Finally, we discussed which remote sensing technologies can be applied for the damage assessment of typical surface objects and expected hazards in Nomi City.

3 Results and Discussions

Here, we examined which remote sensing technology can be used for which decision making, based on the hazards and damage situation that can be grasped by remote sensing, and the connection between them.

3.1 Early Warnings

Early warnings are often used in storm surges, tsunamis, and flood disasters, but these are issued by sensors such as seismometers and water gauges, and it is not possible to predict these hazards with remote sensing data. On the other hand, before the eruption of the volcano, there might be some changes in the ground, which may be observed by interferometry of synthetic aperture radar images taken from satellites and aircraft. It is expected that this observation result may be used for early warnings (e.g. [7–9]).

3.2 Request Supports from Other Stakeholder

When requesting support from other stakeholders, information such as locations and affected areas are needed. To identify this information, areas affected by hazards should be observed. Regarding the methods to detect hazards directly, studies to detect flooded areas and tsunami inundation areas, volcano, snow, fire, and landslide, have been accumulated using optical or SAR satellite data (e.g. [10, 11]).

3.3 Identification of Danger Zones

Areas once attacked by hazards should be treated as a danger zones. Methods to detect hazards directly might be able to apply (e.g. [10, 11]).

3.4 Explore Isolated People

Searching for those who are left in the disaster area is important matter after the disaster, especially when the information and communication networks does not work. It is difficult to extract humans with the spatial resolution of satellite images, but it is possible to capture humans sufficiently with UAV images. Some researches on human detection by UAV have been made assuming emergent response, and these are considered to be effective (e.g. [4]).

3.5 Decide Areas for Search and Rescue

In order to send limited resources to limited disaster-stricken areas, it is necessary to identify areas where human damage is particularly large. Human damage cannot be seen from satellite image, but building damage can be identified. The amount of building damage is related to human damage. Remote sensing data taken by satellites and airplanes is effective for damage assessment of buildings (e.g. [2, 3]).

3.6 Secure Emergent Road Networks

Securing an emergency transportation route during disaster is important for effective emergency response, recovery and reconstruction. Various technologies have been proposed for assessing road damage, such as those using artificial satellites and those using in-vehicle cameras (e.g. [12, 13]).

3.7 Deploying Snow Removal Team

Nomi City has mountainous areas, and should pay attention to the isolation of village areas by snow. In order to prevent the isolation of villages due to snow, it is necessary to dispatch a snow removal corps to an appropriate place. Researches on snow extraction have been carried out, and it is expected that these might be useful for dispatching a snow removal team to appropriate place (e.g. [14, 15]).

3.8 Identification of Isolated Areas

In order to find an isolated village due to the disaster, it is necessary to identify the areas affected by hazard and the location of road interception. By overlaying the existing road map with the distribution of hazards ascertained from satellite images, or detecting road damage, it might be possible to find such kind of isolated areas (e.g. [2, 3, 12, 13]).

3.9 Decide the Quantities of Supplies

Information on how many victims have occurred in the stricken area is important in determining the quantity of supplies. Although the amount of human damage is not known from satellite images, the amount of building damage estimated from satellite images is considered to be useful for predicting human damage (e.g. [2, 3]).

3.10 Individual Building Damage Inspection

After a building is damaged due to a disaster, the damage inspection of the building is carried out officially by local government. This inspection is done on a site by site, but it takes a long time as the number of damaged buildings are too many. A method for classifying image data captured by a handy camera by deep learning has been developed, and it is considered that this result may be very useful in the future for individual building damage inspection (e.g. [5, 6]).

3.11 Estimating Debris

One of the major issues during disaster is waste disposal after a disaster. Estimating the amount of debris caused by disaster is important in planning waste management. Land cover classification using satellite images or 3D data restoration using UAV might be effective for this purpose (e.g. [16]).

3.12 First Aid of Infrastructures

In order to carry out recovery and reconstruction effectively, it is necessary to comprehend the impacts caused by the disaster. Damages on infrastructures owned by the local governments are also important matter. Remote sensing technology using satellites is effective for understanding the damages on infrastructures (e.g. [1, 12, 13]).

3.13 Summary of Discussions

The above examples are part of emergency response works, and off course, it should not cover all activities that remote sensing technology can contribute. However, discussions on how to apply remote sensing technology for decision makings of local governments are needed for promoting practical usage. In particular, in order to adopt a new technology that is not used in the existing framework for disaster countermeasures, it is necessary to design a new framework including new technologies and verify its effectiveness quantitatively. This study is just the brief consideration of application of remote sensing technology on actual disaster management of local government, however, it was found that many works of emergency response have a possibility to be improved with new remote sensing technologies.

4 Conclusion

This study analyzed the disaster response activities of local governments in Japan, and discussed the practicality of the remote sensing technologies to the decision makings of disaster management operations. As the result, it was found there is a large potential in remote sensing technology on the improvements of disaster management of local governments on (1) Early warning, (2) Request supports from other stakeholder, (3) Identification of danger zone, (4) Explore isolated people, (5) Decide areas for emergent rescue, (6) Secure emergent road network, (7) Deploying snow removal team, (8) Identification of isolated areas, (9) Decide the quantities of supplies, (10) Individual building damage inspection, (11) Estimating debris, (12) First aid of infrastructures.

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Case Study on Applicability of Artificial Intelligence for IT Service Project Managers with Multi Value Systems in the Digital Transformation Era

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Abstract. The lead author has in this decade been studying the processes of creating and transferring multinational IT service knowledge among the headquarters of a global IT Service firm in Japan and the firm's local subsidiaries in China and APAC regions. Key findings of the preceding studies are, (1) the average of Project Managers' skill level in China and APAC regions has already reached to the global average determined in the standardized PM skill assessment within the global firm. (2) IT service project managers' value systems are highly influenced by those of organization the PMs belong to, and the value systems vary not only by nations but also by industries. (3) To transfer knowledge from HQ to overseas subsidiaries in China and APAC regions, especially in the case that the knowledge to be transferred is extremely new and unfamiliar to the knowledge transferees (i.e., local PMs), it is better for the knowledge transferrers from HQs to consider the differences between the value systems of the transferrer and the transferee.

In this paper, the author describes the case-studies with interviews of service project managers in the IT service, aerospace, and construction industries who could use or avoid AI to use for their own projects and have opinions on the AI technology for them. And the author's objective is to distinguish the applicable and non-applicable AI functions for professional service managers by evaluating the comments of the service project managers. Also, assuming similarity of the knowledge-creating process among project managers in a multinational environment to the process among human PMs and AIs, as the teaming with unfamiliar partners, the author introduced an extended SECI model to explain the needs for considering the sub-process to connect the major four processes in between "Ba", the knowledge creating field in the SECI model. And referring to the updated technological information, the author considers the possible further research.

Keywords: AI · SECI model expansion · Multinational IT Service · Knowledge transfer · "Ba": knowledge creating field

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1 Introduction: Background of This Research

The lead author has been doing research on Knowledge Creation/Transfer within multinational within IT Service organizations in the industries, as a PMO manager for China and APAC regions of a Japanese leading Global IT Servicer. His Business Objective is studying the reason for the difficulty of transferring the business process knowledge to the Asian subsidiaries and stabilizing/fixing it there.

1.1 Research Questions

The major research question (MRQ) is "What kinds of knowledge were created/transferred within multinational/value-system organizations of a global IT service firm, A Corp., with its headquarters in Japan?".

One of the subsidiary research questions (SRQs) for the MRQ is "How did the PMs and the PMO contribute to make AI supportive to the Service Project?" if the AI is made in different nations or value systems.

1.2 Preceding Research

For the MRQ, the number of preceding studies on Japan-Asia IT Service Outsourcing is limited. There are, however, many studies on Japan-China software offshoring, such as those of Nishinaka (2015) and Tanzawa (2015). And research on the US-India Global Delivery Model (GDM) is also popular, including studies by Friedman (2004, 2005, 2007) and Hamm (2004) and Annual Reports by NASSCOM (2017), the demographic data by Todd (1983), and Multinational model by Ghemawat (2007). Therefore, referring to the close research, the lead author gathered data within the firm he belonged to.

1.3 Self-review of Previous Research Showing the Link Between Multinational Systems and Multi Value Systems

The case studies and analyses were done for SRQs listed above, including comparison of Japanese-China ("plus one") Offshoring Model, and US-India Global Delivery Model, in the previous research by the Author, reported with the previous papers reported in ProMAC (2016, 2017, 2018, 2019), the international conference of Project Management by society of Project Management, and IPMA, summarized as follows:

(1) Multinational and Multi-Value-System IT Service Management: The lead author explained the relationship between human Project Managers and the AI-PM (AI with PM-like capability) as the extension of the relationship among Multinational IT Service Project Managers with different Value-Systems in ProMAC2016, Goldcoast, Australia.

(2) Skill Assessment of IT Service Project Managers in China and APAC Regions: The HQ PMO conducted the PM Skill Assessment in Asian Nations. And the result is that the Average Asian PM knowledge level is close to global standard (the results of the assessments in the subsidiaries in two nations are shown in the

Fig. 1), but management skill for multi-stakeholders needs to be improved (especially in scalability). As a result of the PM level evaluation by the PM assessment and the PM interview (with 13 people in Company A1) after the (12 participants) in the business unit P of Company A1, the top 25% is equivalent to the senior PM standard based on Co. N (Equivalent to IPA level 5, About 5% of the advanced IT skill standard), and about 25% of the next layer is equivalent to Co. N's "Associate PM (mid-sized IT skill standard, equivalent IPA level 3 to 4). This is at the same level as the company N and its affiliated companies in Japan. And with the analogy of the domestic example to the middle layer, the authors conclude that implementation of Stage 3 onwards is effective to the layer and hold Workshops focusing on bilateral discussion of milestones in parallel with PM practice by OJT.

APAC-PM Assessment and Areas to be Extended

(1) Findings from the results of the PM Skill Assessment applied at two overseas subsidiaries of Japanese IT Service Company N in the APAC Region are as follows: (a) the level gap between the "Associate PM" personnel (IPA level 3 to 4) in Japan and middle class PMs in Asia is being narrowed. (b) The further strengthening measures are necessary for the skills that are learned when managing medium and large-scale projects, including risk management skills and budget management skills, even though the difference between them is decreasing.

(2) The PM characteristic analysis based on the results of the Workshop Questionnaire at two subsidiaries of the Japanese IT Service Company N revealed that PM preferences (Value Systems), such as priorities in QCD and within the quality characteristics, differ or are affected not only by Country but also by Business Units.

(3) PMs' preferences regarding three factors (Quality/Cost/Delivery) of IT Service Project.

To investigate the characteristics of PMs, the lead author conducted principal component analysis on keywords derived from the answers to the questionnaire used in PM Workshops in two nations (in 2017 and 2018), and keyword analysis on interviews to the project managers as IT Service Professionals in multinational locations and came to two conclusions. The first is that PMs' preference (Priority) regarding Quality/Cost/Delivery is affected by vertical industries rather than nationality. This means the organizer in Headquarters must consider the globally standardized business processes are to be tailored to comply with the local value systems. The lead author uses an expanded SECI model to explain the process for transferring knowledge among multinational organizations with different value systems. The second conclusion is that the local adaptive level of new technologies, including Deep Learning-based Artificial/Augmented Intelligence (AI), relies on the local engineers' Technical Level, and the tailored level of globally standardized processes. The lead author introduced the case studies to show that some strategies work well and distinguished the applicable and nonapplicable business processes for professional service managers (Table 1).

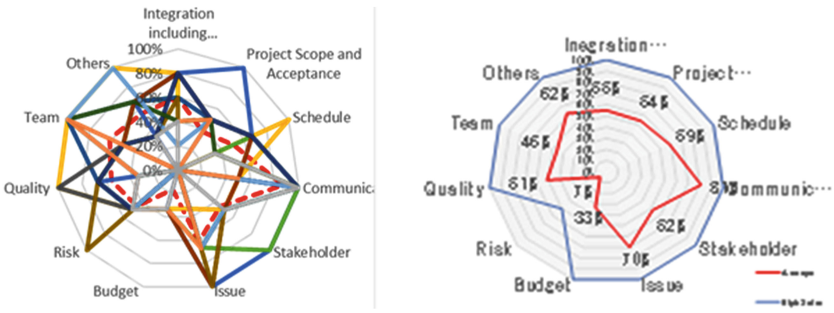

Fig. 1. The assessments results for PM skill in Nation A, and B (2017)

Table 1. Asian PMs' Q/C/D preferences analyzed by the PMs' divisions.

Outline	Correlation of Quality Scores and Business Units of the Subsidiary in Nation B.							
	Samples are gathered from the answers of Questionnaire for PM workshops held in Nation B.							
Regression Statistics								
Multiple Corr. R	0.42381							
H. Detemination	0.179615							
Correction R2	0.006902							
Standard Deviatic	0.652893							
No. of Samples	47							
Variance Analysis Table								
	Deg. Free	Fluctuation	Dispersion	Obs. Disp Rati	Significant F			
Regression	8	3.546435	0.443304	1.039962	0.424213			
Residual Error	38	16.19825	0.42627					
Sum	46	19.74468						
	Coefficient	Std. Error	t	P-Value	LowL 95%	UppL 95%	LL 95.0%	UL 95.0%
Segment (B.Unit)	2.333333	0.376948	6.190065	3.12E-07	1.570242	3.096425	1.570242	3.096425
X Value 1: A	0.245614	0.405617	0.605532	0.548425	-0.57551	1.066743	-0.57551	1.066743
X Value 2: C	0.416667	0.498655	0.83558	0.408614	-0.59281	1.426142	-0.59281	1.426142
X Value 3: Di	0.166667	0.596007	0.279639	0.781271	-1.03989	1.37322	-1.03989	1.37322
X Value 4: Do	0.066667	0.476806	0.139819	0.889541	-0.89858	1.03191	-0.89858	1.03191
X Value 5; F	0.266667	0.476806	0.559277	0.579254	-0.69858	1.23191	-0.69858	1.23191
X Value 6: J	-0.08333	0.498655	-0.16712	0.868165	-1.09281	0.926142	-1.09281	0.926142
X Value 7: Sa.	0.666667	0.533085	1.250582	0.218733	-0.41251	1.745841	-0.41251	1.745841
X Value 8: So	-0.83333	0.596007	-1.39819	0.170163	-2.03989	0.37322	-2.03989	0.37322

2 Focus of This Paper

In the following sections in this paper, the authors explain how project managers in service industries can use AI to support the project management process in the digital transformation (DX) era. They explain this with the case studies focusing on the applicability of AI to the Project Management Service process, in the Service Science

View, considering similarity between multinational systems and multiple value systems.

2.1 PMs' Possible Issues with AI

Kurzweil (2005) predicted that the ability of a single computer with AI will exceed that of a human brain by 2029 (Pre-singularity) and of all human brains in 2045 (Singularity). Kurzweil's prediction in 2005 has limited impact to the professionals or researchers in IT Industry. But, after the deep-learning (DL) technology was established early in the second decade of the 21st century, Shanahan (2015) and Wallach (2015) expressed the threat in the over-progress of AI technology and the ideas of countermeasures for the risks. Artificial Intelligence (AI), or cognitive technology, either on premise or in public clouds, has become sophisticated enough to provide some support for decision making processes, including provisioning and resource-assignment. In the meantime, technology in General Artificial Intelligence is being accelerated by the competitions in development among firms, including Apple, Facebook, Google, IBM, and NVIDIA, and so on.

2.2 Human PM Versus AI (or Human PMs with AI)

Ford (2015) indicated the threat of "Jobless Future" for human, caused by Robots with AI. And Zarkadakis (2015) summarized the possible conflict among human and AI systems. Kahneman (experience-based pro-logic), and Klein (pro-intuition) (2009) discussed the issue with AI, expressed their opinions independently, and did not reach the same conclusion. These fears are to be realized a little bit ahead, but there is a possible threat within a decade because of technology acceleration with the development of autonomous cars by Google or car manufacturers targeting commercialization of level 4 autonomous cars by 2020. If we limit our view to semiconductor integrity or density, Moore's law is getting slower and has a gap between predicted and actual density doubling rates, but in the view of computing power and cost performance it is still applicable. For example, researchers on "Two-person-Zero-sum Finite determination Complete Information Games" and their AI challenged human champions and won.

3 Case Studies in AI Applicability for Service Project Management

Based on the external and self-review of the preceding researches, the lead author thought that the documents above either over- or under-estimate the current/near-future AI capability. He therefore decided to plan case studies with interviews of Service Project Managers in industries. The common questions are as follows: Q0. As the Project Manager of your project, how do you evaluate the current AI (Artificial Intelligence), if it is given to you?

Q1. If you have positive sense to the AI, how (in which way) do you like using AI for your project. Q2. If negative, specify the functions to be added or improved for your project.

3.1 Case 1

Interview in the Workshop "Global Café" of ProMAC 2018 with IT Service Project Managers (2018)

(1) Place and Time: The World Café of ProMAC2018, Bangkok, Thailand, 13:50–15:10 on the 28th of November, 2018, cross interviews on the topic "Does Artificial Intelligence (AI) replace the (human) project manager?", facilitated by Mr. Reinhard Wagner, former president of IPMA (Int'l PM Association).
(2) The Cross Interviewee, and the members of the team with the lead author were from England, India, Japan x2, Malaysia, and Thailand. And the PM from England mentioned that he uses AI for document search of Old design document of the existing/legacy system to migrate to the system to be newly developed. The PMs from Germany and Japan, already use Quality Management of software program development, to monitor the current status of the project and alert someone when critical risk factors are detected. Other PMs mentioned that they do not currently use AI for project management but well know about the functional limitation of the current AI, so that they would use AI to support their project management in ways that are mentioned by UK and German PMs once they confirm that the function and performance of AI reach their expectation.

3.2 Case 2

Interview to the Project Managers in Aerospace Industry (2016).
Time and Occasion: 16:00–17:00 (in Group) and 17:00–17:30 (one-on-one), 14th of July, 2016, IEEE & IECIJ delegation to JAXA/Sagamihara.
Interviewee: Dr. Tsuda, the Project Manager of Hayabusa2(*).

Dr. Tsuda's answer was as follows: "DL-based AI can be used for picking up samples but not for landing/touchdown. His Hayabusa-2 Team landed the satellite landed safely by manual operation and semi-manually picked up the samples of Ryugu. He also said "Among Hayabusa2's operations, including touchdown, shooting and capturing sample, especially the touchdown to the surface with unpredictable conditions, is very difficult, and current (ML-based) AI cannot handle the process." (*) Hayabusa2 is the name of JAXA (Japan Aerospace exploration Agency)'s Deep Space Asteroid Exploring Project, and that of the Explorer(spacecraft to the destination Ryugu, a small type-c asteroid (consisting of Earth-type materials). Following the successful sample capture and return of "Hayabusa" (MUSES-C) in June 2010, JAXA started the "Hayabusa2project and launched the spacecraft "Hayabusa2" in Dec, 2014. The explorer Hayabusa2 successfully made touchdown on Ryugu by manual operation and shot the ground and picked up a sample of the asteroid.

3.3 Case 3

AI Applicability for Service Project Management in Public Construction Industry Time and Occasion: 19th of December, 2019, after his 10:30–12:00 session, titled "Promotion of Introducing Inspection Robot to Infrastructure Inspection ~Feasibility Study of AI for Inspection~", the lead author did a one-on-one interview.

Interviewee: Dr. Nitta, Yasushi, Team leader and Director for AI x Infra Robot Project (**), stated as follows: "AI on the drone can recognize the place to be repaired with 10–100x more photos compared to inspection by human after the learning of similar constructions but has not reached the level of repairing. The next goal of the project is to improve the drone with AI." (**) Ministry of Land, Infrastructure, Transport and Tourism (MLIT), Japan, launched the research project for a drone with AI that can inspect and repair the large infrastructure, including bridges and tunnels (2018). Knowing the number of construction workers is decreasing and the number of large constructions needing to be repaired is increasing, MLIT started the research project above in 2018 in collaboration with Public Works Research Institute, a National Research and Development Agency.

3.4 Summary

Results of interviews of the project managers in three industries are summarized as shown in Table 2.

Table 2. Interview of project managers in IT Service as the focused industry, and in the related industries

Q0. How do you evaluate the current AI (Artificial Intelligence), if given, as the Project Manager of your project?

# Year	Industry that PMs belong to (spec.)	Q1. If you have positive sense to AI, how would you like to utilize AI for your project(s)	Q2. If you have negative sense to AI, specify the functions to be added or improved for the AI
1.1 2018	IT service (already using AI) x3	AI is supportive (positive) while we use the AI as the assistant to select the documents or photos	To be more supportive, more intelligent enough to show me the options to be taken, in the next step
1.2 2018	IT service (not yet using AI) x3	Neutral: Do not use AI now, but do not have fear of AI taking over my position, because current AI is not smart enough for making decisions under complex and unstable/changing conditions	(Same as written in the left box)
2 2016	Aerospace (asteroid explorer without AI)	Though, not used in Hayabusa2, AI is useful for pre-learnable operations, including picking up samples	Current AI is not for unlearnable operations, such as touchdown and shooting

(*continued*)

Table 2. (*continued*)

# Year	Industry that PMs belong to (spec.)	Q1. If you have positive sense to AI, how would you like to utilize AI for your project(s)	Q2. If you have negative sense to AI, specify the functions to be added or improved for the AI
3 2019	Construction (drone with AI)	Project is designed for promoting usage of drones with AI for construction. The drone can recognize the place to be repaired but needs 10–100x more photos than does inspection by humans	AI has not reached the level of repairing. The next goal of the project is improvement of the drone with AI. It is expected to be able to fix the clack after the learning of similar constructions

In short, almost all project managers said that they would use AI for their current or near future projects even though they know it has functional limitations.

4 Conclusion

Reviewing Multinational Projects Cases with group discussion (World Café) and one-on-one interviews (from July 2016 through December 2019) of the project managers in service industries, and discussion with business experts on AI in IT industry and professional users, the authors found some functional limitations of AI technologies for specific users. Detailed comments AI usage for project management are shown as follows:

4.1 DL-Based AI Usage Under the Multinational Condition

Deep-learning/machine-learning-based AI is suitable for recognition/perception but not for cognition/thinking, as Feigenbaum (2020) mentioned. Without pre-learning process, DL-based AI cannot make any decisions or suggestions. It means, even an engine of DL-based AI can be designed in a nation including US, when the AI system introduced to any other nation/region with different value-systems, external database with dictionary or learnt rules formulated through the learning process should be re-done in the local environment. Therefore, PMs may manage the localization process. Current AI's recognition speed exceeded that of manpower in some fields, but applicable fields are still limited. For example, although AI can beat the champions in two-player zero-sum games, it has not learned how to evacuate when a disaster occurs in the place of the game. So some IT companies, including IBM Japan as presented in SPM Spring Conference in 2017, have started Proof of Concept with AI for Project management, i.e. Application for AI's recognitive power to support PM's decision making. But the current level of AI is limited as stated above. Also, the real projects are much more complicated, and not zero-sum, nor with complete information. Therefore, with the current technology level (as of January 2020), only human project managers can recognize the real situation of a project.

4.2 Suggestion to Service Project Managers Who Would Use AI

A human PM may expect AI support to analyze big data and report to him/her. For example, some IT servicers decided to utilize AI, not as "Artificial" Intelligence, but as "Augmented" Intelligence to support the PM's decision.

Mori et al. (2019) proposed using "Machine in the loop" in SECI knowledge creation process of Project Management. SECI model was introduced by Nonaka and Takeuchi (1995) to explain the knowledge creating process with four stages and "Ba", the knowledge creating field. Kohda (2020) explained the relationship between human and AI in the service view. With this idea, human project managers may utilize AI as Augmented Intelligence.

The lead author introduced a modified SECI model (Figs. 2, 3 and 4) with a globalization sub-process as the latter part of the externalization process and with a localization sub-process as the following part of the internalization process to apply the SECI knowledge-creating model to the cases of multinational organizations. To use AI for multinational service project management, the PM must have, in layers 5–7 of Fig. 4, big data gathered in the target nation.

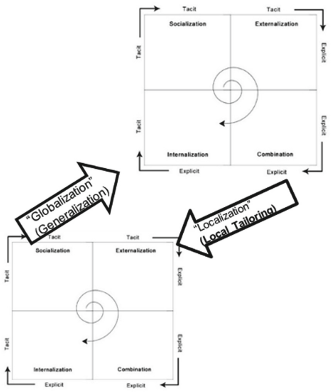

Fig. 2. SECI model in local and global layers.

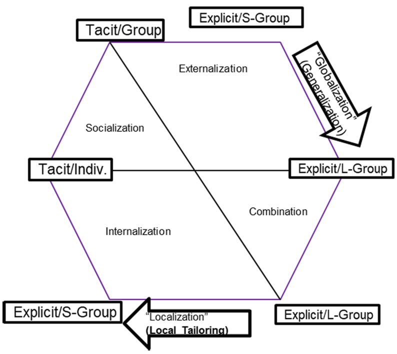

Fig. 3. Modified-SECI model with globalization and localization sub-processes.

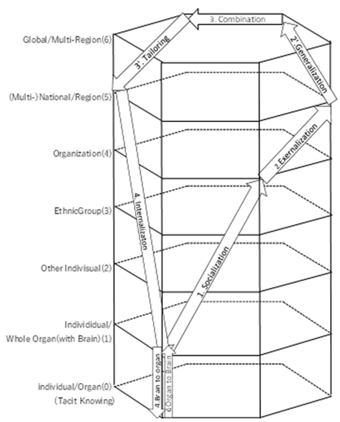

Fig. 4. Modified-SECI model in 3D shape to explain that ML-AI needs big data from each layer.

5 Further Research Plan

5.1 Research on the Applicability of Hybrid AI (Machine Learning-Based and Rule-Based AI)

After discussion of the accountability/explain-ability of deep-learning-based AI, research on the hybrid AI has been started in many R&D centers as one of the solutions for the unaccountability of DL-based AI Feigenbaum (2020). The author would pursue this topic in Service Industries.

5.2 Regional Analysis

The lead author assumed, for the suggestion made in the previous section, that each region/nation has a value system that could affect DL-based AI's output. Therefore research on "how value-system differences affect DL-based AI" is a possible next research item.

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Evolution of Smart Service Architectures Through Cognitive Co-creation

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Abstract. Today, many companies are adapting their strategy, business models, products, services as well as business processes and information systems in order to expand their digitalization level through intelligent systems and services. The paper raises an important question: What are cognitive co-creation mechanisms for extending digital services and architectures to readjust the usage value of smart services? Typically, extensions of digital services and products and their architectures are manual design tasks that are complex and require specialized, rare experts. The current publication explores the basic idea of extending specific digital artifacts, such as intelligent service architectures, through mechanisms of cognitive co-creation to enable a rapid evolutionary path and better integration of humans and intelligent systems. We explore the development of intelligent service architectures through a combined, iterative, and permanent task of co-creation between humans and intelligent systems as part of a new concept of cognitively adapted smart services. In this paper, we present components of a new platform for the joint co-creation of cognitive services for an ecosystem of intelligent services that enables the adaptation of digital services and architectures.

Keywords: Digitalization · Smart service design · Cognitive service co-creation · Digital enterprise architecture

1 Introduction

Influenced by the transition to digitalization [1], many companies are in a process of changing their strategy, culture, business processes, and information systems, and adopting artificial intelligence systems and services. Today, the digital transformation [2, 3] profoundly disrupts existing organizations and economies. The potential of the Internet and related digital technologies, such as the Internet of Things, cognition and artificial intelligence, data analysis, service computing, cloud computing, mobile systems, collaboration networks, cyber-physical systems, and Industry 4.0, are key strategic

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drivers of digitalization. Digitization enables platforms with rapidly evolving ecosystems of intelligent systems and services based on service-dominant logic [4].

Data, information, and knowledge, are fundamental core concepts of our daily activities and drive the digital transformation of today's global society [2]. New services and smart, connected products extend physical components to include information and connectivity services via the Internet. Intelligent systems and services with artificial intelligence (AI) [5, 6] support humans and solve problems that usually require humans. Contemporary advances in artificial intelligence have led to a rapidly growing number of intelligent digital services and applications.

We place digital services [1, 4] and cognitive co-creation [7, 8] in a closely related architectural context of lifecycle-led artifacts: digital strategy, digital business models, intelligent service composition models, digital enterprise architecture, and smart service models. Improvements of digital services and products and their models and architectures are usually manual design tasks for rare experts. However, can this design process be significantly shortened and its content improved by intelligence algorithms, especially machine learning with deep learning and targeted semantic support? Our contribution focuses on a central research question: *What are digitization models and cognitive co-creation platform mechanisms for the evolution of smart digital services and architectures?*

First, we lay the foundations for the design of intelligent value-based digital services that provide a multi-layer mapping of digital strategies to digital architectures. Then we present our approach of the cognitive co-creation platform. We focus on an extended reference architecture for intelligent digital platforms and ecosystems and present our view on multi-perspective architectural decision management. Finally, we conclude our research results and also mention our future work.

2 Smart Service Design

We are at a turning point in the development and application of intelligent digital systems. We see excellent prospects for digital systems with artificial intelligence (AI) [5, 6], with the potential to contribute to improvements in many areas of work and society through digital technologies. We understand digitalization based on new methods and technologies of artificial intelligence as a complex integration of digital services, products, and related systems. For years we have been experiencing a hype about digitalization, in which the terms digitization, digitalization, and digital transformation were often used confusingly. The origin of the term digitalization is the concept of digitization. According to [9], we distinguish different levels of digitalization.

Digital technologies are the main strategic drivers for digitalization because digital technologies are changing the way business is conducted and have the potential to disrupt existing businesses. SMACIT [1] defines the strategic core of digital technologies, with abbreviations for Social, Mobile, Analytics, Cloud, Internet of Things. From today's perspective, we need to add more essential technologies and therefore extend this technological core with artificial intelligence and cognition, biometrics, robotics, blockchain, 3-D printing, and edge computing.

So digitalization is more about shifting processes to attractive, highly automated digital business processes and not just communication via the Internet. Digital redefinition usually leads to disruptive effects on business. Beyond the value-oriented perspective of digitalization, digital business requires a careful adoption of human, ethical, and social principles.

The digital transformation [3, 9] is broader than digitalization and usually starts with a digital strategy [10, 11]. For architecting smart digital services, we first model the digital strategy, as shown in Fig. 1, which sets the digital modeling direction and determines the basis and a value-based framework for the digital business models, with the business model canvas [12] and the value proposition canvas [13]. With the basic models for a value-based digital business, we map these basic services and product models to a digital operating model [1], which defines the basis for scalability and integration of services. The value perspective of the business model canvas [12] results in a suitable mapping [14] to the value models of the enterprise architecture supported by ArchiMate [15]. Finally, we set the framework for the systematic definition of digital services and associated products by modeling digital services and product compositions according to semantically related composite patterns [17].

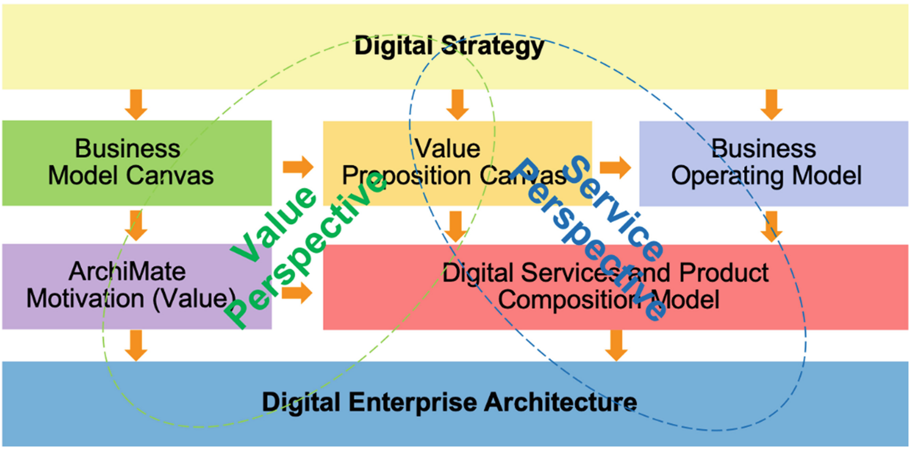

Fig. 1. Integral value and service perspective.

Value is usually associated with worth [4] and aggregates potentially basic categories like importance, desirability, and usefulness. The concept of value is essential for designing appropriate digital services with their associated digital products and aligning their digital business models with value-based enterprise architectures. From a financial perspective, the value of the integrated resources and the price defines the main components of monetary worth. The digital business discipline today has shifted to a nominal use of the value perspective [4], where customer experience and customer satisfaction represent essential value-based concepts. Characteristics of value modeling for a service ecosystem were elaborated by [16].

3 Cognitive Service Co-creation

From today's perspective, probably no digital technology is more exciting than artificial intelligence, which offers massive automation possibilities for intelligent digital systems and services. Artificial intelligence (AI) [5, 8], is often used in conjunction with other digital technologies such as analytics, ubiquitous data, the Internet of Things, cloud computing, and unlimited connectivity. Fundamental capabilities of AI concern automatically generated solutions from previous useful cases and solution elements, which are enabled by causal inference structures such as rules and ontologies [5], and automatically derived from learned solutions based on data analysis with machine learning [8] and deep learning [18] with neural networks [19].

The platform [2] for cognitive co-creation aims to support relevant categories of stakeholders, actors and roles, covering a wide range of users, customers, and other interest groups. We address essential user categories or roles: service users, co-creators and other beneficiaries such as customers, employees, suppliers and competitors, strategists, business architects, and digital enterprise architects. In Fig. 2, we define a core concept of a new cognitive co-creation platform for determining and adapting the value-in-use of services in evolutionary scenarios. The proposed value co-creation [4] platform extends following categories of essential digital artifacts, taking into account the evolutionary dynamics of an integrated architecture lifecycle management for intelligent artifacts, such as digital strategy, digital operating model, smart service composition models, digital enterprise architecture and intelligent digital services and products.

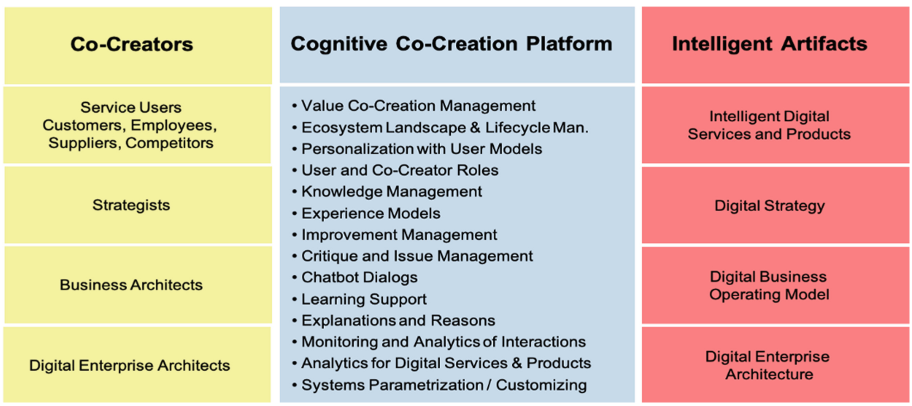

Fig. 2. Cognitive service co-creation platform.

The cognitive co-creation platform provides a framework for intelligent analytics of co-creation feedbacks [2] from both users (e.g. customers) and monitored intelligent systems and services. This cognitive co-creation platform integrates essential functionalities leading to stakeholder-specific individualized views. Novel functionalities concern the human-centric intelligent support of different roles of value beneficiaries and co-creators of services, personalization and user models, user roles, representation of user knowledge, experience tracking, user suggestions for improvement, critiques and solution ideas, problem and issue reports, chatbot dialogues for individualized information, mechanisms for transparency, explanation and rationality, support for user learning, re-parameterization of services, monitoring and analysis of user interactions, and the evaluation of service transactions and the analysis of the product life cycle.

Artificial intelligence is often characterized as impersonal: From this point of view, intelligent systems operate entirely automatically and independently of human intervention. The public discourse on autonomous algorithms that work with passively collected data contributes to this view. However, this perspective of enormous automation obscures the extent to which human work necessarily forms the basis for modern AI systems [5, 8] and makes them possible in the first place. The human element of intelligent systems includes tasks like: optimizing knowledge representations, developing algorithms, collecting and tagging data, and deciding what to model and how to interpret the results. Studying artificial intelligence from a human-centric perspective [20] requires a deep understanding of the role of human ethics [21], justice and human values [22], and of practices and preferences for developing and interacting with intelligent systems. With the success of artificial intelligence, new concerns, and challenges arise regarding the impact of these technologies on human life. These include issues of the security and trustworthiness of AI technologies in digital systems, the fairness, and transparency of systems, and the conscious and unintended effects of AI on people.

4 Digital Enterprise Architecture

Enterprise Architecture Management [23] as defined today by various standards such as [15], uses a relatively large number of different views and perspectives for managing the current IT. An effective and agile architecture management approach for digital enterprises should also support the intelligent digitization of products and services and be both holistic and easily adaptable [24]. A successful digital architecture should use a service platform [2] that supports a network of actors-to-actors and hosts a set of loosely coupled services as part of a rapidly growing digital ecosystem [1]. DEA - Digital Enterprise Architecture Reference Cube [24] extends our holistic architecture reference and classification model for supporting bottom-up integration of dynamically composed micro-granular architecture services and their models (Fig. 3).

In our current research, we are extending a Control Compliance Cockpit in Fig. 4 from [25] of an insurance company that integrates intelligent data analytics for cyber risks - and thereby covers cybersecurity and architecture-related risks. The World Map Viewpoint of the Control Compliance Cockpit serves as an entry point for user interactions. The legend at the bottom of the visualization reflects the scoring system of a particular assessment technique, ranging from “very good” (dark green) to “very poor” (red), with two additional colors for “not available” (dark gray) and “not sharp” (light gray) added. The slider on the right side of the visualization has a direct influence on the thresholds, which are set by an assessment technique for business experts in “what-if” analyses.

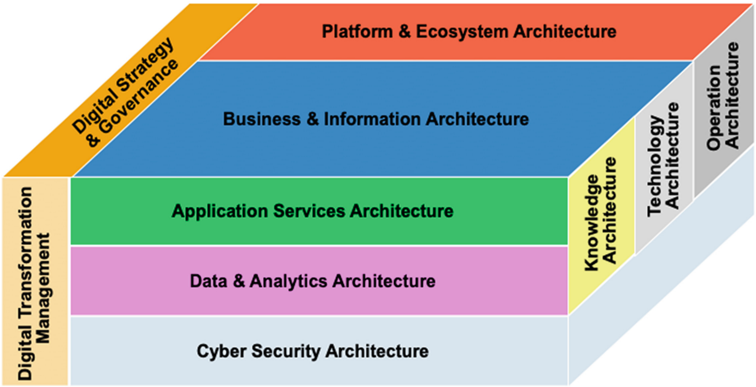

Fig. 3. Digital Enterprise Architecture Reference Cube.

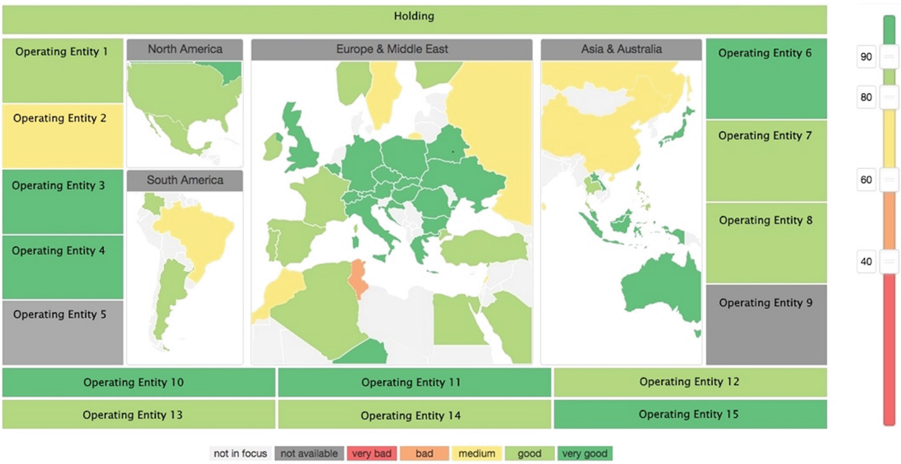

Fig. 4. Intelligent Control Compliance Cockpit.

A service platform is a modular structure that connects and integrates resources and actors that share a common institutional logic [24] and promotes the value co-creation through the exchange of services, according the service-dominant logic [4]. The value of a platform [16] results from the number of users of the platform and services.

5 Conclusion

We have developed a new approach for a cognitive co-creation platform. We contribute to the literature in different ways. Concerning our results, we have identified the need and solution mechanisms for a value-oriented integration of digital strategy models, digital business models, and digital operating models up to architecture models for smart digital services. The limitations of our work result from an ongoing validation of our research and open questions in the investigation of extended AI approaches and their social context of ethics and values. We are working on the extension of human-controlled, dashboard-based decision making by AI-based intelligent decision systems.

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Empowerment of Citizens, Public Sector Employees and Other Stakeholders in the Digital Age

Open Banking and PSD 2: The Promise of Transforming Banking by 'Empowering Customers'

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Abstract. The European Union's revised Payment Services Directive (PSD 2) aims at opening up the market for payment services in the EU. Banks are required to grant other providers access to their customers' payment account data in order to stimulate competition, facilitate the development of new, innovative offerings and allow customers to 'shop around' for better-value, more personalised services. While billed as a major win for customers the regulatory approach of PSD 2 is informed almost exclusively by competition law and supply-side concerns as they take precedence over customers' and public interest considerations, such as data protection and privacy. In an environment that is increasingly dominated by large digital platforms this may prove to be a costly mistake.

Keywords: Human side of service engineering · Financial services · Payment services · Innovation · Data protection · Regulatory policy

1 Introduction

The European Union's revised Payment Services Directive (PSD 2)[1] came into force on 13 January 2018 and marks a major step in the EU's effort to further integrate the internal market for financial services and to complete the Digital Single Market (DSM). It comprises two signature policies:

– Strong Customer Authentication (SCA): PSD 2 obliges payment service providers to apply strict security requirements for electronic payments based on two-factor (or multi-factor) authentication methods to prevent fraud and provide for a consistently high level of payment security.
– 'Open Banking': PSD 2 requires banks to provide access to their customers' payment account data to third-party providers of payment services, subject to customer consent, to enable them to offer new, differentiated services based on the use of these data.

[1] Directive 2015/2366/EU of the European Parliament and of the Council of 25 November 2015 on payment services in the internal market; OJ L 337, 23 December 2015, pp. 35–127.

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This paper focuses on the latter, Open Banking, as a recent example that highlights some of the key public policy issues that arise as a result of the advance of data-centric business models, in general, and the digitalisation of financial services, in particular. Firstly, this paper looks at PSD 2, its policy objectives and potential effects in the context of other relevant EU legislation, in particular the General Data Privacy Regulation (GDPR)[2]. Secondly, it will revisit the regulatory concept of 'unbundling' and consider lessons learnt over the course of the last 30 years in the telecom and digital media sectors. It seeks to illustrate how a 'citizen-centric' approach could potentially inform better regulatory policy decisions.

2 Transforming Banking

The original objective of PSD 2 was to revive competition in the markets for card and mobile payments after the European Court of Justice had found a number of leading banks and credit card firms guilty of anti-competitive practices.[3] In its supporting analysis [4], the European Commission (EC) identified a number of limiting factors the proposed legislations was meant to address: a market characterised by high barriers to entry that favour incumbents and discourage new entrants; gaps in standardisation and interoperability that lead to fragmentation, reduce scalability and stifle innovation; and high costs and limited choice for all types of users (customers and merchants). The DSM, launched in May 2015[4], subsequently added a second objective, that of boosting the competitiveness of EU-based providers of digital services through promoting interoperability and standardisation. According to the EC [3], the 'Open Banking' initiative under PSD 2 aims to modernise EU payment services for the benefit of consumers and businesses; promote the development of innovative online and mobile payments; give consumers more and better choices when it comes to retail payments; improve the level playing field for new service providers (e.g. FinTechs); and contribute to a more integrated and efficient European payments market.

The regulatory approach in PSD 2 encompasses two main aspects: on the one hand, it invests customers and service providers, respectively, with new rights – 'open access' and 'data portability'. On the other hand, it introduces new types of third-party payment services to disaggregate parts of the payment services value chain ('unbundling') in order to reduce the dominance of vertically integrated incumbents, break up existing market structures and stimulate competition. This approach has been widely adopted in competition law since the 1990s as a way of overcoming barriers in network industries, such as utilities and telecommunications.

[2] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data; OJ L 119, 4 May 2016, pp. 1–88.

[3] European Court of Justice: Judgment of 11 September 2014, *MasterCard Inc. and Others vs. European Commission*; C-382/12 P, EU:C:2014:2201.

[4] European Commission: Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Council of the Regions: A Digital Single Market for Europe (COM/2015/0192 final). European Commission, Brussels, 06 May 2015.

'Open access' seeks to strengthen competition in network-based industries by forcing incumbents to grant newcomers access to their core network [8]. PSD 2 introduces a right for third-party payment service providers ('TPPs') to be granted 'open access' to information from a customer's payment account – typically a current account held at a bank, subject to customer consent, in order to offer 'unbundled' payment (and related) services without having to invest in duplicating the incumbent's vertically integrated payment network. PSD 2 defines three types of third-party payment services: Payment Initiation Services ('PIS'), Account Information Services ('AIS') and Card-Based Payment Instruments Issuers ('CBPII'). PIS help consumers make online payments and inform the merchant immediately of the payment initiation, allowing for the immediate dispatch of goods or immediate access to ser-vices purchased online ('instant payments'). AIS give consumers and businesses an overview of their financial situation by consolidating information across different payment accounts they may have with one or more bank(s) or payment service provider(s). CBPIIs are TPPs who issue payment cards and may request confirmation of the availability of funds from the bank or payment service provider servicing the account.

3 Empowering Customers

For customers, PSD 2 establishes a right to 'data portability', enabling them to re-use personal data, i.e. disclose account details and payment records held with one provider to another in order to 'shop around' for better value propositions, personalised offerings and/or new, innovative services. In doing so, customers stand to benefit, on aggregate, from economies of scope that arise when large datasets are shared and processed on digital platforms [11]. They also potentially benefit, individually, from services that are personalised based on their requirements and preferences. In addition to these immediate benefits, the EC argues that EU-based providers of digital services need to have access to data on a par with non-European competitors in order to develop innovative, tailored offerings and remain competitive in the development of AI-based solutions, which rely critically on the availability of training datasets [2].

PSD 2 has been billed as a major step towards empowering customers. While SCA is intended to improve protection of consumers against online fraud 'Open Banking', and the right to 'data portability', in particular, is meant to let consumers take back control of their data so that they are able to switch more easily between banks and other providers of payment services. This approach is anchored almost exclusively in competition law and, to a minor degree, consumer protection law, however, while a third, potentially key aspect of empowering customers remains conspicuously absent: PSD 2 barely addresses customers' data protection rights.

4 PSD 2 and GDPR

In the specific setting of the digital sphere, which includes online payments, the customer takes on a three-dimensional role: (1) owner and provider/supplier of personal data (a 'data subject' in the terminology of GDPR); (2) consumer of (free or paid-for) digital content and/or services ('user'); and (3) producer of ('user-generated', free or paid-for) digital content and/or services in their own right.

EU citizens' rights to privacy and data protection are enshrined in Articles 7 and 8 of the EU Charter of Fundamental Rights (the 'Charter')[5]. They establish a protected sphere that must be respected, *a priori*, in every field of activity. In other words: if the three roles above were visualised as a pyramid, the citizen's role as a 'data subject' should be at its apex. With GDPR, the EU has created a legal framework for putting Article 8 of the Charter into practice. Its Article 5 sets out seven general principles that define the legal boundaries for the permitted use of EU citizens' personal data. Articles 4(11) and 7 GDPR define the conditions for, and meaning of the notion of 'consent'. Article 20 GDPR grants EU citizens a general right, subject to certain conditions, of 'data portability'. 'Open Banking' in PSD 2 could be viewed as an archetypal application of that right.

The relationship between PSD 2 and GDPR is, however, ambiguous. Article 94(2) PSD 2 requires that *'payment service providers shall only access, process and retain personal data necessary for the provision of their payment services, with the explicit consent of the payment service user'* – but does not go on to define 'explicit consent'. This term does, however, figure prominently in GDPR: the definition of, and conditions for 'consent' are set out in Articles 4(11) and 7 GDPR, respectively. It would stand to reason that 'explicit consent', as a precondition for the disclosure of personal information under PSD 2 should be interpreted in accordance with GDPR. This is not the view of the European Data Protection Board (EDPB). In its response to a query from the European Parliament the EDPB opined that the GDPR's definition of 'explicit consent' does not apply to the interpretation of Article 94(2) PSD 2 [5]. Contractual consent given by the customer when instructing a payment may be considered, on its own, as a valid legal basis for the processing of personal data.

A second issue was raised by the European Parliament in respect of so-called 'silent party data'. It concerns parties who are not themselves a party to the contract between the customer and the TPP but whose personal data may be exchanged and processed as part of a transaction between the customer and the TPP. In the absence of any contractual relationship between that party and the TPP – and hence of any form of consent – it is unclear on what legal basis his or her data may be processed, if at all. Item (f) of Article 6(1) GDPR allows for the processing of such (third-party) data if it '*is necessary for the purposes of the legitimate interests pursued by the controller or by a third party, except where such interests are overridden by the interests or fundamental rights and freedoms of the data subject'*. That provision requires a judgment balancing the customer's and TPP's respective interests with that of the third party. This balance may appear fairly straightforward if that third party is the recipient of a payment (payee) but becomes rather more complicated if the third party is not a beneficiary of the underlying contract, e.g. in the case of a contract that involves AIS, where personal data of the third party may be processed without his or her knowledge and without affording him or her any direct benefit. According to the EDPB, processing such data is admissible to the extent that it is covered by the legitimate interest of an account

[5] Charter of Fundamental Rights of the European Union; OJ C 326, 26 October 2012, pp. 391–407.

information service provider (AISP) to perform its contract with the customer [5]. This view effectively implies that the rights of the 'silent party' are, *a priori,* subordinated to the interest of the customer and the AISP.

These two examples go some way towards highlighting the risks of a sectoral, piecemeal approach towards regulating data protection and privacy rights. GDPR sets out a comprehensive set of general rules that enshrine citizens' rights across all areas of their online lives. PSD 2 attempts to adapt these general rules for application in a specific vertical and introduces certain trade-offs. In the process, it appears, some of the clarity and protective effects of GDPR are lost or compromised. PSD 2 relies on 'open access' and 'data portability'. But 'data portability' is an instrument of competition law and does not fit well with the fundamental rights nature of data protection law [6]. Data protection rights, as guaranteed by Article 8 of the Charter and the principles enshrined in Article 5 GDPR, do not figure in PSD 2.

5 'Unbundling' the Supply Side

PSD 2 is expected to pave the way for major structural changes in the financial services industry. Its approach of disaggregating a vertically integrated value chain to stimulate competition employs a similar logic to the 'unbundling' of network operators and service providers that became a core element in the deregulation of the EU telecom industry in the 1990s and early 2000s.[6] So-called 'local loop unbundling' allowed competitors to use parts of the incumbent's network infrastructure – usually the 'last mile' of cable or fibre that connects the end customer's home to the network – to increase competition in the consumer-facing end market. Increased competition in the end market, in turn, was expected reduce prices, stimulate market growth, and attract more investment from suppliers in the network to service the incremental demand.

In practice it has turned out difficult, however, to reliably quantify the contribution of regulatory 'unbundling' to the dynamic development of the telecom sector over the last three decades. For one, it is undisputable that incumbents continue to play a dominant role in most European markets. They have been joined by the winners of a convergence process, which has seen a handful of large, integrated multi-play operators emerge from countless rounds of consolidation. A growing number of studies appear to corroborate that 'unbundling' has not *per se* incentivised new entrants to invest in more modern and powerful infrastructure but has acted as a disincentive to incumbents to doing so [7, 9]. Arguably, technological convergence – ranging from fixed-mobile convergence to convergence in voice telephony (VoIP), television (IPTV) and digital network standards (DSL and DOCSIS) – has done at least as much as regulatory 'unbundling' to keep these markets competitive and facilitate the level of variety and choice on offer today. It is important to recognise the limitations of 'unbundling' as a regulatory tool: a single-minded focus on the supply side, with service coverage,

[6] Regulation (EC) No 2887/2000 of the European Parliament and of the Council of 18 December 2000 on unbundled access to the local loop; OJ L 336, 30 December 2000, pp. 4–8. (Note: this regulation was replaced in 2009 and is no longer in force.)

market share and consumer prices as the first and foremost regulatory indicators, is unlikely to fully capture the welfare effects for the wider economy.

Moreover, 'unbundling', an approach designed to break up vertically integrated monopolies, does not appear well suited for horizontal, data-driven business models. In the communications industry, concern about the dominant position of incumbent network operators has largely given way in recent years to concerns about the emergence of dominant digital platform operators whose position relies no longer on the ownership of network infrastructure but on their capacity to acquire, aggregate and analyse vast quantities of data on a global scale. In view of these digital platforms there is a growing sense that network operators could be at risk of becoming 'dumb pipes' supplying other parties' value-added content [1]. The same dynamics could be seen at work in the financial industry if these digital platform operators were to successfully establish themselves as the PISPs and/or AISPs of choice. Their capacity to extract value from the secondary use of customer data [11] could put them into a position where they gain a substantial advantage over their vertically integrated competitors in the payments industry and secure preferential access to yet another valuable set of sensitive customer data. This scenario is particularly relevant in view of the current public concern about the collection and aggregation of personal data and their use for the purposes of profiling and AI-based decision-making. It has proven difficult so far to adequately monitor and enforce the legal limitations to the secondary use of data by large digital platforms. 'Unbundling' the payments value chain may, deliberately or not, merely shift the concentration of market power to a different set of players. Such an outcome would be the diametrical opposite of the regulatory purpose of PSD 2.

These considerations illustrate that 'unbundling' the supply-side and 'regulating for competition' is unlikely to produce satisfactory outcomes in a data-centric, horizontally structured industry. A 'citizen-centric' approach towards regulating the digital space begins with restoring bargaining power to the demand-side. If data are the most valuable asset in the digital economy citizens' rights over their data are the single most powerful lever for redressing the balance. This could be achieved, for instance, by providing users with one or more legally pre-defined, standardised and encrypted data profiles that are structured in accordance with a binding data taxonomy based on the GDPR and form an obligatory basis for entering into contracts for digital services.

6 Conclusions

PSD 2 has brought customers the convenience of 'instant payments' and the promise of a range of new, big data-enabled financial services. It is not unequivocally clear, however, if PSD 2 has truly 'empowered' customers. Its data access provisions have the potential to expose yet another highly sensitive aspect of the digital citizen's life to dominant digital platform providers whose use of this data may be difficult to control. The apparent inconsistencies between PSD 2 and GDPR highlight the risk that a piecemeal approach to data protection based on sectoral rules could render the task of *'orchestrating the consistency of legal regimes within the Digital Single Market and their mutual interplay'* [6] exceedingly difficult and end up eroding citizens' fundamental right to data protection guaranteed by the Charter as a result. Government and regulators need to strike a balance between protecting citizens' ownership of their personal data – including their freedom to make use of it as they see fit, and protecting citizens from being forced into unequal exchanges where surrendering data is a pre-condition for accessing 'essential' services. Supply-side measures, such as 'open access' for service providers and 'data portability' rights for users, can only be one part of that solution. At this stage of the policy cycle it is for government and regulators to map out a comprehensive policy view towards regulating the digital space as a public good [10]. A 'citizen-centric' approach would restore autonomy and bargaining power to the demand-side and could go a long way towards balancing technological innovation, commercial interest, and the protection of citizens' rights.

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Multi-contextual View to Smart City Architecture

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Abstract. In the Smart Cities, there are several research streams, one of them is represented by the application of service dominant logic and science engineering, which usually identifies different layers in the Smart City depending on their value propositions. Between the layer of IT services and the actual services provided by the city, we found that there is an uncertainty regarding how the city services can be designed and adapted in different contexts. This may be caused by the lack of systematic management and comprehensive overview of the city data such as open data in the city. Therefore, this paper proposes to analyze the multi-contextual environment of Smart Cities and uses the data as an essential source for the key decisions in the city development and service design. It also outlines the process to support such a solution and achieve a sustainable and resilient city.

Keywords: Smart City · Multi-contextual view · Smart services · Smart City architecture

1 Introduction

Smart City development is usually in a multi-contextual environment, as the smart cities have an ecosystem that contains a variety of stakeholders. Thus, different application contexts can be linked together and influenced by each other, where one solution in one context that is effective may cause negative effects in the other context. For example, a simple limitation of the car entrance into the city center because of the intention of reducing the air pollution and lowering danger for pedestrians may increase the traffic jam and air pollution in other parts of the city. Therefore, different contexts in smart cities are interactive and usually affecting each other. In order to understand the contextual changes, it is valuable to analyze the Smart City services and architectures from a multi-contextual view.

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One of the critical aspects to address different contexts is the data flow in the city, since the cities are the producers of different types of data – for example, data from public transport, energy consumption, traffic monitoring, emergency services, environmental data and data from the administration. The usage of that data is still unclear when linking into the city development and understanding their role in the service environment. Most of the data are not analyzed, published or saved. They are isolated, split in the different places, and cannot be combined and help the city in its development. This will in turn cause the isolations of different contexts.

Without enough data support, the city representatives do not have objective information for their decision-making. It is necessary to adapt the analysis of Smart City for designing the services, their data and the value chain in the most efficient way. The paper, therefore, suggests a systematic approach for how to analyze the multi-contextual environment of Smart City architecture.

2 Smart City Architectures

Due to the complexity of smart cities, a variety of works propose Smart City architectures from different perspectives. We have revisited four typical Smart City architectures that are representative in four aspects of smart cities: data flows, resource monitoring, modeling, and ontology, as well as smart services. Those aspects are reflecting the big data analytics, critical infrastructure, semantic web and service-oriented design in smart cities.

From the data flow perspective, Gaura [1] has divided the Smart City components into eight different domains, which are smart health, smart environment, smart energy, smart security, smart office, and residential buildings, smart administration, smart transport and smart industries. For each domain, this work considers that the various data sources are generated from wireless sensor networks, then flow into the data processing workflow, and in the end, to support the customized smart services.

From the resource monitoring perspective, Rodriguez [2] proposed that a Smart City is to intensively use technologies such as IoT or telecommunications to achieve resource monitoring. Therefore, they further consider that there are two types of architectures in smart cities: external architecture and internal architecture. The external architecture is mainly focused on the exteriors of the city, such as the street or building Infrastructure. On the other hand, the internal architecture is to tackle resource monitoring inside the buildings such as the flow of people or air conditioning. The resource monitoring can be used to the reactions in the city.

From the ontological perspective, Stoyanov [3] proposed to virtualize real-world things in smart cities. Their architecture contains three layers: physical layer with IoT devices, middleware modeling, and user-oriented application. Each layer intends to transfer from physical things to a model result. Therefore, their architecture can be used to describe the Smart City such as entities, contexts and relations.

From the service perspective, Simmhan [4] focused on the application of IoT in smart cities. Their architecture considers the process from IoT sensors to final decision making. Along with this process, some cross-layer factors are also discussed, such as security, privacy, and resource management. Also, from the service perspective, Walletzký [5] proposed a model to describe how different services are connected to each Smart City domain. This model is to describe the routes from IT services to supporting services and then to smart service. The smart services in different domains will feature smart cities.

3 Viable Systems Approach for Contexts

According to the studies on Smart City Architectures, and the main insights of Viable System Approach – VSA [6, 7], in every (objective) environment, the (subjective) context of each specific system develops is consolidated [8]. This can affect the daily strategies undertaken and pursued, enhancing or developing the attitudes and the relative survival skills (for example of plants, but also of businesses and organizations in general in the long run of all systems. The relational and holistic views adopted by VSA help us in understanding that the context of each actor is the result of the set of interactions activated by him in accomplishing its own aim [9]; by extending or reducing this set of interactions the boundaries of his context will be definitively changed [10]. Thus, organizations cannot fail to relate to their subjective context of reference, as well as respect the constraints and rules of the objective over-determined environment [11]. For a given system, the context is, therefore, that set of exchange objects whose characteristics influence and are influenced by the behavior of a system [12].

To deepen the new reflections on the concept of S.M.A.R.T. (Acronym proposed by IBM researchers to mean something "specific, measurable, agreed, realistic and timely," [13]), many scholars have tried in recent years to study all possible service applications, defined "on stage," referring to the practical evidence of something truly iterative, interactive, interconnected, intelligent [14–16], and which was representative of a more intelligent planet [17]. Among them, it is interesting to understand which aspects are related to the multitude of actors (workers, citizens, producers, suppliers, authorities, consumers, users, etc.) and facilitators (retail sales, large retailers, networks information, financial services, public health administration), which are fundamental for improving the ability to manage and implement collaboration strategies [9].

Furthermore, under VSA, the action of any organization is contextualized within a dense set of relationships, branched from within the structure of each business organization (therefore considering its sub-components - sub-systems), reaching up to outside of it, referring to all possible systemic superstructures (or supra-systems), which directly or indirectly, can potentially influence action, strategies, and results [18]. Thus, several subjective contexts can take place, as they express the effects of activated interactions of each actor involved in a studied process: one environment, many contemporary, simultaneous, concomitant contexts. Under these conditions, different behaviors influencing each other need to be deepened and contextualized to be explained. By studying these phenomena, a multi-contextual approach can be used to explore and analyze the Smart City services.

4 Multi-contextual View to Smart City

It can be observed that a Smart City can be considered as a system of different interconnected systems that are intelligent or smart to react or adapt to the changing conditions. From this perspective, we can see Smart City as a very complex, viable service system. The main feature of a viable system is the adaptability to the changing conditions during a time span. This adaptation process can affect other systems, can be a source of vulnerability or dysfunction of part or whole services. For example, the upgrade of a database can affect all systems that are connected to it – even in the most of cases the compatibility should be guaranteed, it is usually very hard to ensure a full compatibility. Therefore, it is necessary to analyze the influence on all related systems – if they are known. When a change in one context affects another context that is not properly identified, or with some delay to be identified, as a result of such a change. Meanwhile, all the service providers are trying to improve their services to offer the best product and service for value creation. However, the critical issue is that it is difficult to identify all the related services in the value chain.

In the layered model of Smart City [5] the multilevel model of Smart City services has been introduced. One service can use the output from many services from the bottom layer, and it can be used by services from upper layers. The scheme shows a change in the bottom level of the services (for example any kind of IT service) will affect all services above. For such a situation, it is necessary to guide the service designers through the multi-contextual environment of Smart City. In the paper [19] and [20] the framework of 4 diamonds have been introduced to fill this gap. It intends to define how to work in a multi contextual domain – adding the context as the part of the model.

5 Case Studies in Smart City Services

5.1 Participatory Budget in Mnichovice

Mnichovice is a small town (about 3800 citizens) that is located near Prague, Czech Republic. As a part of their effort to provide services to its citizens, the representatives of the city decide to introduce participatory budgeting. One of the winning projects of the first year (2017) was a purchase of two defibrillators for volunteer firefighters of the town. By supporting this project, the level of the service of volunteering firefighters was improved. The impact of this improvement was not to the citizens only, but to other cases in their fallout area.

The citizen's interest in supporting the firefighters in their town led the representatives to create a first aid workshop for the public to demonstrate the effect of the new equipment. As a result, this action-fueled the interest of citizens in participatory budgeting. Since then, every year a project supporting the volunteering firefighters won. The service of participatory budgeting in Mnichovice led to supporting the existing service of firefighters and created a new service of first aid workshop.

5.2 Open Data for Bike Roads in Brno

Brno, the second-largest city in the Czech Republic with 380.000 inhabitants, is presenting itself as an innovative, developing city, with the support of a healthy lifestyle. The part of this image is also building the portal of open data. The part of this presentation is the development of the cycleways and cycle lane. From this, we can read that the total length of the roads of bikers was more than 63 km in 2018. Brno was announcing that is having about 136 km of the roads for bikers in 2019. This helps the city to build such an image mentioned above. Based on those facts, the new application to support bikers in Brno was developed.

That application, built on the related open datasets and combining the maps´ data is showing that in reality Brno is having only 4,8 km of cycleways (roads reserved for bikers only), then some roads the bikers are sharing with pedestrians (about 29 km). The rest (about 100 km) are cycle lanes on the roads that are used by cars too, which is more dangerous for bikers and their health as well. We can see how one service (Open data) can affect the positive image and motivate the creation of innovative applications in one context. But in another context, the availability of the data and development of independent applications is showing that Brno is not telling the truth to its citizens – what affects the image of the city.

5.3 Queen Elizabeth Olympic Park in London

From 2011 onwards, London has been at the forefront of developing Smart City projects. While the ‘Smart London Plan’ is mainly focused on developing institutional and digital space, it also includes physical aspects, such as improvements in infrastructure and plans for urban regeneration. The most significant of such projects are considered ‘Here East,’ part of the Queen Elizabeth Olympic Park (QEOP) [21]. It currently hosts the start-up hub Plexal, the creative hub The Trampery, three university spaces amongst which a UCL robotics facility and the Staffordshire University Digital Institution London and several companies [22]. Queen Elizabeth Olympic Park was originally built to host the London Olympic and Paralympic Games in 2012.

Upon completion of the Games, the London Legacy Development Corporation, responsible for managing QEOP, pledged that it would be used to create opportunities for the locals and drive innovation and growth [23]. QEOP currently collects and uses a vast amount of real-time local data to navigate across its physical assets, as well as improving the quality of life of residents [24]. The collection occurs via public Wi-Fi, dedicated applications and social media platforms.

While the development in QEOP had as one of its main goals to make the area a smart district and increase the quality of life for residents via the use of data, many argue that it has created an isolated area with little connection to its residents [25]. This is additionally supported by a study that demonstrates that the typical visitor of the QEOP is a white-middle aged person typically visiting the sports facilities on-site, while young people and ethnic minorities were largely absent [26]. This is in contrast with the fact that QEOP is located in the most ethnically diverse borough in London [27]. Thus, while developing QEOP as a smart district has had positive effects on the increase of innovative businesses, it has potentially negatively impacted residents.

6 Conclusion

In this paper, we have presented the idea of multi-contextual view to the Smart City. Using the system lens to interpret dynamics in contexts, we have integrated the Viable Systems Approach and Smart City Architecture. In order to demonstrate the multi-contextual view to the Smart City in practice, we have conducted three case studies and shown how the different contexts are affecting each other, and the link can be taken as a positive or negative externality, depending on the selected context of the view. Our results indicate that the services of Smart City can be designed in the reflection of multi-contextual view and Smart City architects may keep in mind the fact that they can affect various contexts and dynamics in Smart Cities.

As future works, we plan to formally model the contexts and the changes of contexts in Smart Cities. This is to further understand the relationship between the contexts and investigate how the changes in one context will affect other contexts.

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The Impact of Fraternity and Sorority Participation on NAE's Engineer of 2020 Outcomes for Civil Engineering Undergraduates

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Abstract. The rapid pace of technology and innovation in the world has required continuous improvements in the preparation of civil engineers. In 2004, the National Academy of Engineering (NAE) identified ten essential attributes as critical to the future success and relevance of the engineering profession. This paper examines how civil engineering undergraduates' achievement of eight of the NAE's ten Engineer of 2020 (E2020) attributes is impacted by participating in different types of activities outside the classroom. Responses from a survey of 284 civil engineering undergraduates across 23 U.S. institutions were analyzed to explore the link between reported out-of-class activities and perceived outcomes. The overall results indicated that civil engineering undergraduates identified fraternity and sorority membership as a major influencer. This paper provides civil engineering educators and students a broad view of potential student outcomes from activities beyond the in-class curriculum.

Keywords: Fraternity and sorority · Civil engineering students · Engineering 2020 attributes · Out-of-class activities

1 Introduction and Literature Review

In 2004, the National Academy of Engineering (NAE) initiated the Engineering of 2020 Project that centers on envisioning the future to actively shape U.S. engineering education. The NAE [1] anticipated engineers starting in the year 2020 would need to work with bewildering arrays of technologies and a hyper-connected world. The Policy Statement 418 of the American Society of Civil Engineers (ASCE) has indicated the important role of civil engineers in ensuring national sustainability (i.e., environmental, economic, social and technological development) and bridging science and society [2]. Future civil engineers will need greater breadth and depth of technical and professional knowledge. Therefore, the undergraduate engineering learning experience needed to be reshaped and refocused to meet the demands placed on the engineer of 2020. To accomplish this goal, NAE [1] advocated ten key attributes for the engineer of 2020 and beyond: (E1) strong analytical skills; (E2) practical ingenuity; (E3) creativity; (E4) communication; (E5) business and management; (E6) leadership; (E7) ethical

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standards; (E8) professionalism; (E9) dynamism, agility, resilience, and flexibility; and (E10) lifelong learning. Eight of the ten attributes (E2–E9) are broad in nature, extending beyond technical, discipline-specific knowledge and skills, and are the very attributes that have been persistently less developed in graduating civil engineers.

The current, formal, and crowded curriculum of the typical four-year undergraduate degree presents a challenge when preparing civil engineers for the future [3]. Throughout most of the 20th century, many institutions required civil engineering students to complete 140–150 semester credit hours to receive a 5-year undergraduate degree [4]. By the 1990s, most institutions were moving to lessen the number of credit hours in the curriculum to fit a conventional 4-year college degree program. Today U.S. institutions usually require students to complete a minimum of 120 credit hours to receive a 4-year college degree, and 128 credit hours to earn an undergraduate engineering degree [5]. The reduction in program completion time helps students save money by lowering tuition costs and increases graduation rates for undergraduate students [6], but also challenges the ability of the curriculum to fully prepare civil engineers for practice. While electives such as classes in communication, social sciences, business, and economics, and cross-cultural learning experiences are essential to preparing the civil engineer of 2020, in most undergraduate engineering programs there are only 32 credit hours available for electives after core engineering classes are completed [1]. In civil engineering plans of study, many of these remaining credit hours are filled by civil engineering courses (i.e., technical courses).

With little room for additional courses and experiences in the existing formal curriculum for civil engineering undergraduates, what students do outside of the classroom becomes vitally important. The National Research Council (NRC) [7] has estimated that undergraduate students spend around 7.7% of their waking hours in a formal learning environment. For every hour spent in class, civil engineering undergraduates spend approximately 1–1.25 h outside of class on work related to that class [8]. Based on these aforementioned estimates, civil engineering students spend around 80% (12.8 h a day) of their waking time devoted to out-of-class and personal activities beyond the formal classroom setting and related course assignments. This out-of-class time offers civil engineering students additional time to obtain professional skills outside of the curriculum.

In this paper, out-of-class activities refer to any activity a student engages in that occurs outside of the classroom, including curricular-related, co-curricular, and extracurricular activities [9]. Recent studies have shown that out-of-class activities can provide engineering students opportunities to develop professional skills beyond the curriculum. For example, civil engineering students demonstrated improvement in leadership and communication skills after participating in a design competition team such as a concrete canoe competition [10] and reinforced soil competition [11]. Other studies have linked engineering students' out-of-class activity participation to a range of beneficial outcomes such as improved ethics [12], creativity [13], and teamwork [14].

With many civil engineering programs shedding credit hours, educators must be ingenious and intentional in their own practices and advice to students. This includes understanding the role of out-of-class activities in the professional preparation of civil engineers. This paper examines civil engineering undergraduate students' beliefs about the impact of out-of-class activities on eight of the E2020 attributes (E2–E9). The use of descriptive analysis is especially informative since there exists little understanding about the profile of 2020 engineers in general, and civil engineers in specific [15]. Therefore, the primary research question investigated in this study was: Do civil engineering undergraduate students believe that their participation in out-of-class activities helped them develop E2020 attributes, and if so, which out-of-class activities were perceived as the most and least impactful?

2 Methods

Data were drawn from a broader National Science Foundation-funded project that sought to investigate the impact of out-of-class activities on student involvement, affective engagement, and learning outcomes, especially for students from underrepresented groups. Data were collected using the Postsecondary Student Engagement (PosSE) survey administered over a two-year period ending in 2017 [9]. The PosSE survey purposefully oversampled female students and students from underrepresented ethnic/racial groups. This study analyzed responses from 284 civil engineering undergraduates from 23 four-year engineering programs across the U.S (see Table 1 for sample demographics). The data used in this study came from responses of the two survey questions:

- Q1: From the activities you have participated in, select your top one, the one from which you gained the most outcomes.
- Q2: To what extent do you agree that you gained the following outcomes (i.e., attribute) from your involvement in your top out-of-classroom activity?

For Q1, students selected one activity from a list of 20 out-of-class activities. For Q2, students responded using a 4-point Likert scale (strongly disagree, disagree, agree, strongly agree) for each listed learning outcome. The eight E2020 attributes (E2–E9) were part of the Q2 learning outcomes.

Table 1. Sample demographics

Demographic	Count	%
Race/ethnicity		
Asian	23	8.1
Black	15	5.3
Hispanic	63	22.2
White	159	56.0
Multiracial	20	7.0
Other race/ethnicity	4	1.4
Gender		
Female	139	48.9
Male	143	50.4
Other	2	0.7

The percentages of responded outcomes were computed and disaggregated by the reported top out-of-class activities to examine activities that helped students develop E2–E9 attributes. Activities with small sample size (n < 5) were removed from the analysis. A diverging stacked bar chart was built to illustrate the results (see Fig. 1).

3 Results

Civil engineering students do believe that their participation in out-of-class activities help them develop E2020 attributes. As shown in Fig. 1, data indicated that civil engineering students perceived the most outcomes from participation in social fraternities or sororities, professional experiences, and service-related activities. For example, 78% strongly agreed, 19% agreed, 4% disagreed, and 0% strongly disagreed that their participation in a social fraternity or sorority helped them develop the eight E2020 (E2–E9) attributes. In contrast, students perceived the fewest outcomes from participation in pre-professional activities, international experiences, and sports.

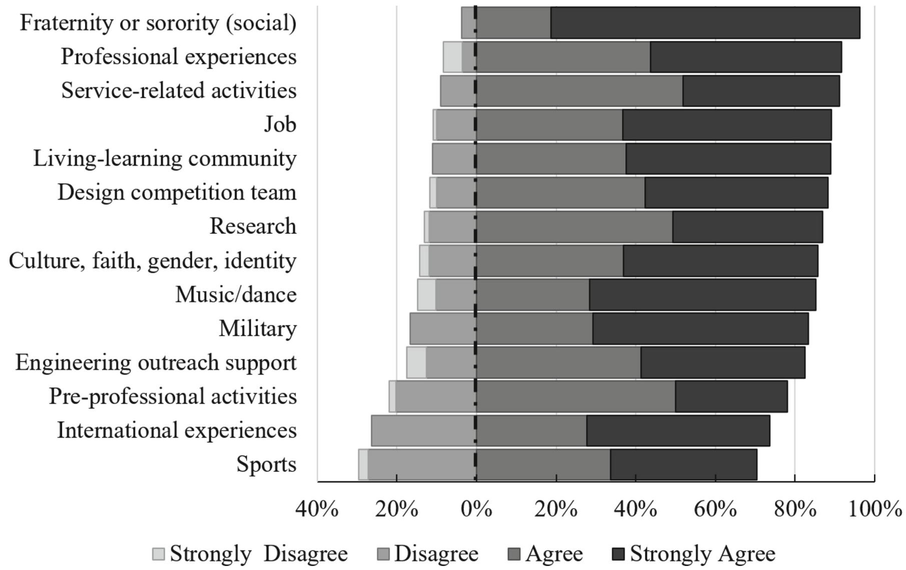

Fig. 1. Percentage of agreement on gaining eight engineering 2020 attributes by types of out-of-class activities

4 Discussion

The identification of professional experiences and service-related activities as two of the top three out-of-class activities that provide the most E2020-related outcomes is not surprising given the nature of these activities. Professional experiences like internships and co-ops and service-related activities like Engineering Without Borders and service-learning have been previously shown to support a range of professional outcomes such as understanding professional and ethical responsibility, leadership, creativity, and communication [14, 16]. The finding that social fraternities and sororities were perceived as providing the most opportunities to develop the selected E2020 attributes is somewhat unexpected and interesting as the value of participating in a fraternity or sorority has been a controversial topic in American higher education. Detractors have focused on the detrimental side of fraternities and sororities participation such as alcohol use, sexual assault, cheating, and hazing [17] while supporters have pointed to the beneficial side such as increased leadership skills, improved self-efficacy, academic achievement, and personal development [18–20].

While previous work has explored fraternities and sororities in engineering students [20, 21], future research should further investigate this connection in civil engineering students. While our sample is small, the results indicate civil engineering undergraduates may benefit from participating in social fraternities and sororities. Although the small group size precluded further statistical analysis, the results of this descriptive statistics encourage future research to reconsider the missed opportunities of fraternity and sorority in civil engineering professional development.

In terms of activities that had the least amount of agreement (i.e., students agreed they provided opportunities to develop E2020 attributes but not at as much as other activities), international experiences and sports were in the bottom three. While these activities provide many benefits, the outcomes are not aligned with the E2020 attributes. Beyond professional development, participation in sports can provide civil engineering students a means to improve health and personal well-being [22]. International experiences likely provide opportunities to develop cross-cultural awareness and global competencies [23]. Future research should further investigate other benefits of out-of-class activities, beyond the E2020 attributes, to provide civil engineering students a well-rounded college experience.

A finding of concern is that pre-professional activities had one of the lowest levels of agreement concerning the provision of opportunities to develop E2020 attributes. Pre-professional activities include participation in student chapters of professional organizations like American Society of Civil Engineers (ASCE). These types of activities can provide students with opportunities to develop a host of skills and competencies that support E2020 attributes, such as sense of professionalism, business management, and leadership [24]. This finding suggests engineering educators and organizations like ASCE may need to work to promote the benefits of pre-professional activities.

5 Conclusion

Using a sample of 284 undergraduate civil engineering students, this paper examined if students perceived E2020-related benefits from their out-of-class activity participation and how different activities were perceived as resulting in different levels of outcome development. Data indicated civil engineering undergraduates believed their participation in a social fraternity or sorority provided the most E2020-related (E2–E9) outcomes. Given that the negative aspects of social fraternities and sororities are often emphasized, the result implies there may be a missed opportunity for civil engineering students to develop professional skills from participating in a social fraternity or sorority. Regardless of activity type and motivated by the current, formal, and crowded curriculum of the typical four-year civil engineering undergraduate degree programs, the results suggest that out-of-class activities should receive more attention and support from researchers and universities to fully provide civil engineering students a practical means for personal and professional development.

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Empowering European Mobile Youth: Case Studies from Austria and Estonia

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Abstract. This paper presents the preliminary findings of two case studies currently conducted in Austria and Estonia on the empowerment of mobile youth in the European Union, i.e. citizens from other EU member states aged 16 to 29 who are resident in Austria and Estonia. The case studies are actions within the framework of a two-year project funded by the European Union (Empowerment of European Mobile Youth - EMY). The project's principal objective is to identify opportunities and barriers for the democratic and social engagement of mobile youth in these two countries. More specifically, the two case studies aim to (1) explore how young EU citizens experience the exercise of their EU citizenship rights in their host country and (2) identify requirements for a practical web-based tool to facilitate their engagement in the political live in their host country. This tool should potentially be transferable to other EU member states.

Keywords: Human side of service engineering · Empowerment · Citizenship · Mobile youth · User requirements

1 Introduction

This paper presents the preliminary findings of two case studies currently conducted in Austria and Estonia on the empowerment of mobile youth within the European Union. The case studies are actions within the framework of a two-year project funded by the European Union (Empowerment of European Mobile Youth - EMY).[1] The project's main goal is to identify opportunities and barriers for the engagement of young citizens from other EU countries in the political and social life in Austria and Estonia. The following sections outline the preliminary results of activities undertaken in the first project phase from 1 February to 30 June 2019.

[1] The European Union's Rights, Equality and Citizenship Programme (2014–2020). Project duration: 1 February 2019–31 January 2021. See https://europeanmobileyouth.eu/.

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1.1 Context

Mobile EU citizens have been neglected as a specific target group in elections and other forms of democratic participation across all levels of government in the 28 EU member states.[2] [3] Young people are the most mobile age group within the EU living in large numbers outside their home countries, especially for studying. Moreover, evidence shows that young people in general, are the least engaged in traditional democratic participation, asking for more and different channels of participation [1, 4].

While Austria and Estonia are fairly small EU member states,[3] they have been chosen as pilot countries because of their unique features: Austria was the first EU member state to grant citizens the right to vote at the age of 16 in elections at all government levels, including at the EU level. This also applies to other EU citizens who are resident in Austria. Estonia is a pioneer in the use of online voting ('i-Voting'), which has been in use for elections at all levels for more than ten years now [1]. i-Voting in Estonia is also available to other EU citizens who are resident in Estonia.

1.2 Target Group and Key Stakeholders

The project covers two types of beneficiaries: (1) Direct beneficiaries (the "target group") are students and other young citizens from EU countries aged 16 to 29 who are resident in Estonia and Austria but not citizens of their respective country of residence and (2) indirect beneficiaries ("key stakeholders") are member-state governmental authorities dealing with the support for and integration of international students into the political and social life and responsible for mobility; electoral authorities interested in fostering active involvement and participation in local and European Parliament (EP) elections; universities and schools; political parties; civil society organisations; as well as EU politicians and officials responsible for EU citizenship rights, mobility policies and educational/exchange programmes.

Students from other EU countries who are resident in Austria and Estonia to pursue their academic studies are the principal target group. Students in higher education including, in particular, participants of the Erasmus+ programme,[4] are the largest segment of this target group. They also tend to be socially and politically active. Much of this activity takes place within the organisational setting of student unions, which renders this target group relatively accessible. As the circumstances of students in higher education, such as their motivation for travelling and staying abroad and the time limitation of their stay, are quite specific the project seeks, in a second step, to address an extended target group of young mobile EU citizens who are not university or secondary school students.

[2] 27 EU member states as of 1 February 2020 due to the UK leaving the European Union.

[3] Population size: approx. 8,9 million in Austria, approx. 1,3 million in Estonia.

[4] Erasmus+ is an EU programme (budget: € 14.7 billion) which funds opportunities to study, teach/train, and gain experience abroad, https://ec.europa.eu/programmes/erasmus-plus/node_en.

1.3 Objectives

The overall objective of this project is to test ways to raise the level of inclusion and democratic participation of mobile youth in the social and political life of the EU, in general, and of their host EU countries, in particular. A particular emphasis is put on EU citizenship rights enshrined in Art. 20 of the Treaty on the Functioning of the European Union, which establishes the right to vote and stand as candidate in European and local elections in the country of residence (host country) for all EU citizens.[5] Member states' governments are free to extend these rights to national and/or regional elections, but so far, no one member state has done so. In doing so, we aim to explore how support can be best provided to young EU citizens living and/or studying in Estonia and Austria to strengthen their interest and participation in EU elections and policy making and to assist them in engaging in the democratic life of their host country.

Earlier studies have already singled out a number of barriers to engagement of mobile citizens at EU and local level such as the lack of harmonization of national electoral systems across the EU, technical and administrative requirements, as well as the provision of timely and accessible information. [3] We examine the relevance of these barriers for mobile EU youth in Austria and Estonia and, more specifically, aim to:

– Gain a better understanding of the motivation of young mobile EU citizens to engage in the political life in their host country; their awareness of the political choices in their host country; and their preferred communication and voting channels, especially in connection with the 2019 EP elections[6];
– Identify the reasons why young mobile EU citizens are not exercising their democratic rights emanating from EU citizenship and to find ways to encourage more active engagement and participation;
– Explore a more effective use of technology and social media channels to support the target group based on their requirements.

The findings of the case studies will inform policy recommendations for EU decision makers. In addition, the project aims to create a sustainable community and to pilot a practical tool to support young mobile EU citizens to exercise their democratic rights while being abroad.

2 Methodology

The apparent lack of democratic engagement among young Europeans has been the subject of intense research. [5, 7] Limited information, educational deficits, unemployment, social exclusion, and low overall levels of trust in government [8] and in the

[5] EU citizens can choose whether to vote in their home or host country provided they are registered according to national election regulations, which differ in terms of administrative requirements.

[6] European Parliament elections take place every five years. The last elections took place from 23–26 May 2019.

EU institutions have been highlighted variously as the main contributing factors. Researchers and policymakers are coming to the conclusion, however, that young people's disappointing participation in the polls cannot be blamed solely on political apathy. [2] We therefore examine a number of other explanatory factors in relation to the specific target group described in Sect. 1.2 including social and cultural aspects, such as home-country bias, information and communication deficits, and administrative barriers.

The methodology follows a mixed method approach using mapping activities such as online surveys, focus groups and interviews, and other interaction activities such as online debates and crowdsourcing activities. Mapping and other interaction activities are conducted in two phases: before and after the EP elections in May 2019.

In the first project phase (February to June 2019) the following activities were conducted in Austria and Estonia: a pre-election survey, four focus groups and approximately 30 interviews with key stakeholder. Section 3 summarizes the findings from activities undertaken in Austria and Estonia in the first project phase. They cover three main topics: (1) The general political activism and engagement of the target group in Austria and Estonia; (2) Their voting experience, interest in and attitudes towards the 2019 European Parliament elections; and (3) The use of communication channels in getting and handling the information about the elections.

3 Findings from Mapping and Interaction Exercises

3.1 Austria

In the academic year 2017/2018 all Austrian universities (public and private) hosted 98,663 international students in total. The majority of them came from Europe, with 70% from EU member states, 17% from other European countries and 13% from other parts of the world. [9] The actual number of all mobile students from the EU may differ slightly (but not significantly) at this stage.

Part of the mapping exercises was a pre-election survey, two focus group discussions with mobile students and a series of interviews with key stakeholders relevant to the target group, who have a direct and indirect influence on European mobile youth. In total, there were 191 survey participants and 13 focus group participants. Overall, students from 23 EU member states (out of 28) participated in the survey and focus group discussions.

Both the survey and the results of the focus groups showed that there was awareness of the possibility of voting for candidates in the host country. There was however little awareness about the right to stand as a candidate in the host country. 63% of survey respondents were aware of the right to vote for a candidate from Austria and only 24% were aware of their right to stand as a candidate in Austria in the 2019 EP elections. The majority of survey respondents who considered voting in EP elections, had they decided to vote, would have voted for a home-country candidate; 25% would have opted for an Austrian candidate.[7]

The main obstacles identified by respondents to the survey and focus groups were different registration procedures in each EU member state, non-uniform registration deadlines, lack of notification by the responsible authorities, lack of appropriate information to make informed decision, and the language barriers in the host country, as all events, promotions, appearances, etc. take place only in that language, and finally, the lack of information about elections. Despite the participants' interest in the EU, there was a distinct lack of a deeper understanding of its complex political and governance system. Furthermore, applications, tools, platforms, and campaigns of the EU only reach people if they proactively involve themselves through different channels (EU relevant communities and social media channels). EU issues of high interest to the participants were the environment, education, youth policy, EU processes and decision making, access to information, and the simplification of democratic engagement across the EU. With regard to electronic voting, concerns about secrecy, security and trust were raised.

While a large proportion did not show any proactive interest in the Austrian political landscape, more than half indicated that they were interested in events related to the EP elections in Austria. The results also showed that participants tended to look for election information about candidates from their home country rather than from their host country. The channels that were particularly highlighted included official websites of political parties, host-/home-country media, and social media, notably Facebook and Instagram. It was also observed that student unions do not seem to play an active role in facilitating democratic participation of mobile students in Austria.

3.2 Estonia

The mapping exercises identified 2,170 mobile students from the EU studying in Estonia's three main universities - Tallinn University of Technology, Tallinn University, Tartu University - as of April 2019 (degree-seeking as well as exchange students). The actual number of all mobile students from the EU could have been slightly (but not significantly) higher, if it were to include other Estonian universities. Overall, as many as 188 mobile students responded to the survey, with 169 completing it by answering most of the total of 37 questions offered for answering. The overall response can be considered as a good one confirming the interest on the part of the mobile students in the issues raised by the survey. The respondents represented 25 EU countries. The mapping exercises also included the conduct of two focus groups in two main universities of Estonia, namely Tartu and Tallinn University. In total, nine participants took part in the focus groups.

The findings from the mapping exercises in Estonia demonstrate that most of survey respondents (75%) were aware of the right to vote for a candidate from Estonia

[7] No precise election data (e.g. sociodemographic data, percentage of mobile young people who actually made use of their active and passive right to vote, etc.) is legally recorded in Austria by the Ministry of the Interior or other statistical offices.

and 39% of all respondents were aware of their right to stand as a candidate in Estonia at the 2019 EP elections. Furthermore, focus group participants perceive the EU citizenship through the prism of its practical benefits (such as traveling and studying abroad) and stressed the complexity of the EU's political and governance system; the importance of political engagement was mentioned to a much lesser extent. Also, the significance of understanding the direct influence of the EU on everyday lives of its citizens was highlighted. Moreover, the majority of survey respondents who considered voting in the 2019 EP elections, if they decided to vote, they would have voted for a home country candidate and 24% would have opted for an Estonian candidate. Focus group discussions demonstrated similar results, indicating that home-country candidates are still the preferred choice.

When it comes to the most significant barriers to participation in EP elections in Estonia, findings from both the online survey as well as the focus groups indicate that the voting registration procedure (selected by almost half of all survey respondents), insufficient information in order to make an informed electoral choice and not knowing the Estonian language were among the most noteworthy. More specifically, even though almost all focus group participants received the application letter from the Ministry of Internal Affairs of Estonia, some expressed uncertainty about certain aspects of the registration procedure.[8] Likewise, barriers and difficulties with registration procedures for voting for home-country candidates and the lack of clear information about the right to vote either for home- or host-country candidates were stressed. Language was emphasized as one of the crucial barriers to democratic engagement in the host country, as a certain level of proficiency is needed to make an informed electoral choice. It was also observed that student unions do not seem to play an active role in facilitating democratic participation and social integration of mobile students in Estonia.

4 Conclusions

Overall, the results of the pre-election mapping and interaction exercises, although specific to the project target group and the two EU member states where they were conducted, reflect the results of a survey carried out by the EP shortly after the elections in May 2019. [6] The findings also confirm the project assumptions outlined in Sect. 1.3 in the main. Respondents in both countries were well aware of and interested in the EP elections. This was confirmed by the EP survey, which reported the highest-ever degree of mobilization of young voters. [6] They were generally aware of their right to vote but much less aware about their right to stand as a candidate in an EU host

[8] Citizens of the EU have the right to vote in local government (council) elections and in EP elections while residing in Estonia. A person must be of at least 18 years of age to be eligible to vote, except in local government (council) elections, where 16- and 17-year-olds have been given the right to vote. The procedure to register for voting in EP elections in Estonia in brief, is the following: the paper notice is sent by the Ministry of Internal Affairs of Estonia to all EU citizens who have the right to vote in Estonia to their registered residency address. The notice includes the information letter as well as the application letter to be filled in and sent back to the Ministry in due time.

country. Generally, home-country bias was still prevalent among the target group. Engagement in the host country is strongly affected by language barriers and the expected/ actual length of stay is a key variable for political and social engagement in the host country. Administrative issues such as insufficient information about registration and voting procedures in the host country - and in the home country for eligible voters living abroad - constitute major barriers to participation in EP elections. While most young citizens are very interested in voting online, there are still lingering doubts and a lack of trust in the reliability of e-voting systems. Social and online media are important sources of information but not generally considered as a preferred forum for (political) discussion with peers. So far, EU communication efforts largely failed to reach this particular target group while national policy makers and key stakeholders do not seem to pay particular attention to the target group's needs.

The second project phase will include another set of mapping and interaction activities to deepen and validate the findings of the pre-election activities. One of the key challenges in this second project phase will be to provide different categories of mobile youth with targeted and regularly updated information about engagement opportunities at the EU level and in the host country. In order to support young mobile EU citizens in political participation processes digitally, information should be readily accessible based on a user-centric design and optimized for mobile devices.

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