Green Energy and Technology

Adriano Bisello · Daniele Vettorato
Pierre Laconte · Simona Costa *Editors*

Smart and Sustainable Planning for Cities and Regions

Results of SSPCR 2017

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Green Energy and Technology

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Foreword

This book presents a selection of the best papers delivered at the Second international conference on *Smart and Sustainable Planning for Cities and Regions 2017*, hosted by EURAC Research in Bolzano, Italy, and held on 22–24 March 2017. Comprising forty-six papers from policymakers, academics and consultant researchers, it sets out the state of the art on smart and sustainable planning, the findings of the groundbreaking research already conducted into the subject and progress made by cities and regions in meeting the challenges they face in championing future actions directed at climate change adaptation and the mitigation of global warming.

The groundbreaking research, challenges, adaptations and mitigations the book compiles include:

- Smart planning for adaptation and mitigation;
- Information and communication technologies (ICTs), space and society;
- The "next economy" for the city;
- Strategies and actions for good governance;
- Urban-rural innovation; and
- Rethinking mobility.

In addressing these themes, this book serves to show how climate change adaptation is only a headline in the smart and sustainable planning of cities and regions. It does this by getting beneath the headline and uncovering the lesser known, but no less significant contribution ICTs make to the smart and sustainable planning of cities and regions. In uncovering this contribution, the book reveals how the smart and sustainable planning of cities and regions assembles a platform for the design and construction of those spaces which society cultivates as the built environments of a "next economy". That "next economy" which is seen by cities and regions alike to be equally significant for the reason the governance of the urban and rural innovation this gives rise to is also able to rethink mobility.

Collectively, the papers force those policymakers, academics and consultant researchers championing the climate change adaptation measures of smart and sustainable planning, to not only rethink mobility, or call for the good governance of urban and rural innovation across cities and within regions, but also reflect on what the “next economy” contributes to the design and construction of those spaces which society considers key to the cultivation of built environments that are capable of mitigating global warming.

Edinburgh, UK

Prof. Mark Deakin
Edinburgh Napier University

Preface

Since 2015, the Urban and Regional Energy System research group at EURAC Research has organized the international conference on *Smart and Sustainable Planning for Cities and Regions* (SSPCR—http://www.sspcr.eurac.edu/).

This biannual event is gaining even more attention on the international level, thanks to its holistic and multidimensional approach. Indeed, the SSPCR conference focuses on innovative planning methodologies, tools and experiences aimed at supporting the transition of our cities and regions towards a smarter and more sustainable dimension, approaching various investigation scales, branches of science and intervention perspectives. Contributions from fields of research covering the scientific and professional communities of urban and regional planning are presented at SSPCR by international keynote speakers and complemented by selected participants. At SSPCR, research findings emerging from demonstration projects are also represented, so as to disseminate innovative approaches to smart and sustainable planning.

The keynote speakers at SSPCR 2017, hosted by EURAC and held in Bolzano, Italy, on 22–24 March 2017, are:

- **Mark Deakin**, Professor of Built Environment and Head of the Centre for Smart Cities, Institute for Sustainable Construction, at Edinburgh Napier University. He offers a critical synthesis of the smart-city literature. This is based on an interdisciplinary reading of smart cities and the insights a Triple Helix-inspired account of future Internet-based developments offers into the digital infrastructures, data management systems and renewable energies of cloud computing.
- **Hans Dubois**, Research Manager of the Living Conditions and Quality of Life unit at the European Foundation for the Improvement of Living and Working Conditions (EUROFOUND). Hans' talk is about the costs and consequences of inadequate housing in Europe and the quality of life in urban and rural Europe. He also outlines a new project on neighbourhood quality and the role of local-level measures in building up the quality of life.

- **Lia Ghilardi**, Founder and Director of NOEMA, a UK-based organization working internationally to deliver place mapping and strategic cultural-planning projects. Lia kicks-off and moderates the international debate on how cultural resources and culture-led regeneration strategies are playing a crucial role in the transformation of many European post-industrial cities. Such approaches to local development have been closely linked to economic competitiveness, attraction of investment and cultural tourism flows. International case studies are presented on Matera and Taranto (Italy), Amsterdam (the Netherlands) and Prague (Czech Republic).
- **Tamara Krawchenko**, Policy Analyst in the Regional Development Policy Division of the Organization for Economic Co-operation and Development (OECD). Tamara presents the findings of the OECD's report on The Governance of Land-Use in OECD Countries, offering analysis and recommendations on land-use policies and practices, with particular attention paid to the interactions between planning tools, fiscal frameworks and incentives.
- **Pierre Laconte**, President of the Foundation for the Urban Environment (FFUE). He is a past President of the International Society of City and Regional Planners (ISOCARP) and the former Secretary General of the International Association of Public Transport. He was also evaluator for the European Green Capital Award in 2012 and 2013 and a member of the Lee Kuan Yew World City Award Council. Pierre's presentation offers insights into how to answer the following questions about smart and sustainable cities: what is smart? What is sustainable?
- **Manel Sanmartí**, Head of the Electrical Engineering Research Area (EERA) at the Catalonia Energy Research Institute (IREC). Manel's talk is about the GrowSmarter project, a smart-city project funded by the European Commission under its SCC1-2015 call, which had the objective of transforming cities for a smart, sustainable Europe by deploying 12 smart energies, mobility and ICT solution in three main European cities: Stockholm, Cologne and Barcelona.
- **Sabine Sulzer**, Head of the Lucerne Competence Center for Energy Research (LUCCERNE) and Professor of Sustainable Energy Systems at the Lucerne University of Applied Sciences and Arts (HSLSU). Sabine offers a presentation on the coordinated research project in Switzerland concerning energy efficiency in buildings and districts. The goal of the project is to reduce the environmental footprint of Swiss building stock by a factor of three.

SSPCR 2017 keynote speakers and international guests have the paramount role of inspiring the discussion among delegates and introducing the thematic sessions. During the three conference days, about ninety oral and poster presentations are given over to attendees coming from 20 countries. The organizers believe this goes some way to confirm the status of SSPCR 2017 as a high-level international communication platform and event for members of the scientific and professional community to share their latest experiences of smart and sustainable planning.

This book comprises a selection of the best contributions presented at SSPCR 2017, facing the challenge of inspiring the transition of urban areas and rural regions towards smarter and more sustainable places to live. To this aim, planners and stakeholders are called to take over—in a multidimensional perspective—both the urgent issues related to climate change and energy efficiency and the new changes introduced by cities' digitalization and the integration of ICT into infrastructures, mobility and social interactions.

The second edition of the international conference on *Smart and Sustainable Planning for Cities and Regions*—SSPCR 2017—is supported by ISOCARP, OECD, Springer, EUROFOUND, FFUE, AISRe, Urbasofia, and in partnership with Klimamobility 2017 and New Metropolitan Perspectives 2018.

We wish to express our sincere gratitude to the reviewers, Scientific Committee members, keynote speakers, session chairpersons, Organizing Committee and members of staff at EURAC for making this conference successful. Finally, the editors would like to express special thanks to Mr. Pierpaolo Riva, Springer editor, for his professional assistance in publishing this volume in the book series Green Energy and Technology.

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About the Editors

Adriano Bisello is an Urban and Environmental Planner, with more than ten years of working experience and a strong interest in the field of smart-city projects and low-carbon urban-regeneration strategies. He did his Ph.D. in Real Estate Economics, investigating the co-benefits of smart-energy projects at the urban level. From 2006 to 2012, he worked as a consultant and a freelancer for public administrations and engineering companies in northern Italy, contributing to strategic and operative planning document design and strategic development of environmental assessment processes. Since 2013, he has been a member of the Urban and Regional Energy Systems team at EURAC in Bolzano (Italy) as a senior researcher, working in a multidisciplinary and international team. His current activities range from local to European-funded projects in the field of smart cities, international energy planning and sustainable energy policies and plans. He is a passionate public speaker and co-author of research works published in international books and journals. Since 2015, Adriano has managed the international conferences on *Smart and Sustainable Planning for Cities and Regions* (SSPCR), where researchers and practitioners from all over the world meet to discuss how to address the main contemporary challenges of urban, regional and energy planning. Since 2015, he has been a member of SIEV (Italian Real Estate Appraisal and Investment Decision Society) and, since 2016, of ISOCARP (International Society of City and Regional Planners).

Daniele Vettorato is an Urban Planner, holding a Ph.D. in Environmental Engineering, and works on Smart and Sustainable Energy Systems for cities and regions. Since its foundation in 2012, he has been the coordinator of the Urban and Regional Energy Systems research group at the Institute for Renewable Energy—EURAC. He has been the Vice President of ISOCARP (International Society of City and Regional Planners) since 2017 and a board member since 2015. He is one of the promoters of the international conference on *Smart and Sustainable Planning for Cities and Regions—SSPCR*. Daniele has been a project and financial manager in many EU projects (FP7 smart-city project SINFONIA, H2020 smart-city project

STARDUST, Interreg Alpine Space RECHARGE.GREEN, Interreg South East Europe LOCSEE, Interreg Alpine Space GRETA).

Pierre Laconte is a Doctor of Laws and also of Economics (Catholic University of Louvain) and an honorary Ph.D. (Edinburgh Napier University). He is President of the Foundation for the Urban Environment, which seeks to link urban planning, transportation and the environment, and he is a past President of ISOCARP (International Society of City and Regional Planners) and former Secretary General of the International Association of Public Transport. Pierre was an evaluator for the European Green Capital Award in 2012 and 2013 and a member of the Lee Kuan Yew World City Award Council. He is one of the three planners responsible for the Louvain new university town in Belgium, which received the Abercrombie Award of the International Union of Architects. His publications include *Sustainable Cities—Assessing the Performance and Practice of Urban Environments* (co-ed., C. Gossop, 2016); *Brussels: Perspectives on a European Capital* (co-ed., C. Hein), which shared the Society for Human Ecology's 2008 award for best publication; *Water Resources and Land-Use Planning: A Systems Approach*" (co-ed., Y. Y. Haimes, 1982); and *Human and Energy Factors in Urban Planning: A Systems Approach* (co-eds., J. Gibson and A. Rapoport, 1982).

Simona Costa is a Senior European Policy Expert with long experience in Regional Policies, Energy, Sustainable Transport, Innovation and Financial Engineering for public authorities. She has gained more than 23 years' experience in the multilevel European lobbying context in Brussels, working for EU institutions (European Parliament and European Commission) and in industrial lobbying (Leonardo Group). From 2000 to 2015, she was head of the office of the representative of the Regione Liguria (Italy) in Brussels. At present, she represents the city of Genoa in Brussels. She plays a facilitator's role in involving local and regional stakeholders in the low-carbon-economy process uptake and in the EU's project management. She is actively involved in the implementation of complex projects in the energy and transport fields (i.e. TEN T programme, H2020 programme and COSME). In the European Innovation Partnership for Smart Cities and Communities, she is the chairman of the Integrated Planning Policy and Regulation Action Cluster.

Part I
Smart Planning for Adaption and Mitigation

Smart and Sustainable Cities: What Is Smart?—What Is Sustainable?

Pierre Laconte

Abstract **"Smart cities"** are cities using information and modern communications technology to connect activities hitherto unconnected. This became a buzzword supported by a variety of interests including, among others, the producers of knowledge-based consulting services making use of "big-data" collections. Four examples of smart cities applications are presented. **"Sustainable cities"** are those that meet the needs of their present citizens without compromising the ability of future generations to meet their own needs, reconciling the environmental, social and economic "pillars" of long- term durability. Sustainability applies at the levels of individual buildings, neighborhoods, entire cities, their peripheries and their regions. Benchmarking aims at systematically comparing sustainability in space and time, at each of these geographic levels. Focus is put on assessment criteria reflecting political orientations. Three pioneering examples are presented.

Keywords Smart · Big data · Energy · Transnational · Assessment
Global · Local · Sustainable

1 "Smart Cities"

1.1 "Smart Technology" for "Smart Cities"

"Smart city" services vary according to the actors involved and their aims, interests and objectives, including:

- applications of big data, optimizing the use of urban technology and urban networks,
- integrating planning and transportation,

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- saving natural resources and fossil energy,
- optimizing the use of energy distribution networks,
- optimizing consumer behavior in line with the objectives of the actors ("human engineering").

Suppliers of smart technology for cities include, *inter alia*, IBM, Siemens, Microsoft, Cisco, Deutsche Telecom and Panasonic (Libbe 2016).

1.2 Four Examples of "Smart City" Applications

1.2.1 Using Mobile Phones for Banking

M-Pesa (M for mobile, Pesa for money, in Swahili) is a mobile phone-based money transfer, financing and microfinancing service, launched in 2007 by Vodafone in Kenya and Tanzania. It has since expanded to Afghanistan, South Africa, India and, more recently, to Romania and Albania.

The service enables users to deposit money in an account stored on their own cell phones, to send balances using PIN-secured SMS text messages to other users, including sellers of goods and services, and to redeem deposits for regular currency.

The service has been lauded for giving millions of people access to the formal financial system and for reducing urban crime in a largely cash-based society.

However, such services also allow the buyers of the big-data flows involved to know about many aspects of the consumers' behavior, e.g., transport operators wanting to optimize bus-route networks or locate new bridges, as in Abidjan (Blondel 2013).

Orwell's "Big Brother" is not far away (Jaivin 2014), see Fig. 1.

1.2.2 Enhancing Education and Participation

"Medellin Ciudad Inteligente" emphasizes popular IT education, including a network of large and small libraries, even in metro stations, in addition to an iconic main library, see Fig. 2.

It is part of the successful metamorphosis of the Colombian "capital of crime" into a "normal" city, with the help of the active participation of its citizens (Lee Kuan Yew World City Prize 2016 Laureate).

1.2.3 Taking Advantage of Big-Data Exchange Platforms Between Users

Multinational service providers to cities and citizens are involved in platforms, ranging from health-data exchanges down to information on work opportunities and

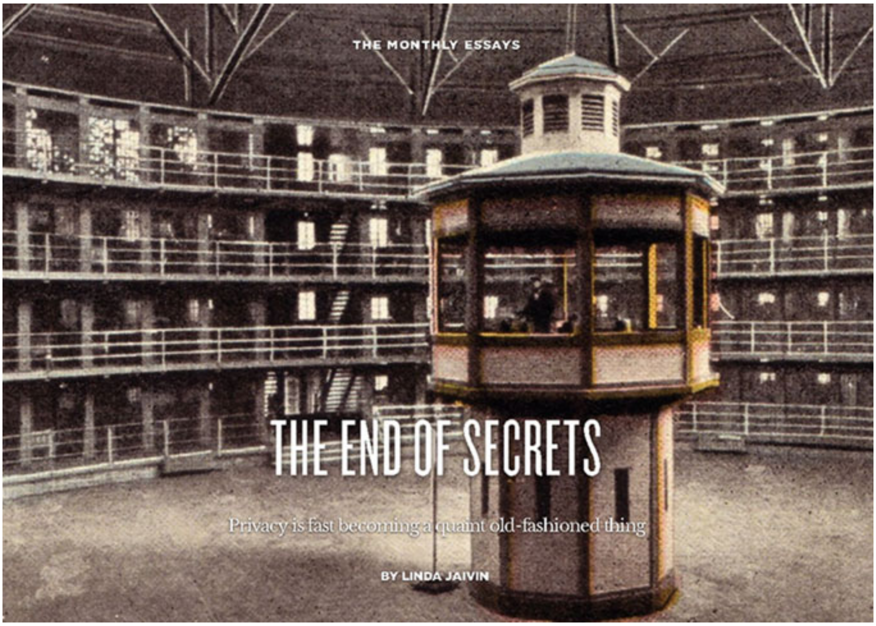

Fig. 1 A postcard showing the interior of Stateville correctional centre, Illinois, modelled on Bentham's panopticon (cover of Linda Jaivin's essay on privacy: "The End of Secrets", published in The Monthly, June 2014)

Fig. 2 España Library of Medellin. A strong statement in favor of "knowledge city". © Municipality of Medellin

personal transport. They enjoy access to international funding by the European Union (EU) and public and private financial institutions, based on long-term monopolistic profit perspectives and low levels of regulation. “Uber” taxis are an emblematic example of such a capitalistic platform, which has generated the term “Uberisation”.

Smart platforms, however, can very well be owned by independent cooperatives such as the initial platform “Blablacar”, that links long-distance travelers. A challenge to smart (and sustainable) cities is the ownership of the data exchange platforms, including the ownership of their algorithms.

1.2.4 Smart Vehicles and Cities

Autonomous vehicles (AV), or zero-occupancy-vehicles, have been often described as a “liberation from the driving chores”. However, according to the International Association of Public Transport (UITP 2017), they will also result in users acquiring greater tolerance for long-distance commuting, and in fleets of unstaffed vehicles looking for customers. They will therefore increase sprawl and urban congestion, instead of reducing it, unless they are used as short-distance links to public transport, avoiding the costly use of land for “park-and-ride” facilities (e.g., Keolis’ automated vans in Lyon in 2017, see Fig. 3).

Fig. 3 Automated vans operated by Keolis in Lyons starting in 2017 (UITP 2017)

2 "Sustainable Cities"

2.1 *Definitions*

2.1.1 The Space/Time Dimension

Sustainable cities are, in accordance with the Brundtland Report (WCED 1987), those that meet the needs of their present citizens without compromising the ability of future generations to meet their own needs. This requires reconciliation of the environmental, social and economic 'pillars' of sustainability.

The Brundtland sustainability definition was further elaborated by the planning-related "Sustainable Development Goals", adopted by the UN General Assembly (2016).

Assessment of best practices requires a clear spatial view of each of the geographic levels of observation, considering the likely policy conflicts between global and local concerns. Global concerns focus on global warming and climate threats at the planetary level, while local concerns focus on the needs and aspirations of citizens "here and now".

Assessment of best practices also requires putting them in a time perspective. The time perspective includes the will by political decision makers to pay for immediate investments, which will benefit only to voters not yet born. A case in point is N. Stern's plea for a lower discount rate in favor of "sustainability" investments, i.e., investments helping to reduce global warming (Stern 2006) and the debate around his views (Weitzman 2007).

Benchmarking aims at assessing the performance and the practice of sustainable development.

2.1.2 The Resource Dimension: The Case for Circularity

According to the traditional linear metabolism, cities consume resources and create waste, pollution and CO_2, plus other greenhouse-gas emissions (GHG) at a high rate.

In contrast to this linear metabolism the concept of circular economy, "Cradle to Cradle" (C2C) instead of "Cradle to Grave", has been pioneered by Mc Donaugh and Braungart (2013).

2.2 *Evaluation Tools for the Sustainable City*

2.2.1 Is the Reduction of CO_2 and Other GHG Emissions a Correct Indicator of Urban Sustainability?

A survey of accounting methods for GHG-emissions methods has been done in a (too) little-known comparative study by Bader N. and Bleidschwitz R., at the

College of Europe in 2009 (Bader and Bleidschwitz 2009). Unlike the measurement of GNP, for which there is a generally agreed method, there is no such agreement about the GHGs.

The **measurement tools** differ vastly according to the institutions in charge of measuring. These currently are, among others:

- CO_2 Grobbilanz/EMSIG (Climate Alliance Austria, Energy Agency of the Regions)
- ECO_2 Region (Climate Alliance, Ecospeed)
- GRIP (Tyndall Centre, UK Environment Agency)
- Bilan Carbone (ADEME)
- CO_2 Calculator (Danish National Environmental Research Institute, Local Government Denmark, COWI)
- Project 2 Degrees (ICLEI, Clinton Climate Initiative, Microsoft).

The **measurement** covers either all of the six different Kyoto GHGs, or only some of them, i.e., mainly carbon dioxide and methane.

Different estimates of potential global warming effects are obtained depending on whether the second, third or fourth Intergovernmental Panel on Climate Change (IPCC) report is used.

The reporting standards are different.

The **scope** of measurement either only includes direct emissions or also includes indirect and life-cycle emissions, taking into account the imported and exported emissions.

The sectoral emissions definitions are highly unclear, e.g., those for transport, which does not include aviation nor shipping.

2.2.2 Measuring Fossil-Fuel Production and Consumption as an Alternative to Direct Measurement of CO_2 Emissions

Considering the very low political probability of a global agreement on the calculation of CO_2 and other GHGs, the second-best tool for assessing sustainability could be to analyze the production and use of fossil fuels as sources of energy. Fossil fuels, according to N. Stern (Stern 2006), generate some 80% of the GHG emissions. On the other hand, these emissions offer plenty of possibilities for reuse, if appropriate incentives make this attractive (Mulhall and Braungart 2016).

In any case, there is a possibility of agreement that smart and sustainable cities should be aiming at energy savings, as well as improving the quality of life of their citizens, including the quality of air, water and soils, independently from any future climate changes (Laconte and Gossop 2016).

Three pioneering approaches resulting from the author's professional experience are briefly described:

- Zurich, a high-performing member city of the International Association of Public Transport (UITP), which he managed from 1985 until 1999;

– Bilbao, also a highly successful smart and sustainable city, having devised a tool for achieving this at a minimum cost, and laureate of the Lee Kuan Yew World City Award 2012; and
– the New Louvain University town/neighborhood, of which he was one of the three planners, and which was a laureate of the International Union of Architects' Abercrombie Award.

3 Three Pioneering Approaches to Smart and Sustainable Cities or Neighborhoods

3.1 Zurich: Planning for Low-Energy Land Use and Transport as a Tool for Quality of Life (1985-)

3.1.1 Traffic Management

In Zurich, trams and buses enjoy absolute on-street priority. When approaching a traffic light, sensors (seen on the lower left in Fig. 4) ensure they have a priority green light at all time of the day. The reliability of timetables therefore makes public transport the city's fastest mode of transport. The modal split is around 80% in favor of public transport, notwithstanding the lack of underground railways, see Fig. 4.

3.1.2 Parking Management

The real political ingenuity of Zurich, however, lies in a parking policy favoring its local voters, versus commuters voting elsewhere.

Unrestricted on-street parking is exclusively reserved for Zurich-registered residents (the voters) in their neighborhoods, while cars entering the city from other neighborhoods or municipalities are limited to a maximum of 90 min' parking time (blue zone, see Fig. 5).

This measure triggered a large-scale return of inhabitants to the city, and benefitted the paid-for public car parks. It has been politically rewarding for the city fathers, while suburban rail travel has increased and improved. This system could be applied in any city where commuters largely come from other electoral districts.

Fig. 4 Effective priority for public transport and non-motorized vehicles is ensured by street-level detectors (see lower part of the picture)

3.2 Bilbao: Smart and Sustainable Urban Regeneration Through Public-Public Planning Partnerships (1989)

The prosperous, long-standing steel industry was wiped out by the 1989 crisis. Industrial land was re-used for new activities, based on services and culture, while preserving architectural heritage.

Some 40 ha of derelict industrial land along the Rià, adjacent to the city's central business district (seen on the left in Fig. 6), owned by several public bodies ranging from local to national, was unified by a public-public partnership embodied in a common redevelopment corporation—"Rià 2000".

This valuable land—situated between the two anchors and very close to the central business district—was developed by "Rià 2000", with an obligation to invest all of the proceeds in new public infrastructure along the same canal.

The huge surplus generated by the land sales was thus to be used entirely to enhance connectivity and further urban regeneration.

Transport was part of Bilbao's renewal. Partly new (with metro stations designed by Norman Foster) and partly renovated railways enhanced connectivity throughout the city and the region, and attracted energy-saving use of public transport. This extensive rail network includes metro, regional rail, tram and funicular (see Fig. 7).

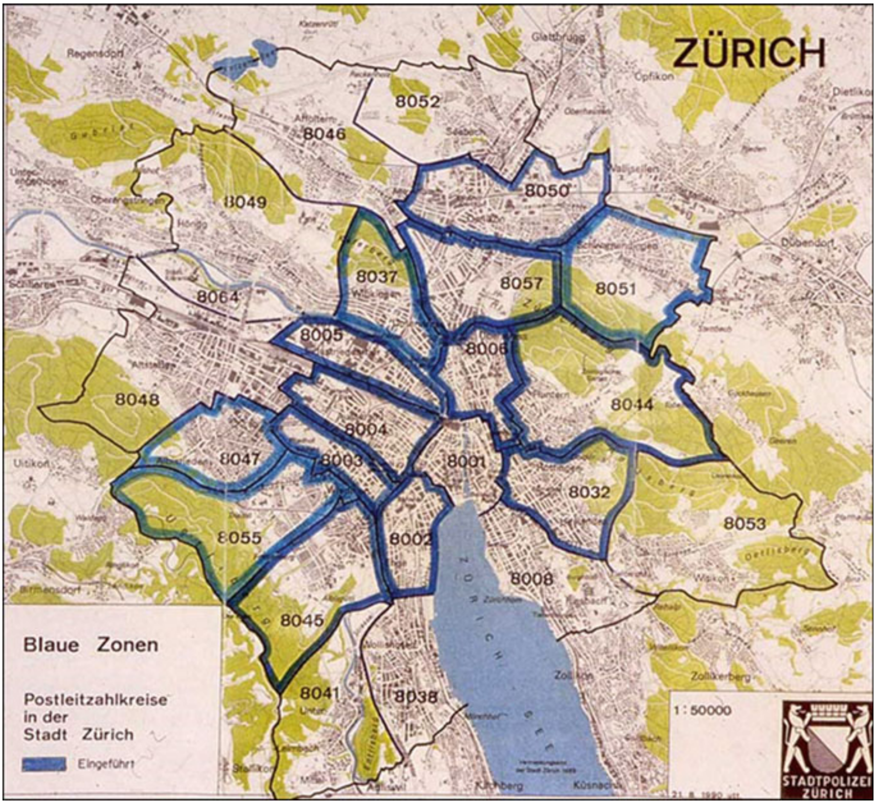

Fig. 5 Unrestricted street parking is exclusively reserved for residents of individual neighborhoods (postal districts). In the blue zone, a 90-min restriction applies to all other motorists

3.3 Louvain-la-Neuve: Planning for Low Energy and Resource Saving (1969)

3.3.1 The Case for a New University Town

Because a 1968 law required the exclusive use of the Dutch language in Flanders, the French-speaking Louvain Catholic University was forced out of the city of Louvain/Leuven. The university bought ca. 920 ha of agricultural and forest land in a rural area close to the Brussels-Namur road (N4): the central part was set aside for urban development, while forest land in the north was preserved. The overall master plan and architectural coordination was entrusted to the “Groupe Urbanisme-architecture” (Laconte 2016).

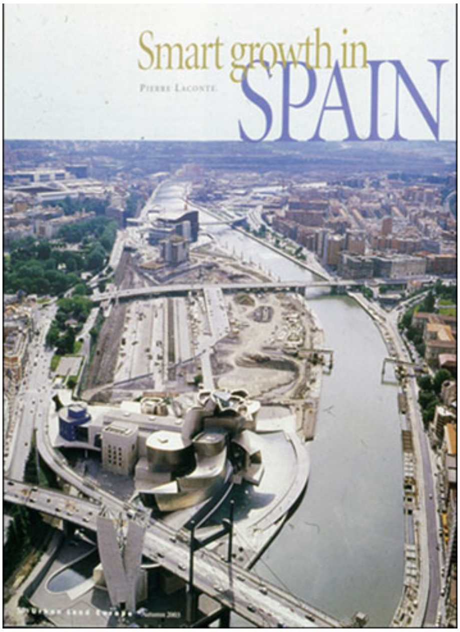

Fig. 6 The two anchors for Bilbao development, at each end of the site, were the new Guggenheim Museum and the Congress and Concert Center (Laconte 2003)

3.3.2 Planning for Land Saving and Uncertainty

Being left with only the annual resources allocated to all Belgian universities, a pedestrian-focused option was chosen. A linear pedestrian spine starting from the only existing road allowed the university to save land and advance investment in transport and parking infrastructure, see Fig. 8.

The main pedestrian street was implemented from the first phase, starting at the existing road east of the site in 1972, later being extended to the railway station opened in 1975, at the center of the city, and towards the western part of the site. Car access to buildings and parking is placed outside the spine, with some underpasses enhancing access, see Fig. 9.

The center of the first phase was the Science Library, an iconic concrete building seen as the cathedral of a university town, with its plaza (parvis) above an automobile underpass. For some 45 years, it has been a social gathering place surrounded by university buildings, shops and restaurants (arch. A. Jacqmain), see Fig. 10.

The National Belgian Railways agreed to build a subterranean railway link to the existing express-rail line between Brussels and Namur. All streets are pedestrianized and combine university buildings, housing, retail and cultural services. Land remains the property of the university and is leased to investors. All motorized transport is located underground, see Fig. 11.

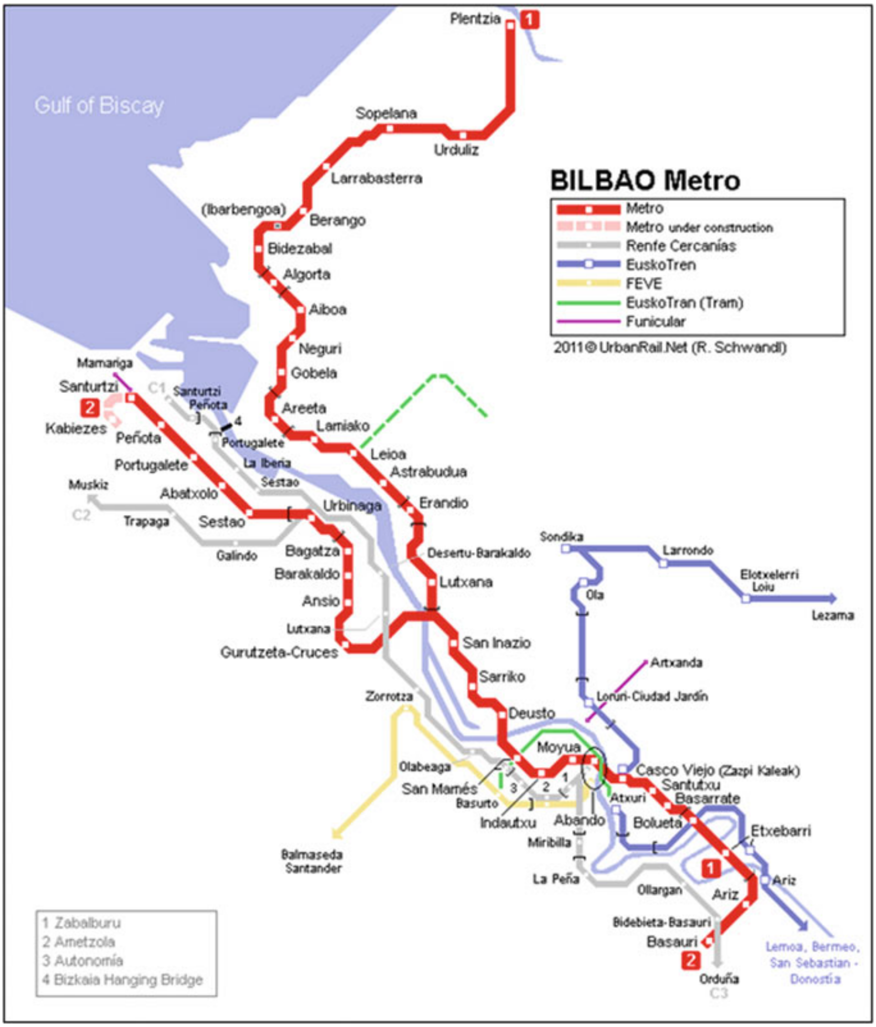

Fig. 7 Bilbao transport network

The space above the slab is built up with multifunctional, high density-low rise buildings. The shopping mall adjacent to the railway station (8 million visitors/year in 2015) and the private Hergé museum (arch. de Portzamparc, Paris), also near the station, are part of the high density-low rise development, see Fig. 12.

In Louvain-la-Neuve, all storm water is funneled to a reservoir which is treated as a lake, saving infrastructure costs and attracting residential investment, see Fig. 13.

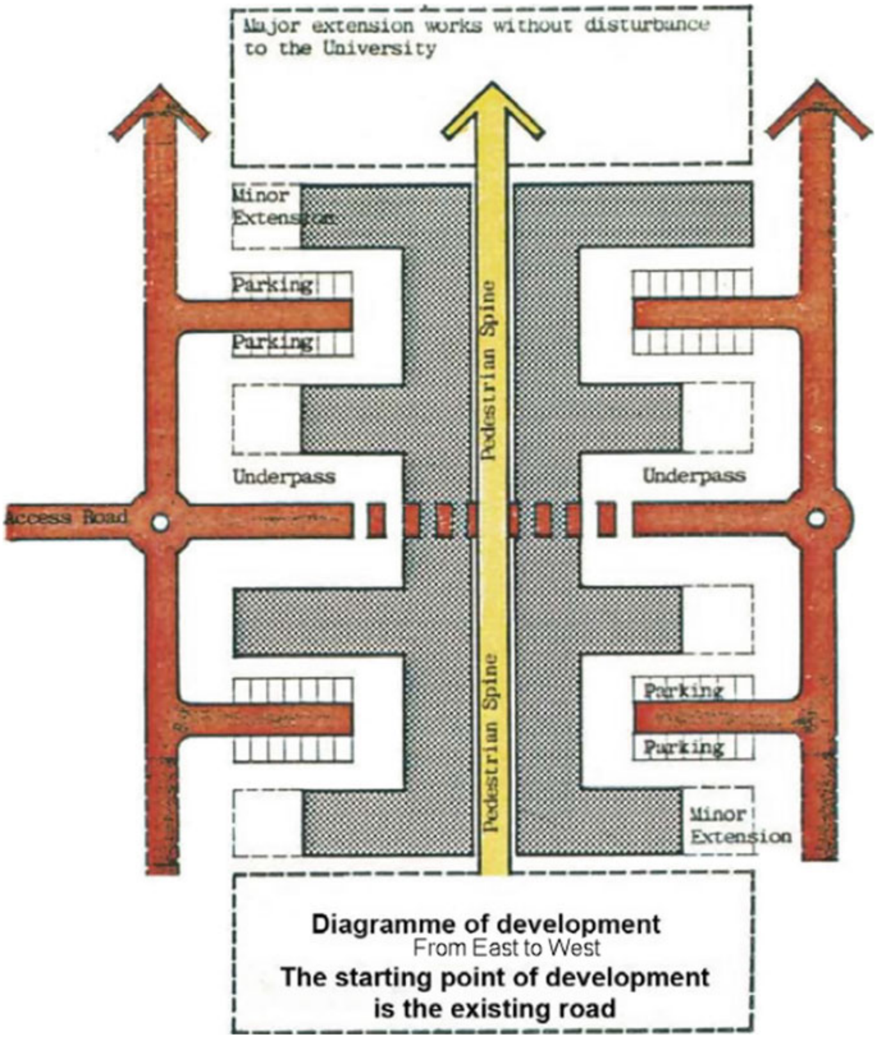

Fig. 8 A linear pedestrian central spine—in this case inspired by the University of Lancaster—allowed a step-by-step mixed urban development with automobile access to buildings and parking being placed outside the spine, with occasional underpasses

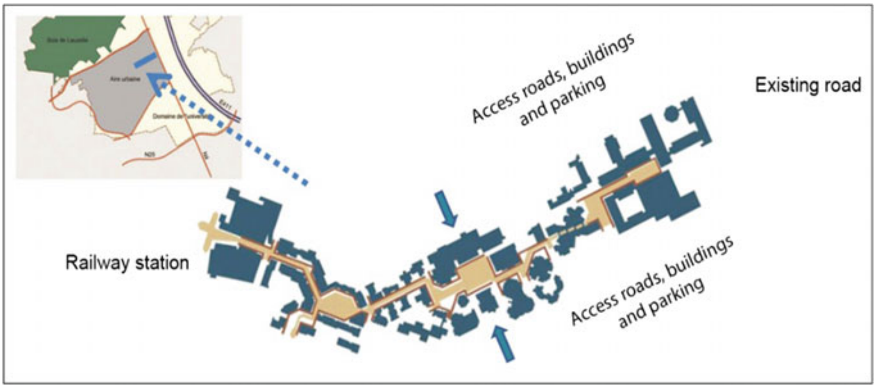

Fig. 9 Implementation of the spine on the ground—a string of public spaces for movement and leisure

Fig. 10 The science library

Fig. 11 Street-level entrance to the railway station

Fig. 12 Apartments, shops, lecture halls, faculty buildings and green space on top of the slab

Fig. 13 General view including the water reservoir treated as a lake

4 Conclusion

This opening keynote address has attempted to separate the concepts of “smart” and “sustainable” planning, the goal of urban planning being sustainability, with the best possible use of available resources and technology.

As to “smart cities”, four examples of technology-based “smart” planning tools have been presented as illustrations, stressing in each case both their added value and their potentially negative side effects.

As to “sustainable cities”, the distinction has been drawn between the global and local levels.

Global threats related to global warming and the GHG emissions, potentially affecting climate, result mainly from the use of fossil energy. The direct measurement of emissions has, however, escaped any agreement between countries and stakeholders, allowing measurement discrepancies, unreliability and room for fraud. The proposed solution to better measuring global warming threats is to analyze the production and consumption of fossil fuels and ways to reduce the gigantic subsidies they enjoy in most countries.

At the local level, quality of life and reduction of air and water pollution also relate to reducing the need for energy based on fossil fuels for transport and other urban uses, while contributing to reducing GHG emissions at the global level.

Three pioneering examples of local-level sustainable planning have been presented. Not ignoring the multiplicity of best practices, but always limited in space and time, a one-time best practice risks becoming a worst practice at a later stage, or vice versa.

References

Bader, N., & Bleidschwitz, R. (2009). *GHG study report*. Bruges: College of Europe.

Blondel, V. (2013). Les promesses du Big Data. *La Recherche*, *482*.

Jaivin, L. (2014). *The end of secrets*. Accessed at: April 31, 2017, from https://www.themonthly.com.au/issue/2014/june/1401544800/linda-jaivin/end-secrets.

Laconte, P. (2003). *Smart growth in Spain. Urban land Europe, Autumn 2003*. London: Urban Land Institute.

Laconte, P., & Gossop, C. (Eds.). (2016). *Sustainable cities. Assessing the performance and practice of urban environments*. London: I. B. Tauris. Accessed at: May 1, 2017, from http://www.ffue.org/2015/12/sustainable-urban-environments-in-europe-evaluation-criteria-and-practices/.

Laconte, P. (2016). The founding and development of Louvain-la-Neuve, the only new town in Belgium. In *Historical perspectives—"History, Urbanism, Resilience"*, *International Planning History Society Proceedings*, *17th IPHS Conference* (Vol. 5, pp. 211–222). Delft: IPHS.

Libbe, J. L. (2016). *IKT/Digitalisierung und Smart CityVorbereitung DASL Jahrestagung 2017 Neue Dynamik in Metropolregionen—Planung in unübersichtlichen Zeiten*. Berlin: DIFU, Deutsches Institutfür Urbanistik.

McDonough, W., & Braungart, N. (2013). *Cradle to cradle: Remaking the way we make things*. USA: Rodale Press/North Point Press.

Mulhall, D., & Braungart, M. (2016). Transforming the psychology of emissions. In P. Laconte & C. Gossop (Eds.), *Sustainable cities. Assessing the performance and practice of urban environments*. London: I. B. Tauris.

Stern, N. (2006). *The Stern review on the economics of climate change*. London: HMSO. Accessed at: May 1, 2017, from http://webarchive.nationalarchives.gov.uk/20100407172811/http://www.hm-treasury.gov.uk/stern_review_report.htm.

International Association of Public Transport—UITP. (2017). Autonomous vehicles: Potential game changer for urban mobility. In *UITP policy brief*. Brussels: International Association of Public Transport. Accessed at: May 1, 2017, from http://www.uitp.org/news/autonomous-vehicles-urban-mobility.

World Commission on Environment and Development—WCED. (1987). *Report of the world commission on environment and development: Our common future (the Brundtland Report)*. New York: WCED.

Weitzman, M. (2007). A review of the Stern review on the economics of climate change. *Journal of Economic Literature*, *XLV*, 703–724. Accessed at: May 1, 2017, from https://en.wikipedia.org/wiki/Stern_Review.

Author Biography

Pierre Laconte is President of the Foundation for the Urban Environment, which seeks to link urban planning, transportation and the environment. A past President of the International Society of City and Regional Planners, and former Secretary General of the International Association of Public Transport, he was evaluator for the European Green Capital Award in 2012 and 2013 and a member of the Lee Kuan Yew World City Awards Council. He is one of the three planners in charge of the Louvain new university town in Belgium, which received the Abercrombie Award of the International Union of Architects. His publications in English include “Sustainable Cities—Assessing the Performance and Practice of Urban Environments” (co-ed., C. Gossop, 2016); “Brussels: Perspectives on a European Capital” (co-ed., C. Hein), which shared the Society for Human Ecology 2008 award for best publication; “Water Resources and Land-Use Planning: A Systems Approach” (co-ed., Y. Y. Haimes, 1982); and “Human and Energy Factors in Urban Planning: A Systems Approach” (co-editors, J. Gibson and A. Rapoport, 1982).

Multicriteria Approach for a Multisource District Heating

Alice Dénarié, Marco Calderoni and Marcello Aprile

Abstract The EU project SmartReFlex—smart and flexible, 100%-renewable district heating and cooling systems for European cities—aims to promote the massive use of renewable sources for heating and cooling in cities through district heating networks. Among the project activities, the analysis of real case studies shows the potential of renewables in district heating systems. AIRU, Italian Association of District Heating, and the Department of Energy of Politecnico di Milano are supporting the promotion of local initiatives for renewable networks in the Emilia Romagna region: the feasibility of a multisource DHC system in Mirandola is assessed and presented in this paper. In Mirandola's district heating and cooling system, natural gas is only one among several possible energy sources: alternative configurations integrating biomass, biogas and solar thermal have been included in the study. The analysis deals with the extension of the network and with the choice of the best new energy source to cover the new heat demand. The use of MCDA has been applied in order to perform a holistic analysis of possible energy-related choices by considering competing objectives. For instance, the use of biomass is quite controversial: biomass is a renewable, local and a CO_2 neutral source, able to reduce GHG emissions. However, biomass burning can have negative impacts on air quality by producing pollutants such as PM_{10}, BaP, SOx and NOx. This paper presents the multicriteria process applied to plant design, the various alternatives and the criteria used. The result is a combination of natural gas, biogas, solar thermal energy and biomass, which corresponds to the preference of both the utility and municipality.

Keywords District heating · Multicriteria · Renewable energy Sustainable planning

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1 Introduction

One of the main aims of current European energy policy (Decision No 406/2009/EC) is the minimization of fossil-fuel consumption to increase energy-supply security and sustainability (Baños et al. 2011). If the objectives of energy policies are clear, the path to reach them is not unique: several combinations of various renewable energy sources can be integrated in a sustainable energy project. This is particularly true for district heating. District heating (DH) is a system that delivers hot water from a production site to several users distributed across the city through a piping network. The European Commission (EC COM 2011) is mostly focusing on buildings' heat demand savings and electrification of the heating sector. The Heat Roadmap Europe (HRE) project (Connolly et al. 2012, 2013) highlights that the use of district heating fed by renewable-energy sources and industrial waste heat can significantly reduce primary energy consumption and emissions' impact. This study revealed a different scenario than the one proposed by the EU commission, with the same energy results and at lower costs. Consistent with the HRE philosophy, the SmartReFlex project promotes 100%-renewable district heating and cooling networks by supporting local authorities. Among project activities, the analyses of several case studies have been performed. This paper describes the feasibility study for one of them in Mirandola, a small town of 24, 000 inhabitants in the Po Valley of Italy. The case study deals with the extension of an existing district heating and cooling system. It is currently based on natural gas and biogas, and it is planned to double its capability to meet the heat demand. Consequently, it will require the integration of new generation plants. The extension of the DH line is foreseen by the local authority as the energy infrastructure that will bring renewable heat to the city's historical center. DH is an interesting way to bring renewable energy to historical buildings, a type of energy that would otherwise rarely be integrated because of architectural restrictions. The project's main purpose is to support the heat provider and the local authority in the choice among various alternative heat sources and technologies for the new heat demand. The process is based on a comprehensive cost-benefit analysis, which includes the environmental impact. In particular, a combination of natural gas, biogas, solar thermal energy and biomass has been assessed. Biomass is a renewable and local resource, and its burning is mainly considered CO_2 neutral in energy policies (IPCC 2006), even if various recent studies are questioning the carbon neutrality of biomass (Liu et al. 2017). Despite this benefit, biomass burning can have negative impacts on air quality, in particular in the case of outdated inefficient technologies. In the regional report about emissions, the ambivalence of biomass is evident by looking at the various fuels impact on air quality (Fig. 1).

Primary sources of air pollution, such as PM_{10}, and secondary ones, such as SO_x and NO_x, were found to be produced by biomass burners, mainly old firewood boilers and open chimneys (ARPA and Regione Emilia 2010). DH systems, compared to individual heating systems, are not necessarily less polluting a priori (Genon et al. 2009), although the centralization and the use of one larger burner far

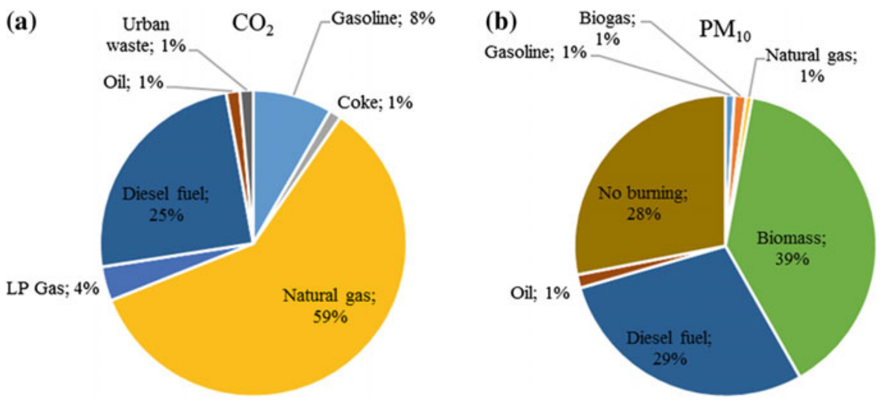


Fig. 1 Fuels' impact in terms of CO_2 (**a**) and PM_{10} (**b**) emissions in Emilia Romagna (ARPA and Regione Emilia 2010)

from residential areas allows the use of higher stacks, higher-quality pollution-reduction devices and higher efficiencies (Jonsson and Hillring 2006). Moreover, DH networks allow the integration of various renewables. In this study, the "zero emission" solar thermal technology has been chosen to reduce the biomass impact on air quality in summer, since such a configuration has proved to be an effective solution (Mathiesen et al. 2012). Biomass and solar radiation are energy sources that imply intensive land use; despite their beneficial application in sustainable-energy systems, their use in agricultural regions is creating some concerns because of the competition over land use for food production (Bentsen and Møller 2017). The adverse opinion by local authorities or citizens is not new (Dénarié et al. 2017). For these reasons, the use of such land-intensive energy sources requires an integrated approach in planning that privileges biomass residues instead of energy crops (Calvert and Mabee 2015). A detailed calculation of the biomass supplied to DH is crucial to assess its availability and the impact in case of stock shortages.

2 Methodology

Dealing with renewable-energy projects at urban scale, such as DH, local authorities and the utilities providing heat have to answer several questions about the choice of energy sources. The sustainability of system is now considered not only from the economic perspective, but also from the point of view of environmental impact, air quality and social impact (Wang et al. 2009). DH decisional process involves multiple actors and considers a wide range of energy sources under multiple aspects, as introduced in the previous paragraph. These are the reasons why the Mirandola case study has been evaluated through multicriteria decision analysis (MCDA) techniques. MCDA can break down the problem of decision making into steps that can be evaluated with comparison criteria, meanwhile granting mathematical robustness even to subjective evaluations (Kablan 2004). In this work, a Multi Attribute Utility Technique (MAUT) has been applied (Neumann and Morgenstern 1953; Savage 1954).

Application of MCDA to decisional problems follows normally the following steps (Wang et al. 2009):

- Identification of goals → DH sustainability
- Definition of alternatives: $a_1, a_2, \ldots, a_j, \ldots, a_m$ → Four combination of solar and biomass (Chap. 3)
- Identification of criteria: $C_1, C_2, \ldots, C_i, \ldots, C_n$ → Seven criteria considered here (Sect. 3.1)
- Scoring: calculation of performances for every alternatives according to chosen criteria: $x_{11}, x_{12}, \ldots, x_{ij}, \ldots, x_{nm}$ → simulations' results (Chap. 3 and Sect. 3.1)
- Criteria weighting $w_1, w_2, \ldots, w_i, \ldots, w_n$ → according to actors' preferences (Sect. 3.1)
- Application of multicriteria decision analysis methods → MAUT method (Sect. 3.1 and 3.2)
- Aggregation of methods, in case of multiple Decision Makers (Sect. 3.2)

The MCDA methods are applied to the decision matrix, or performance matrix $\underline{X} = [x_{ij}]$ resulting from the first five preliminary steps

$$\begin{array}{ccc|c} & & & \begin{array}{ccc} a_1 & a_j & a_m \end{array} \\ \hline C_1 & & w_1 & \\ C_i & \rightarrow & w_i & \begin{bmatrix} x_{11} & x_{1j} & x_{1m} \\ x_{i1} & x_{ij} & x_{im} \\ x_{n1} & x_{nj} & x_{nm} \end{bmatrix} \\ C_n & & w_n & \end{array} \tag{1}$$

In the decision matrix, each element x_{ij} describes the performance of the various alternatives j, with respect to each criterion i, which are the results of simulations and spreadsheets. In MCDA problems, the performance matrix is filled with data expressed in various units, and consequently they are first normalized to make them comparable. In a MAUT application (Beinat 1997), the normalization from 0 to 1 is done through expected utility functions. Expected utilities are mathematical functions with various forms (linear, parabolic, Gaussian) that represent a preference. They are used in decision problems under uncertainty and in risk analysis, and they can quantify the decision maker's subjectivity. A utility function $u_i(x_{ij})$ enables affirming that the performance result x_{ij1} of a certain alternative j_1 is better than another alternative j_2's result x_{ij2} with respect to the same criteria i and its objective (maximization or minimization):

$$u_i(x_{ij1}) \geq u_i(x_{ij2}) \tag{2}$$

Linear utility functions are used in this paper: they consist in giving utility values to all performances by simple interpolation between extreme values 0 and 1; if a criteria objective is its minimization, the score $x_{ij,\min}$ with the minimum value has $u_i\left(x_{ij,\min}\right) = 1$ and $u_i\left(x_{ij,\max}\right) = 0$. The intermediate values are linearly interpolated. See the application in the case study in Table 2.

The last step of the process is the weight attribution to each criterion. Criteria weights reflect the relative importance of criteria given by the decision maker. In this paper, a rank-order weight method has been applied, called SMARTER method (Edwards and Barron 1994). The SMARTER method uses the #centroid method to obtain criteria weights from decision makers, in this case, the heat provider and local authority. It consists of giving weights to each criterion through an algorithm that follows decision makers' rankings based on its preference. Being that $i = 1$ is the first preferred criteria and $i = n$ the last, the less important one, the criteria weights are calculated as:

$$w_i = \frac{1}{n}\sum_{k=i}^{n}\frac{1}{k} \tag{3}$$

with $\sum_{i=1}^{n} w_i = 1$. After having scored and normalized alternatives, utility values $u_i\left(x_{ij}\right)$ substitute nonhomogeneous scores x_{ij} in the decision matrix, which is now filled with comparable values between 0 and 1. After having defined weights for each criteria, the MCDA can be applied to combine results. The last step here is the weighted sum of the utility values of all the alternatives for the various criteria.

$$s_j = \sum_{i=1}^{n} w_i \cdot u_{ij} \tag{4}$$

At the end of this process, every alternative has a final weighted utility score s_j which enables alternatives' ranking, the final decision being the solution with the highest value.

3 The Case Study

The existing district heating network covers an energy demand of 4010 MWh/year of heat and 360 MWh/year of cold (data refers to 2014). The system recovers heat from a natural-gas cogeneration heat and power plant (56% heat needs) and from a third-party biogas internal-combustion engine (32% of heating needs), whereas a natural gas back-up boiler (12% of heating needs) covers the peaks. The district cooling system delivers chilled water produced by an absorption chiller (Fig. 2).

The local authority is willing to recover local residual biomass, currently treated as waste, to be exploited in the new plant through a biomass boiler with high efficiency. Solar-heat integration is of particular interest to reduce air-pollutant

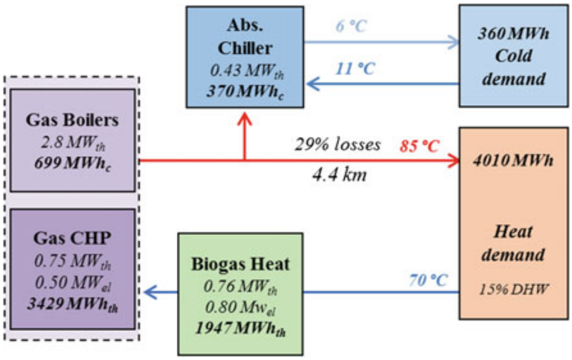
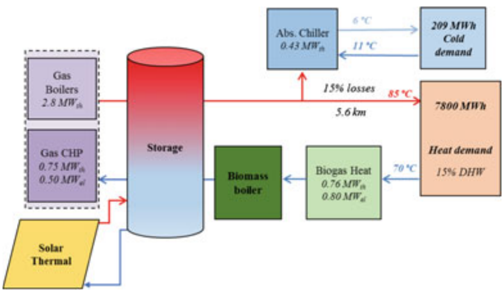


Fig. 2 Existing district heating and cooling system

emissions associated with biomass burning, especially in times when heat demand is low. The feasibility assessment has been done considering energy performances, economic aspects and environmental impacts. Such performances have been quantified through simulations of future possible alternatives with energy PRO, a simulation software for technical and economic analyses (EMD 2014). A model of the current configuration of district heating with cogeneration systems, including Italian electricity market interaction, has been built and validated through monitoring data (Dénarié et al. 2016). The validated model has been used to simulate four configurations of various types of renewable-energy integrations for the extension of the system (Fig. 3).

Four alternative plant configurations have been analyzed to exploit biomass and solar radiation, maximizing the various aspects. Alternative 1 considers the simple addition of a biomass boiler with a storage tank to guarantee good boiler management. This solution is the one originally foreseen by the heat provider. Being aware of the air-quality impact of biomass and having as a main goal the reduction of fossil-fuel consumption, the add-on of a solar thermal collector field has been proposed in order to reduce the operational hours of the biomass boiler. Therefore, two alternative solutions, n. 2 and n. 3 mixing biomass and solar thermal energy have been added, with solar fields of, respectively, surfaces of 1600 m^2 and



Case.	Biomass boiler	Solar thermal	Storage
1	1 MW	-	200 m^3
2	1 MW	1600 m^2	160 m^3
3	1 MW	2500 m^2	1000 m^3
4	-	1600 m^2	160 m^3

Fig. 3 Alternative solutions for the system's extension

2500 m^2. The first option is sized considering the space available, while the second option maximizes economic incentives (D.M. 2016). Lastly, alternative n. 4 foresees only a 1600 m^2 solar thermal plant integrated into the existing district heating system, which is mainly based on natural gas, this being the solution with lowest PM_{10} impact. The four alternatives have been simulated in order to calculate the energy, environmental and economic results. Details of the simulation's input data and hypothesis can be found in Dénarié et al. (2016).

Figures 4 and 5 show the four alternatives' energy production, environmental impact and cash flow resulting from investment costs, operational costs, revenues and incentives. Alternative n. 1 with the simple integration of a biomass boiler, has the best financial results with lowest PBT (payback time) and highest NPV (net present value), but it has the highest production of PM_{10}. Solution n. 3 has the highest renewable-energy production with the lowest environmental impact, both in terms of greenhouse gas and particulate emissions. Nevertheless, its initial costs are the highest, even if the NPV is not the lowest because of the practically nonexistent costs of solar thermal operation. Solution n. 2 is quite similar to n. 3, performing less well from an environmental point of view but with better economic results. Solution 4 has the largest use of natural gas, which causes the highest production of CO_2, but with the lowest impact on air quality (PM_{10}). It's interesting to note that the highest natural-gas consumption, despite the low investment costs, causes the lowest NPV at the end of the system's lifetime, clearly highlighting the high operating costs associated with cogeneration. In conclusion, none of the solution emerges as the best, and there are pros and cons for the three analyzed dimensions, so a decision cannot be made without using a comprehensive holistic method.

3.1 MCDA Applied to the Case Study

The decision problem of selecting the new renewable-energy source to integrate in the existing system can be better addressed by the MCDA method. In order to compare the four alternative combinations of renewable energy and existing sources

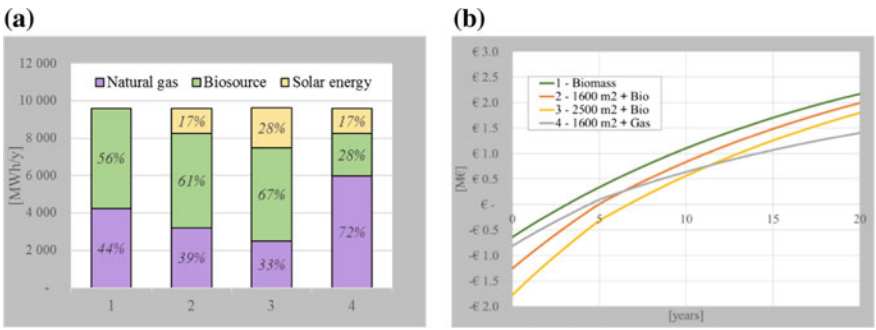
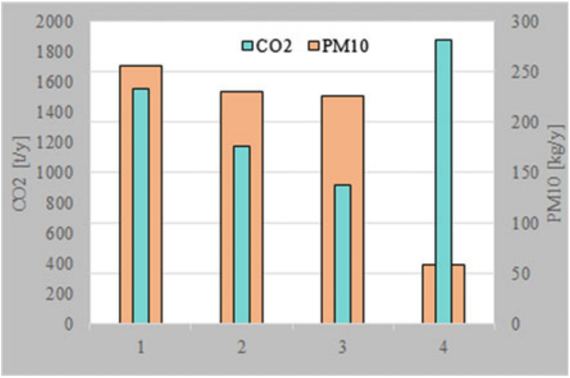


Fig. 4 Energy (**a**) and economic (**b**) performances of the four alternative solutions

Fig. 5 Environmental impact of the four alternative solutions



according to decision makers' preferences, different criteria could be considered. Since the sustainability of the project is the main goal, usually four main criteria are considered: technical, economic, environmental and social. Here, a total of seven sub-criteria, have been considered to better address the main goal and considering the project framework:

- Technical: Renewable Energy Ratio (RER)
- Economic: Investment costs, Payback Time (PBT), Net Present Value (NPV)
- Environmental: CO_2, PM_{10} emissions
- Social: Land use

Renewable Energy Ratio: RER is defined as the ratio of renewable-energy production to total energy load, which gives an idea of the fossil-fuel savings in favor of renewable energy.

Investment costs include all costs of technologies, installation and engineering of the district heating extension project. This criterion is crucial since these costs are very high compared to the individual system's costs.

Pay Back Time is the period of time needed for the initial investment to be repaid. For district heating projects, PBTs are quite long and this parameter is usually crucial for private companies.

Net Present Value: is defined as the total cash-flow value at the end of system's lifetime, a commonly used indicator for long-term projects. It includes all costs and measures financial feasibility.

CO_2 emissions quantify the system's greenhouse-gas impact (Biomass is considered carbon neutral).

PM_{10} quantifies the impact on air quality, a crucial parameter for projects including biomass (see Chap. 1).

Land use is considered here as a social criterion because of aesthetic issues and controversial opinions with regard to competition between agricultural and energetic use of land (Chap. 1). Because of this, it can be an indicator of the social acceptability of the project.

The performance matrix of the four alternatives is presented in Table 1.

Table 1 Performance matrix of alternatives

Criteria	Subcriteria	Goal	Unit	Alternatives			
				a_1	a_2	a_3	a_4
Technical	RER	Max	%	56	67	74	38
Economic	Investment costs	Min	M€	0.64	1.26	1.77	0.81
	NPV	Max	M€	2.17	1.99	1.80	1.40
	PBT	Min	Year	6	7	9	7
Environmental	CO_2	Min	t	1551	1173	916	1877
	PM_{10}	Min	kg	256	231	226	58
Social	Land use	Min	m^2	500,000	475,158	488,609	4000

Details of calculation are in Dénarié et al. (2016). The need to deal with the problem of finding the best alternative with MCDA techniques is clearly demonstrated by the fact that the best alternative is not always the same, when based on different criteria. By using linear utility function, as explained in Chap. 2, for each criterion every alternative's score x_{ij} in Table 1 is substituted by its normalized utility value $u_i(x_{ij})$ in Table 2. The performance matrix became the decision matrix:

The weights have been obtained through the SMARTER method based on the preferences of the heat provider running the plant (survey result) and the local authority (estimated) respectively:

- Criteria importance for heat provider: 1. Economy > 2. Energy > 3. Environment > 4. Land use
- Criteria importance for local authority: 1. Energy > 2. Environment > 3. Land use > 4. Economy

Table 2 Decision matrix of alternatives

	ω_{local}	$\omega_{heat\ prov}$	a_1	a_2	a_3	a_4
RER	0.52	0.27	0.5	0.8	1	–
Investment costs	0.02	0.17	1	0.5	–	0.8
NPV	0.02	0.17	1	0.7	–	0.7
PBT	0.02	0.17	1	0.9	0.7	–
CO_2	0.10	0.07	0.3	0.7	1	–
PM_{10}	0.10	0.07	–	0.1	0.1	1
Land use	0.21	0.06	0	0.05	0.02	1

As expected, the most important criterion for the private company providing heat is the project's economics, while the local authority's priority is to increase the renewable-energy ratio in the town. According to formula (3). the heat provider's weights for the four main criteria are: 0.52 for economy, 0.27 for energy aspects, 0.14 for environmental aspects and 0.06 for social aspect. Subcriteria weights have been obtained simply by dividing the relative main criteria weights by the number of sub-criteria. The same process has been applied for local authority ranking.

3.2 Results

By applying the averaged sum of Eq. (4) for the two decision makers, final scores of the four alternatives are calculated, as shown in Fig. 5. The outcomes of the MCDA show the mathematical results of the stakeholder preferences.

According to the heat provider's criteria preferences, economic performance is the most important parameter, and the best solution is the one with the lower costs and shorter PBT, n. 1. The second preferred criterion is the renewable-energy ratio. Alternative n. 3 is actually the best solution in terms of the renewable-energy fraction only, so the second in ranking is alternative n. 3, which has good performance according to every criterion. The same happens for the ranking according to the local authority: the best solution is n. 3, the one with the highest RER. According to the second criterion, environmental impact, the best solution would be n. 4, although it has very poor performances in other criteria. The second is again alternative n. 2. By averaging the rankings of the two decision makers (giving the same weight to the local authority's and the heat provider's rankings), a unique expected utility value can be obtained. Figure 5 shows the final ranking obtained by the application of MCDA for the two stakeholders involved, the heat provider and the local authority (Figs. 6 and 7).

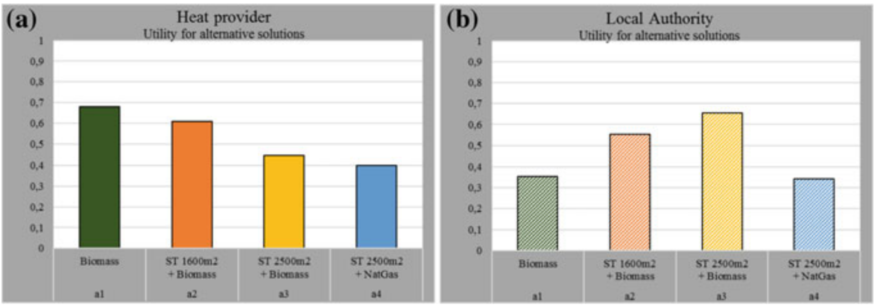


Fig. 6 Expected utility of the four alternative solutions according to heat provider (**a**) and local authority (**b**)

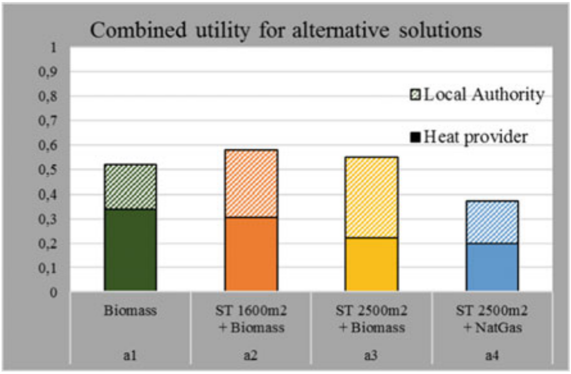


Fig. 7 Aggregated final expected utility of the four alternative solutions

The best alternative is n2, with a difference in expected utility with the second alternative n. 3 of only 0.029. A sensitivity analysis on the weighting methods could state in what case these two alternatives could be equal or when a reverse ranking could happen. The last alternative, the one which uses no biomass and has a higher use of fossil fuels, is quite distant from the 3rd position, but this result strongly depends on the price of biomass: the economic figures have been calculated here considering a price given by the utility, considering residuals biomass recovery and a short supply chain. Because a systematic, public analysis of the potential of residual-biomass recovery at the local level is not available, consequently, in the past, some district heating projects based on biomass have faced problems of stock shortage. They are forced to buy biomass from the market, with a heavy impact on the economics of the project and on the environmental impact due to transport issues. A second round of simulations has been done for this case study showing that, considering the biomass market price instead of residuals price, the economic performances of alternatives 1, 2 and 3 worsen, so that alternative n. 1 becomes comparable to n. 4. It is important to note that the weighting method has a significant impact: the used SMARTER method has the advantage of being easier, requiring just the ranking of criteria importance from the decision makers. However, it creates a very marked distribution of weights with substantial differences between the most and the least important one. Other methods, such as Analytic Hierarchy Process (Saaty 2008), give weights through pairwise comparison of criteria, obtaining more homogenous weights.

4 Conclusions

In this paper, a multicriteria process has been applied to assess four alternative configurations of renewable-energy integration in an existing district heating and cooling system to cover the new heat demand. A combination of natural gas, biogas, solar thermal energy and biomass has been defined which corresponds to the preferences of the two decision makers involved: the heat provider running the systems and the local authority. The alternatives have been ranked following seven criteria: renewable-energy ratio, investment costs, net present value, payback time, CO_2 emissions, PM_{10} emissions and land use. Criteria weights have been assigned according to the SMARTER method, and the ranking has been done using linear utility functions. The application of MCDA techniques is an effective way to deal with environmental sustainability of DH projects, by assessing through a holistic approach a broad set of alternative solutions, with the various stakeholders involved and their conflicting objectives. The application of MCDA techniques can give mathematically rigorous shape to subjective evaluations, though they are strongly dependent on weights and utility functions, which are very sensitive to subjective parameters.

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References

ARPA, & Regione Emilia, R. (2010). *Aggiornamento Inventario Regionale delle Emissioni in Atmosfera Anno* 2010 (Vol. 2010).

Baños, R., Manzano-Agugliaro, F., Montoya, F. G., Gil, C., Alcayde, A., & Gómez, J. (2011). Optimization methods applied to renewable and sustainable energy: A review. *Renewable and Sustainable Energy Reviews, 15*(4), 1753–1766.

Bentsen, N. S., & Møller, I. M. (2017). Solar energy conserved in biomass: Sustainable bioenergy use and reduction of land use change. *Renewable and Sustainable Energy Reviews, 71,* 954–958.

Calvert, K., & Mabee, W. (2015). More solar farms or more bioenergy crops? Mapping and assessing potential land-use conflicts among renewable energy technologies in eastern Ontario, Canada. *Applied Geography, 56,* 209–221.

Connolly, D., Mathiesen, B. V., Østergaard, P. A., Möller, B., Nielsen, S., Lund, H., et al. (2012). *Heat roadmap Europe 2050—First pre-study for EU 27 for Euro heat & power*. Brussels: Aalborg University.

Connolly, D., Mathiesen, B. V., Østergaard, P. A., Möller, B., Nielsen, S., Lund, H., et al. (2013). *Heat roadmap Europe 2050—Second pre-study for EU27 for Euro heat & Power*. Brussels: Aalborg University.

Dénarié, A., Calderoni, M., & Muscherà, M. (2017). Technical, financial and Urban potentials for solar district heating in Italy. In A. Bisello, D. Vettorato, R. Stephens, & P. Elisei (Eds.), *Smart and sustainable planning for cities and regions: Results of SSPCR 2015* (pp. 15–32). Cham: Springer.

Dénarié, A., Calderoni, M., Nourrice, K. S., & Acerbis, S. (2016). Solar and biomass for Italian communities: Analysis of two case studies. In *International Solar District Heating Conference*, Billund.

Edwards, W., & Barron, F. H. (1994). SMARTS and SMARTER: Improved simple methods for multiattribute utility measurement. *Organizational Behavior and Human Decision Processes, 60,* 306–325.

Genon, G., Torchio, M. F., Poggio, A., & Poggio, M. (2009). Energy and environmental assessment of small district heating systems: Global and local effects in two case-studies. *Energy Conversion and Management, 50*(3), 522–529.

Jonsson, A., & Hillring, B. (2006). Planning for increased bioenergy use—Evaluating the impact on local air quality. *Biomass and Bioenergy, 30*(6), 543–554.

Kablan, M. M. (2004). Decision support for energy conservation promotion: An analytic hierarchy process approach. *Energy Policy, 32*(10), 1151–1158.

Liu, W., Zhang, Z., Xie, X., Yu, Z., von Gadow, K., Xu, J., et al. (2017). Analysis of the global warming potential of biogenic CO_2 emission in life cycle assessments. *Scientific Reports, 7* (January), 484–489.

Mathiesen, B. V., Lund, H., & Connolly, D. (2012). Limiting biomass consumption for heating in 100% renewable energy systems. *Energy, 48*(1), 160–168.

Neumann, J. V., & Morgenstern, O. (1953). *Theory of games and economic behavior*. Princeton, NJ: Princeton University Press.

Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *International Journal of Services Sciences, 1*(1), 83.

Savage, L. J. (1954). *The foundations of statistics*. New York: Wiley.

Wang, J. J., Jing, Y. Y., Zhang, C. F., & Zhao, J. H. (2009). Review on multi-criteria decision analysis aid in sustainable energy decision-making. *Renewable and Sustainable Energy Reviews, 13*(9), 2263–2278.

Europe's Building Stock and Its Energy Demand: A Comparison Between Austria and Italy

Simon Pezzutto, Franziska Haas, Dagmar Exner and Stefano Zambotti

Abstract The building sector is responsible for approximately 40% of the European Union's total primary energy demand, which is mainly attributed to space heating, cooling and domestic hot water. In 2010, its value reached 1800 Mtoe/y, to which buildings contributed 720 Mtoe/y. While the Austrian and Italian building stocks are well investigated (e.g., classified by different building typologies, existing floor area, ownership etc.), there still is a lack of information concerning energy/demand values for space heating, cooling and domestic hot water per the various construction periods. In order to identify differences in energy demand, we first classified residential and service sector buildings in Austria and Italy and then attributed specific demand values in kWh/m^2 year. We further subdivided existing buildings per construction period: buildings (i) constructed before 1945, (ii) erected after World War II and before 1960, (iii) built between 1960 and 1980, (iv) constructed during 1980–1990 and 1990–2000, (v) dating to 2000–2010, and erected after 2010. The investigated buildings in the residential sector comprise: single-family houses, multi-family houses and apartment blocks (>eight floors); and in the service sector: offices solely. We concentrated our service-sector research on offices motivated by their highest space-cooling-demand ratio within the whole European building stock. The main results show that Austria and Italy share a certain homogeneity among building typologies, construction methodologies, portions of built-floor area per construction span, and specific energy demands per construction period.

Keywords Building stock · Europe · Energy demand · Austria · Italy

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1 Introduction

The EU is aiming to decrease greenhouse gas (GHG) emissions by 20% by 2020 with respect to 1990s' levels. In parallel, renewable-energy sources (RES) production is expected to increase by 20%, along with a 20% overall efficiency upgrade (EC 2017a).

By 2030 an integrated policy framework will compel EU Member States (MS) to direct a coordinated approach and to provide investors with sound regulatory guidelines. By that year, the EU intends to decrease domestic emissions of GHG by 40% relative to 1990 levels. National policies are designed to permanently improve energy efficiency and aim to increase the energy produced with RES to 27% (EC 2017b).

In order to achieve the 2050 targets, the EU must pursue further efforts. The EU MS have declared a goal of decreasing GHG emissions in Europe by 80–95%, relative to 1990 levels by 2050 (EC 2017c).

EU's 2010 primary-energy demand amounted to about 1800 Mtoe/y, principally attributable to various heating and cooling applications (almost 900 Mtoe/y, accounting also for industrial heat), followed by transportation and electricity—about 540 and 360 Mtoe/y respectively (Pezzutto 2014). Of the total, buildings account for around 720 Mtoe/y (40% of the entire EU primary-energy demand). The largest shares of energy demand within the European building stock are assigned, in decreasing order, to space heating (SH), domestic hot water (DHW) and space cooling (SC) with respectively around 2900, 400 and 200 TWh/y (Pezzutto et al. 2015).

Recently, the EU and all its MS conducted a thorough investigation aimed at classifying their building stocks based on building typologies, existing floor area, ownership etc. (EC 2017d), without however specifying energy- demand values for SH, SC and DHW according to the various construction periods.

A proper investigation aimed at determining these specific values is still lacking. The majority of energy-demand data is related to earlier investigations, such as: the Intelligent Energy Europe (IEE) project TABULA—Typology Approach for Building Stock Energy Assessment (TABULA 2017), the BPIE Data Hub for Energy Performance of Buildings (BPIE 2017) and confidential data kindly provided by the Vienna University of Technology (Invert/EE-Lab 2015).

Further relevant sources of information to explore Austria's and Italy's building stock are national statistical offices—Statistik Austria and ISTAT–Istituto nazionale di statistica (Statistik Austria 2017; ISTAT 2017).

The main obstacles encountered in our study relate to the erroneous interchange of the concepts regarding energy demand and energy consumption and the scarce availability of space-cooling data. In addition, there is only isolated information on the energy demand of the historic non-residential building stock.

Section 2 details information collection and analysis methodologies. Section 3 presents the outcomes for Austria and Italy, and discussion and conclusions are provided in Sect. 4.

2 Methodology

Data per construction periods in millions of square meters (Mm^2) and specific demands for SH, SC and DHW (kWh/m^2 year) were collected separately for Austria and Italy and sorted by the household and service sectors, addressing specific subsectors such as single-family houses (SFHs), multi-family houses (MFHs) and apartment blocks (ABs—buildings characterized by >8 floors). We concentrated our service-sector research only on offices motivated by their highest SC demand ratio within the entire European building stock (Pezzutto 2014).

Concerning the collected information, it is important to distinguish between energy demand and consumption.

Demand represents the net energy required to cover SH and SC needs; consumption is the energy input at the devices required to satisfy the demand. The two quantities thus differ by disparate conversion factors (Capehart 2007). In dealing with SH and DHW, since the efficiency of boilers is < one (0.8–0.9 for currently installed technologies in Europe), energy consumption is higher than demand.

An energy-efficiency ratio (EER) greater than one for electrically driven SC equipment (around two–three for currently installed technologies within the EU) causes air-conditioning (AC) energy consumption to be lower than demand (Recknagel et al. 2010). We wish to stress that, while it is correct to compare SH and SC demand, electricity consumption (in heat pumps and air-conditioners) can only be fairly compared to fuel consumption (e.g., gas in a gas boiler) by performing an adequate conversion to primary energy. Indeed, the two energy carriers have a different content of grey energy when employed in the final consumption. Primary energy (usually expressed in terms kWh or toe) accounts in fact for the consumption of fossil resources providing a basis for a clear comparison among various different energy carriers (Pezzutto 2014).

In order to present a complete picture of the Austrian and Italian building stocks and to describe time-related specifications, we proceeded on the basis of the following breakdown:

(i) Buildings constructed before 1945 are generally classified as historic buildings. The historic-building stock is highly inhomogeneous, making it difficult to make a standardized assessment. Nevertheless, certain characteristics may still be generalized, such as the massive construction for historic residential buildings;
(ii) Buildings erected after World War II and before 1960—the building-industry boom—are generally characterized by poor insulation and inefficient energy systems (caused by the choice of cheap construction materials and short building times) resulting in a higher specific energy demand;
(iii) Buildings built between 1961 and 1980 present the first insulation applications (as a consequence of the world energy crises of the 1970s);
(iv) Buildings built during 1981–1990 and 1991–2000 reflect the introduction of thermal protection ordinances (around 1990);

(v) Buildings dating to 2001–2010 are considered to assess the impact of the European Performance of Buildings Directive (2002/91/EC and following recasts);
(vi) Buildings constructed after 2010 are analyzed to understand the impact of the economic crisis on Europe´s construction branch.

Data quality, completeness, accuracy, and reliability proved to be very important aspects in the process of establishing the database for this investigation. Among others, the following main points have been taken into consideration: (i) Data inventory, (ii) Data reliability and (iii) Data definition and comparability:

(i) Data inventory

One of the major challenges in developing an inventory of data for building-stock analysis is to provide a complete list of all existing information. Unfortunately, the data provided are never fully complete. The authors therefore collected data from national statistics to increase data coverage and availability.

Filling in the data gaps implied not only extrapolating and assembling data from large data tools available online (e.g., IEE TABULA, BPIE Data Hub for Energy Performance of Buildings, Statistik Austria, ISTAT etc.), but also researching data source-by-source from single scientific literature fonts such as journal papers, conference proceedings and project deliverables.

One important aspect of the data inventory is to ensure that the information can be understood and interpreted correctly. The data provide standardized structured information explaining origin, creator, and a time reference.

(ii) Data reliability

The present analysis has been carried out after consulting a few dozen peer-reviewed papers and over ten databases (of which only a small part has been included in the present list of references due to the sources' lack of reliability). All sources have been analyzed assessing data reliability and complementing missing gaps by in-depth investigations.

(iii) Data definition and comparability

The use of standardized formats and units by most data providers doesn't imply that data are necessarily fully comparable. Adjusting differences and inconsistencies among different measures, assumptions, methods, time references and specifications to improve data comparability is one of the most important aspects of the whole process of data elaboration.

Data has been collected for each country with reference to the most recent year.

Next coming Figs. 1 and 3 of the results section are based on data retrieved with a unit of Mm^2. The percentages indicated are based on the respective floor areas. In contrast, portions shown in Figs. 2, 4, 5 and 6 are based on the number of buildings erected.

In the case of Figs. 8 and 10, no reliable values could be found concerning the historic-building stock, and therefore this part of the indicated charts are empty. The same applies for the case of Italy with regard to Figs. 4 and 6.

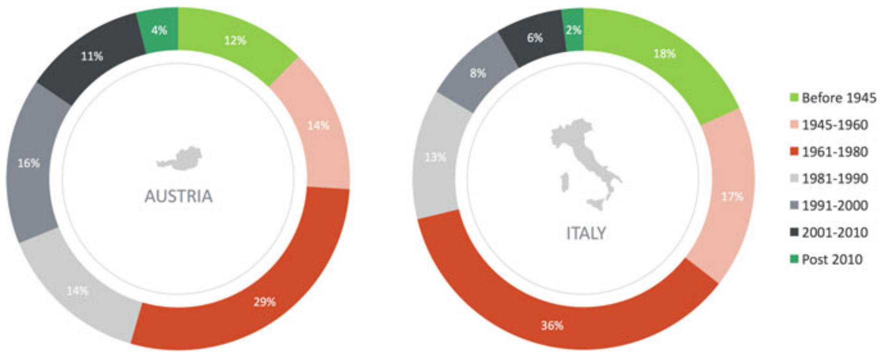

Fig. 1 Subdivision of the Austrian and Italian residential building stock raised per construction period (Before 1945–Post 2010)—% (Amtmann and Altmann-Mavaddat 2014; Statistik Austria 2017; Norris and Shiels 2004; Hartl 2010; ISTAT 2017; Invert/EE-Lab 2017)

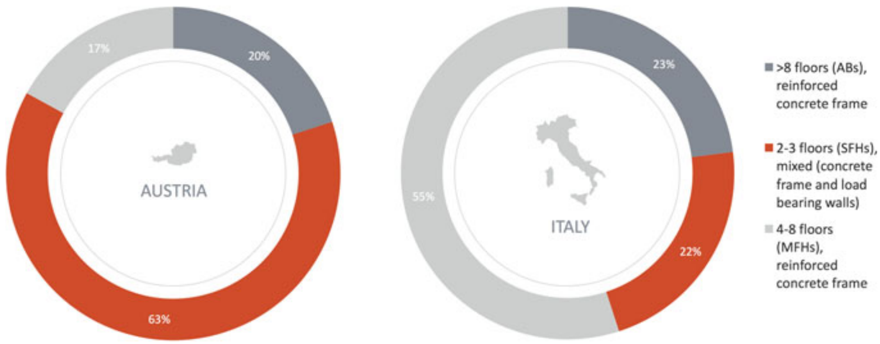

Fig. 2 Subdivision of the Austrian and Italian residential building stock per different building types—% (Baulicher Brandschutz 2008; Demuth and Malloth 2006; Corrado 2012)

3 Results

Figure 1 compares Austria and Italy with regard to the residential building stock erected per construction period (Before 1945–Post 2010) in percentages.

These two figures show that both countries have a peak in built construction during the period 1961–1980, with values around 30%. Both in the previous and following time frames, percentages decrease, showing smallest values for Austria, as well as for Italy, in the time periods 2001–2010 and Post 2010. A number of recent investigations show this trend being present for the entire EU building stock (Economidou 2011; Meijer et al. 2009; Pezzutto 2014).

It should be noted that historic buildings are present in a much higher percentage in Italy than in Austria, i.e., 18 and 12% respectively. The difference in the historic-building stock is the result of increased construction activity in Austria in the post-war period. Austria shows a double amount with respect to Italy during 1991–2000 (again with around 16 and 8%).

Figure 2 visualizes the breakdown of various building types within the residential sector of the two countries investigated. The residential buildings analyzed are usually characterized by two–three floors in the case of SFHs, MFHs by four–eight, and ABs have more than eight floors (Baulicher Brandschutz 2008; Demuth and Malloth 2006; Corrado 2012).

With regard to the construction methodology, SFHs are usually characterized by concrete frames and load bearing walls and Abs, as well as MFHs, by reinforced concrete frames (Baulicher Brandschutz 2008; Demuth and Malloth 2006; Corrado 2012).

As shown in Fig. 2, Austria and Italy significantly differ for all of the investigated aspects. Austria's residential sector is dominated by SFHs with more than 60%. In contrast, SFHs are the least common building type in Italy with approximately 20%. Next, MFHs in Austria do not reach 20%, while in Italy these dominate the household sector with 55%. The only similarity concerns ABs: in both countries their presence comprises around 20%.

Figure 3 compares Austria and Italy with regard to the built-floor area of the office-building stock per various construction period.

As shown in Fig. 3, the majority of offices in Austria were built within the time period 1961–1980. The same situation exists concerning the residential buildings (Fig. 1). By contrast, in Italy the highest share of offices belongs to the historic-building stock, built before 1945. The percentage of offices built after World War II and before 1960 is almost twice as high for Austria for Italy, with 17 and 10% respectively. The residual construction periods show decreasing values from the 1980s until today, with one exception for Italy: during 1991–2000, fewer offices were erected than in the next construction period of 2001–2010. Moreover, it has to be highlighted that, from 2010 onwards, a significant higher percentage of offices were built in Italy compared to Austria—respective values of 9 and 2%.

Figure 4 subdivides various building types within the Austrian office sector. With regard to the construction methodology, buildings with four–eight floors are

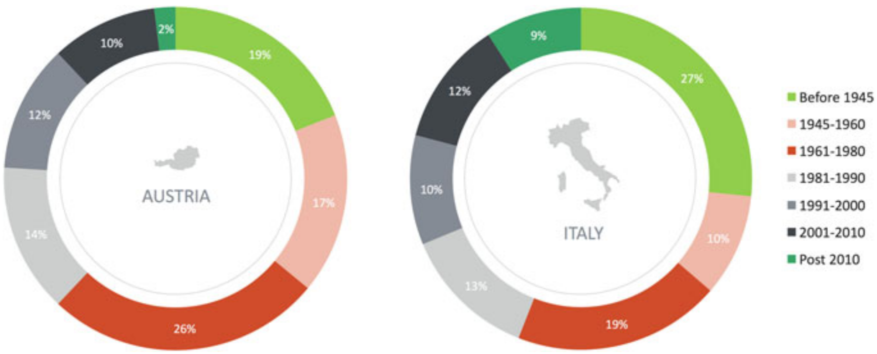

Fig. 3 Subdivision of the Austrian and Italian office building stock per construction period (Before 1945–Post 2010)—% (Hartl 2010; Amtmann and Altmann-Mavaddat 2014; Meijer et al. 2009; Norris and Shiels 2004; ISTAT 2017; Invert/EE-Lab 2017)

usually characterized by a reinforced concrete frame or a mix of concrete frame and load bearing walls. The same is true for office buildings with more than eight floors.

As visible in Fig. 4, the absolute majority of office buildings have between four and eight floors, with more than 60 and almost 20%. Structures higher than eight floors are less common—a total of 18%. In the case of Italy, the only information found is that the majority of office buildings are characterized by more than eight floors and reinforced concrete frames.

Figure 5 displays the ownership patterns of dwellings within both investigated countries.

As shown in Fig. 5, in both nations the absolute majority of dwellings are owner occupied. It has to be stressed that in this respect, Italy is characterized by a persistently higher value than Austria, with more than 90 and almost 60% respectively. In fact, Italy has the highest percentage of owner-occupied dwellings within the European Union (EC 2015). The second position is held by rented dwellings and social housing for Austria and Italy, respectively. Other forms of tenure (e.g., cooperative, squatting etc.) are 3% in Austria and 1% in Italy. Furthermore, for Italy it was possible also to find information regarding commercial and state, region and municipality ownership. However, these cover just a small part—2 and 1%, respectively.

Figure 6 visualizes the ownership pattern of Austrian offices.

As visible in Fig. 6, a parity is present between single and multiple ownership, with 41% of both. The remaining part—almost 20%—belongs to other ownership types (e.g., fractional ownership).

Figure 7 indicates the evolvement of SH and DHW demand for Austria's and Italy's household sectors within a time range spanning from before 1945 until today.

As shown in Fig. 7, the historic-building stock is characterized by a lower SH and DHW demand than for the time period 1945–1960. The difference in energy need of

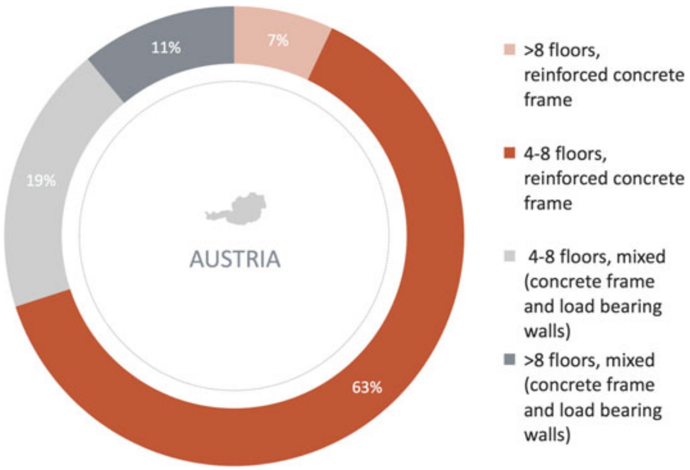

Fig. 4 Subdivision of the Austrian office-building stock per different building types—% (Statistik Austria 2017; Cost-effective 2017)

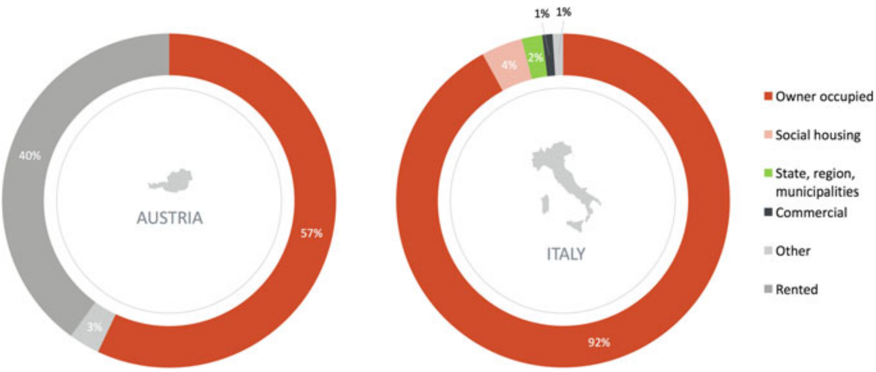

Fig. 5 Subdivision of the Austrian and Italian ownership patterns, residential sector—%. (Norris and Shiels 2004; Melograno and Pezzutto 2010)

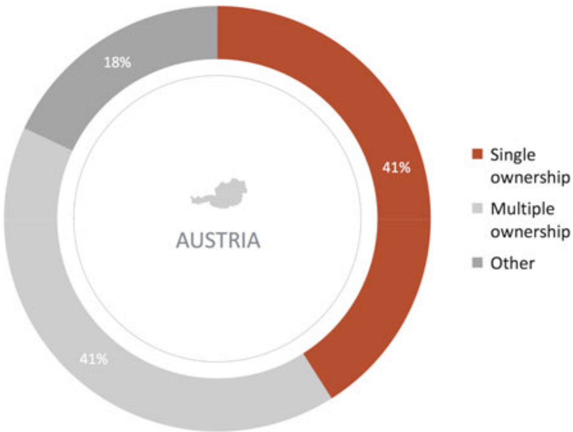

Fig. 6 Subdivision of the Austrian ownership structure, office sector—% (Statistik Austria 2017)

the buildings erected within the two latter time periods is considerable. In the case of Italy, we see a rise from approximately 80 to 220 kWh/m^2 year, while in Austria an increase is seen from around 160 to almost 200 kWh/m^2 year. The following time periods see a constant decrease for both countries from about 200 kWh/m^2 year after World War II until $\sim$50 kWh/m^2 year for buildings erected after 2010. Italy shows a slightly higher energy demand than Austria's buildings for almost all time periods, with one exception: the historic-building stock.

A possible reason for Italy's higher SH and DHW demand in the period 1945–1960 to today is related to Austria´s better and more widespread buildings insulation, as well as a more efficient use of SH and DHW technologies (TABULA 2017).

Figure 8 visualizes the evolution of SH and DHW demand for Austria's and Italy's office sector for buildings erected from World War II until today. Unfortunately, it was not possible to find data for the given graph concerning offices constructed before 1945.

Fig. 7 Development of the space-heating and domestic hot-water demand in Austria and Italy (Before 1945–Post 2010), residential sector—kWh/m^2 year (Mahlknecht 2009; Lazzarin et al. 2001; Solair 2008; Energi 2002; Ostermann et al. 2010; Benejam et al. 2012; Invert/EE-Lab 2017)

Fig. 8 Development of the space-heating and domestic hot-water demand in Austria and Italy (Before 1945–Post 2010), office sector—kWh/m^2 year (Mahlknecht 2009; Lazzarin et al. 2001; Solair 2008; Energi 2002; Öhlinger et al. 2010; Benejam et al. 2012; Invert/EE-Lab 2017)

As shown in Fig. 8, there is a constant decrease of SH and DHW demand from the period of 1945–1960 until 2010 and afterwards. From World War II up to today, the values for the two investigated countries differ more and more, reaching numbers of approximately 90 and 10 kWh/m^2 year for Italy and Austria respectively in 2010 until today. Italy shows consistently higher values than Austria.

Figure 9 indicates the evolution of SC demand in both countries in the residential sector from the time period before 1945 until today.

As can be seen in Fig. 9, in both nations the SC demand is highest for buildings from the period 1945–1960. Afterwards, in both countries, the SC demand constantly decreases until today (Post 2010). Italy is characterized by a reduction in

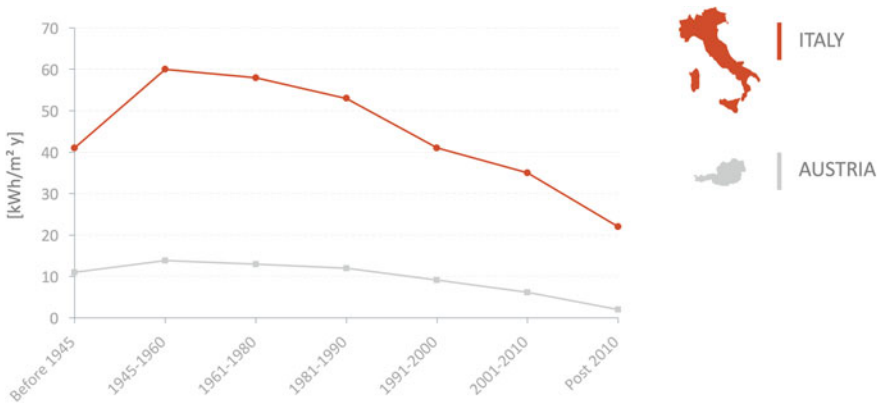

Fig. 9 Development of the space-cooling demand in Austria and Italy (Before 1945–Post 2010), residential sector—kWh/m^2 year (Aprile 2007; Adnot 2011)

energy demand of approximately 60–20 kWh/m^2 year and Austria from 10 to 2 kWh/m^2 year. Thus, Italy has reduced its energy demand for SC by about a factor of 3 and Austria by about a factor of 5.

Italy shows much higher values than Austria—on average, around 40 compared to 5 kWh/m^2 year, respectively. A possible reason for the discrepancy could be warmer climatic conditions in Italy compared to Austria (Vetmeduni Vienna 2017).

Figure 10 depicts the evolution of SC demand for the two countries in offices erected before 1945 until Post 2010.

As apparent from Fig. 10, a constant decline in SC demand occurred both in Austria and in Italy from World War II until 2010 and afterwards. Italy is characterized by a reduction in energy demand of approximately 90 to 30 kWh/m^2 year and Austria from 20 to 4 kWh/m^2 year. Thus, as was the case for Fig. 9, Italy has reduced its energy demand for SC by about a factor of 3 and Austria by about a factor of 5.

4 Discussion and Conclusions

The European Union is facing unprecedented challenges related to climate and energy aspects, with specific goals to be achieved by 2020, 2030 and 2050.

The European primary energy demand amounted to about 1800 Mtoe/y in 2010, mainly caused by various different types of heating and cooling applications (almost 900 Mtoe/y, not only related to building' space heating and cooling, but also industrial heat), followed by transportation and electricity (about 540 and 360 Mtoe/y respectively). Buildings account for about 720 Mtoe/y (40% of the entire EU primary energy demand). The majority of energy demand within the European building stock is attributed, in decreasing order, to space heating, domestic hot-water and space-cooling purposes, with approximately 2900, 400 and 200 TWh/y respectively (Pezzutto et al. 2015).

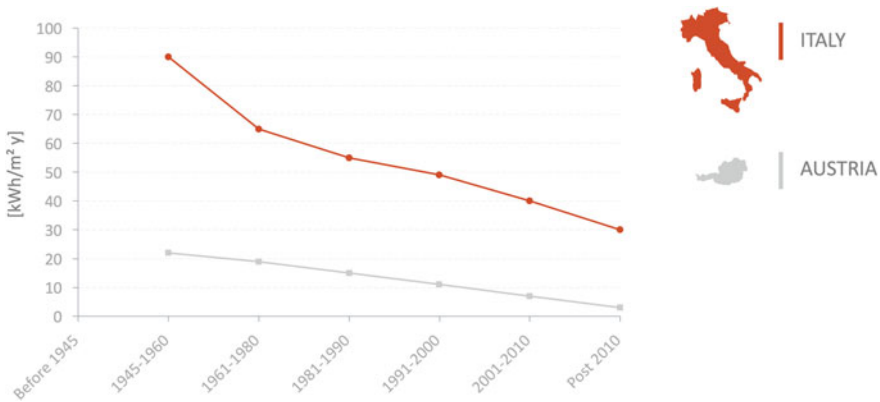

Fig. 10 Development of the space-cooling demand in Austria and Italy (Before 1945 Post 2010), office sector—kWh/m^2 year (Aprile 2007; Adnot 2011)

Our results show that Austria and Italy share a number of homogeneities among building typologies (in total percentage), construction methodologies, portions of built-floor area per construction span, and specific energy demands per construction period.

In fact, looking at the subdivision of the Austrian and Italian residential and service (offices) building stocks raised per construction periods (Before 1945–Post 2010)—Figs. 1 and 3—one can notice that almost all construction spans show similar values and follow the same trends.

Similarities are present also in the subdivision of the Austrian and Italian residential-building stocks per different types—Fig. 2—with regard to the proportions of sections given and respective construction methodologies.

Concerning the subdivision of the Austrian and Italian ownership patterns for the residential sector—Fig. 5—once again nearly all construction features show relatively similar values and follow the same trends.

Regarding the development of space-heating and domestic hot-water, as well as space-cooling, demands, Austria and Italy (Before 1945–Post 2010) exhibit a peak (kWh/m^2 year) for residential and office sectors during 1945–1960, Figs. 7, 8, 9 and 10. Afterwards, in all cases, the values for both investigated countries follow a decreasing trend in energy demand—in Italy higher than in Austria.

Identified differences between the two investigated countries concern mainly historic buildings, building types in the residential sector and the ownership patterns in households.

It has to be stressed that historic buildings are a much higher percentage in Italy's residential sector than in Austria's: 18 and 12%, respectively (Fig. 1). Also, in the service sector (offices), in Italy the highest share belongs to historic buildings, while in Austria it does not (Fig. 3). Moreover, space heating and domestic hot water during the period before 1945 is halved in Italy compared to Austria, namely, reaching values of 80 and 160 kWh/m^2 year respectively (Fig. 7).

With regard to the different household building types, Austria and Italy differ with regard to all investigated aspects (Fig. 2). In fact, Austria's residential sector is dominated by single-family houses (with a share of over 60%), while Italy's share of single family houses is as low as 20%, approximately. Italy's household sector is in fact dominated by multi-family houses (55% of the total); in Austria these represent only 20%.

Concerning the ownership pattern in the residential sector (Fig. 5), Italy's is characterized by a persistently higher value than Austria with over 90 and almost 60%, respectively.

It would be interesting to find out to what extent building components (e.g., different window types, space heating, domestic hot-water and space-cooling equipment, façade types etc.) and U-values (walls, windows, roofs and ceilings) are similar in the two countries with regard to the various construction spans taken into consideration.

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References

Adnot, J. (2011). Limiting the impact of increasing cooling demand in the European Union: Results from a study on room air-conditioner energy efficiency.

Amtmann, M., & Altmann-Mavaddat, N. (2014). *Eine Typologie Österreichischer Wohngebäude. Österreichische Energieagentur*. Vienna: Austrian Energy Agency.

Aprile, M. (2007). *European market prospects*. Santiago: PolySMART.

Brandschutz, B. (2008). Accessed at: February 8, 2017, from http://www.brandschutz.at/BS/BK_08/Adobe/BK_08_62_.pdf.

Benejam, G., Mata, É., Kalagasidis, A., & Johnsson, F. (2012). Bottom-up characterization of the Spanish building stock for energy assessment and model validation. In *Retrofit 2012 Conference*. Manchester.

BPIE. (2017). *Data hub for energy performance of buildings*. Accessed at: December 7, 2017, from https://www.buildingsdata.eu/.

Capehart, B. (2007). *Encyclopedia of energy engineering and technology*. London, England: CRC Press.

Corrado, V. (2012). *National scientific report on the TABULA activities in Italy*. Torino: Politecnico di Torino.

Cost-effective. (2017). Accessed at: February 8, 2017, from http://www.cost-effective-renewables.eu/publications.php?type=brochure.

Demuth, C., & Malloth, T. (2006). *Gesetzliche und Wirtschaftliche Rahmenbedingungen des Energieausweises*.

EC. (2015). *Housing statistics*. Accessed at: December 7, 2015, from http://ec.europa.eu/eurostat/statistics-explained/index.php/Housing_statistics.

EC. (2017a). *The 2020 climate and energy package*. Accessed at: February 11, 2017, from http://ec.europa.eu/clima/policies/package/index_en.htm.

EC. (2017b). *2030 Framework for climate and energy policies*. Accessed at: February 9, 2017, from http://ec.europa.eu/clima/policies/2030/index_en.htm.

EC. (2017c). *EU action on climate*. Accessed at: February 9, 2017, from http://ec.europa.eu/clima/policies/brief/eu/.
EC. (2017d). *EU building stock observatory*. Accessed at: February 10, 2017, from https://ec.europa.eu/energy/en/eubuildings.
Economidou, M. (2011). *Europe's buildings under the microscope.*
Energi, E. (2002). *Characterization of heating systems and their market.*
Hartl, N. (2010). *KeepCool II—Simulationsergebnisse*. Vienna: Austrian Energy Agency.
Invert/EE-Lab. (2017). Accessed at: February 16, 2017, from http://www.invert.at/.
ISTAT. (2015). Accessed at: December 7, 2015, from http://dawinci.istat.it/MD/dawinciMD.jsp?a1=u0GG0c0I0anda2=mG0Z8048f8andn=1UH93709OG0andv=1UH0MC09OG00000.
ISTAT. (2017). Accessed at: December 7, 2017, from http://www.istat.it/en/.
Lazzarin, R., Busato, F., & Castellotti, F. (2001). *L′impatto energetico ed economico dell′ isolamento termico degli edifici in Italia.*
Mahlknecht, H. (2009). *Refurbishment and monitoring of an historical building*. Bolzano.
Meijer, F., Itard, L., & Sunikka-Blank, M. (2009). Comparing European residential building stocks: Performance, renovation and policy opportunities. *Building Research and Information, 37*(5–6), 533–551.
Melograno, P., & Pezzutto, S. (2010). *Italian country report.* IEA ANNEX 34.
Norris, M., & Shiels, P. (2004). *Housing developments in European countries*. Dublin: The Housing Unit.
Ostermann, V., Gotzl, G., & Steckler, P. (2010). *Energie der Zukunft.*
Öhlinger, C., Dell, G., Egger, C., & Aufreiter, R. (2010). *Beleuchtung, Innovative und effiziente.*
Pezzutto, S. (2014). *Analysis of the space heating and cooling market in Europe*. Ph.D. thesis, Vienna.
Pezzutto, S., Toleikyte, A., & De Felice, M. (2015). Assessment of the space heating and cooling market in the EU28: A comparison between EU15 and EU13 member states. *International Journal of Contemporary Energy, 2,* 35–48.
Recknagel, R. (2010). *Handbook for heating and air-conditioning technology*. Munich: Industry publishing.
Solair. (2008). *Market report for small and medium sized solar Air-conditioning appliances.*
Statistik Austria. (2017). Accessed at: February 19, 2017, from https://www.statistik.at/web_de/statistiken/index.html.
TABULA. (2017). Accessed at: February 15, 2017, from http://episcope.eu/iee-project/tabula/.
Vetmeduni Vienna. (2017) Accessed at: February 13, 2017, from http://koeppen-geiger.vu-wien.ac.at/.

Energy Consumption and Indoor Comfort in Historic Refurbished and Non-refurbished Buildings in South Tyrol: An Open Database

Francesca Roberti, Dagmar Exner and Alexandra Troi

Abstract To achieve the EU energy-saving targets, renovation of existing buildings requires particular attention. In total, historic buildings amount to one fourth of Europe's building stock. Also, in the Province of Bolzano (Northern Italy), 30% of the building stock was built before the end of World War II—in some municipalities even around 60%. Therefore, energy refurbishment of this sector represents an opportunity to reduce CO_2 emissions and to provide comfortable living space using existing resources and preserving cultural and social values. In this work, we collect information on the energy behaviour of historic buildings in South Tyrol, analyzing some representative "best practices". "Best practices" have been selected in accordance with the local heritage authority, and have been defined as successfully retrofitted buildings that satisfy both energy and heritage conservation aspects. The aim is to show that retrofitting historic buildings is feasible and also can achieve high levels of comfort and low-energy consumption, while keeping our cultural heritage alive and exploiting existing resources. The collected information is based on interviews and on-site visits that includes: the use of the building, the building geometry, the thermal envelope, the heating system, the use of renewable energy sources, the energy consumption and the perceived comfort inside the building. All this information is made available in an open database that enables building owners and planners to estimate the energy consumption of their building, to learn the most frequently used retrofit solutions, and to forecast the possible

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energy savings and the improvement of comfort if the building is refurbished. The database represents a knowledge source and an access to trustworthy information for all stakeholders, going beyond the state of the art certainly in the respect to architectural quality of deep renovations.

Keywords Historic building · Energy consumptions · Energy retrofit
Comfort improvement · Open database

1 Introduction

Increasing the current EU renovation rate from 1.2% per annum to 2–3% is essential to meet both the EU 2020 targets and the commitment undertaken in Paris in December 2015. About 75% of the EU's 210 million buildings are not energy efficient, and 75–85% of them will still be in use in 2050. Ensuring a highly-efficient and fully decarbonized building stock by 2050 is a major challenge (Saheb 2016). A non-negligible share of the total residential building stock were built before World War II—here referred to as historic buildings: they amount to one-fourth of Europe´s residential dwelling stock, 14% from before 1919 and other 12% from 1919 to 1945, housing an estimated 120 million Europeans (Troi 2011). In South Tyrol in Northern Italy, actually about 30% of the residential building stock was built before the end of World War II (Province of Bolzano-Bozen 2001). Energy refurbishment of this sector represents thus not only an opportunity to reduce CO_2 emissions but also a way to provide sustainable and comfortable living spaces using existing buildings as a valuable resource.

When retrofitting historic buildings, preserving their aesthetic, cultural and social values is however of major importance. To understand the most appropriate retrofitting interventions and to reliably estimate the potential energy savings, a detailed knowledge on the typical energy demand and the real energy performance of historic buildings are prerequisites. This should include all aspects that affect energy consumption, such as the actual use, architectural features, the construction method, the building materials, the construction details and their behaviour from an energetic and building physics point of view, as well as weak and critical points. At the same time, high-quality retrofits that possess the potential for deep renovations while respecting cultural and social values can provide robust and transferable retrofitting measures for various building typologies, since standard solutions are not suitable for historic buildings.

This paper presents the typical historic building typologies in South Tyrol and some representative *best practices* of energy-retrofitted buildings. Moreover, it presents the online database in which information are collected and available to building owners and planners.

2 Methodology

2.1 Data for the Baseline Scenario

For the baseline scenario and the typology definition, two data sets are used. The first is the population census (Province of Bolzano-Bozen 2001), particularly Table 4.3 regarding residential buildings per construction period and municipality. The second is the Monument Browser (Province of Bolzano-Bozen 2011) a tool that collects all listed buildings in the Province of South Tyrol in a GIS-based online map along with the location, a photo, a short description, the assigned specific monument category, and the protection status.

2.2 Definition of Typologies

To enable the calculation of a baseline scenario for the historic building stock and to estimate their energy consumption, as well as to select and analyze typical high-quality retrofits, it is necessary to define exemplary building typologies in the region. Based on analysis of data on 7.732 listed objects of the local heritage authority of Bolzano (Province of Bolzano-Bozen 2011), we determined the primary representative categories of historic building in the region. The selection criteria for these main building typologies were: (i) mainly built as living spaces; (ii) primarily used all year round and heated; and (iii) number per category: more than 20. The further defined 12 sub-typologies reflect their use, their location and climate, as well as their architectural characteristics and construction method.

2.3 Identification of Best Practice

Best practices are those that result in retrofitted historic buildings with an optimized energy performance and improved internal comfort, while at the same time maintaining their historic characteristics. A threshold for maximum energy demand was not defined, as each historic building is unique and has therefore specific aspects that should be preserved. In fact, some buildings should maintain the historic façade, some other the interior cladding (e.g. *Stube*), others the paintings on the inner walls etc. For this reason, we consider as *best practices* retrofitted buildings that reach their specific best level of energy efficiency while maintaining their original historic value. The representative examples have been identified in accordance with the local heritage authority of Bolzano and are based on existing awards on the topic, among them: (i) the *Premio ITAS*, an award for the preservation of farm houses; (ii) the *Premio: ottimizzazione energetica nelle* *ristrutturazioni*, an architecture award for the retrofitting of historic buildings, and (iii) the local certification label for the refurbishment of buildings, called *CasaClimaR*.

2.4 Documentation of Best Practice and Database

The examination of *best-practice* buildings is based on interviews and on-site visits that collect information about the use of the building, the building geometry and dimension, the construction of the thermal envelope, the heating system type and control, the use of renewable energy sources, the energy consumption from bills and the perceived comfort inside the building. It also includes the description of typical technological solutions transversal to all buildings typologies (e.g. the insulation of the wooden roof or restoration of the windows), or specific to each building typology (e.g. the interior insulation of the *Stube* in the case of rural residential buildings). Based on that analysis, we developed a database in which the user can find well-documented representative buildings of each building typology of the historic building stock showing the typical energy performance and the typical construction method, as well as approved retrofitting interventions.

The open database allows both building owners and planners to estimate the energy consumption for various historic-building typologies and to understand the most appropriate retrofitting solutions for their building type in order to achieve optimized energy performance also in an historic building. It forecasts the possible energy savings and the improvement of comfort if the building is refurbished as a *best practice*. Showing well-executed, approved examples, the database gives both planners and building owners the opportunity to browse through the catalogue of buildings and become inspired—an incentive to preserve and renovate their own historic building.

The developed database is structured into the six main chapters *Architecture, Thermal Envelope, Building Services, Energy Efficiency, Comfort* and *Products/ Refurbishment Solutions*. Users can precisely select examples that match their particular interest by filtering according to specific building typologies (degree of protection, use, size and location) or to specific building materials, retrofitting solutions or certain building services.

3 Results and Discussion

3.1 Age of the South Tyrolean Buildings

Figure 1 shows the age of the residential buildings in the single municipalities and in the whole Province of Bolzano/Bozen calculated from the population census

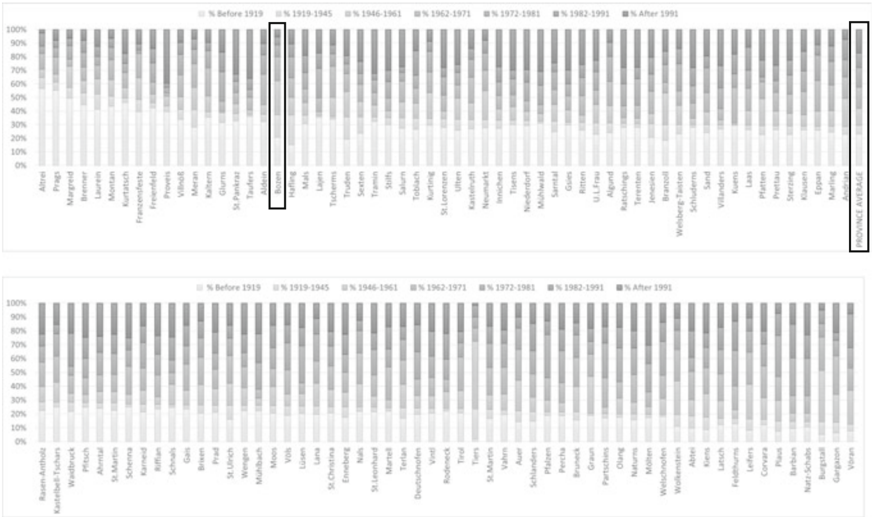

Fig. 1 Buildings' age in the municipalities of the Province of Bolzano/Bozen. *Source* EURAC

2001 (Province of Bolzano-Bozen 2001). The number of buildings built before 1945 is 21.458, about 29% of the total 73.042. Also, actualizing the values with a growth rate of 1% (Economidou et al. 2011), buildings built before 1945 represent still 25% of the total.

Looking at the subdivision into municipalities, the highest percentage of building dating before 1945 is around 60% (Altrei, Prags, Margreid, Brenner), and the largest towns in the Province reach about 40% (37% Bolzano/Bozen, 41% Merano/Meran). It is interesting to note that in most of the municipalities the share of buildings from before 1919 dominates compared to the interwar period: actually out of the 29% of historic buildings, 23% date from before 1919 and only 6% from 1919–1945—while on the European level, the numbers are 26, 14 and 12%, and on the Italian level 24, 14 and 10% (Troi 2011).

3.1.1 Listed Buildings in South Tyrol

Only a small part (4.180) of this large number of historic buildings is listed (under protection, as defined by the local heritage authorities) and of these 4180 only 2.931 are in use or potentially usable as living spaces. Figure 2 shows them divided by building category or rather by their destination use, defined by the heritage authority. The largest part comprises rural residential houses (1479 units), followed by the urban residential buildings, including, e.g. *Laubenhäuser/Portici* and then by the manors *Ansitze*. Rural restaurants, the parsonage "Widum", hotels, schools and palaces are other important typologies. As explained in Sect. 3.2, within these main

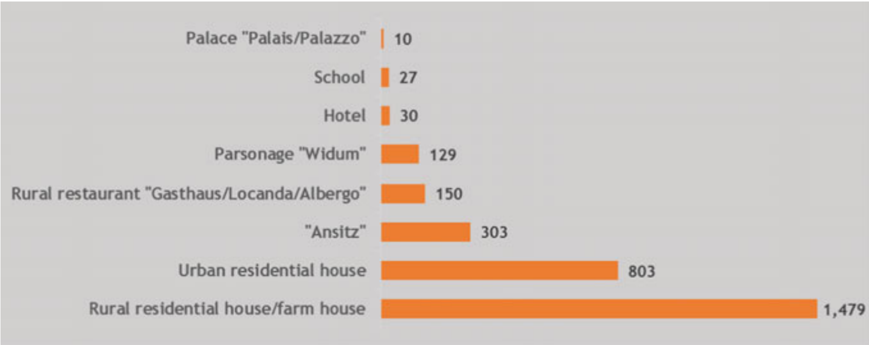

Fig. 2 Listed buildings in South Tyrol divided by use. *Source* EURAC

typologies, sub-typologies were identified according to the building construction, topographical location and age. Data have been elaborated starting from information available in the Monumentbrowser (Province of Bolzano-Bozen 2011).

3.2 *Identified Typologies and Sub-typologies*

We determined four representative main categories of historic building in the region: *the rural residential building/farm house, the urban aggregated residential house, the freestanding (rural) dwelling house* and the standalone categories.

3.2.1 Rural Residential Buildings—Farm Houses

The rural residential building or farm house is the most commonly occurring monument category in South Tyrol with approximately 1500 buildings. From an energy point of view, a distinction according to the location is useful, as climate conditions, such as the solar radiation, influences the dimension, orientation and shape of the farmhouse, and the altitude determines the type and dimensions of the functional areas and the use of space. The location is also connected with the construction materials, which are mainly two: natural stone and wood (combined with lime or clay). They are used in varying quantities depending on their availability (connected to the altitude).

Following the distinguishing criteria of construction method, we determined three groups: stone buildings with wooden roof (WR), which is found mainly as wineries in the lowlands or lower valley locations; stone buildings with wooden roof and last floor (WRF) and stone buildings with wooden roof and last two floors (WRFF), which are found in various forms on higher elevations (see Fig. 3).

Fig. 3 Rural residential buildings, from the left: Mairhof/Maso Mair in the lower Vinschgau/Val Venosta (WR); Huberhof/Maso Huber at the entry of Pustertal/Val Pusteria (WRF); Rainhof/Maso Rain (Gsieser Tal/Valle di Casies); and Aussergrubhof/Maso Aussergrub (Ultental/Val d´Ultimo) both in block construction (WRFF). *Source* EURAC

3.2.2 Urban Aggregated Residential Buildings

The urban aggregated residential building is found in the dense urban construction of the historic city centers. From the energy point of view, we distinguished three large building-age classes, connected with the use of the building material: the medieval arcade buildings *Laubenhäuser/Portici* (MB), the urban residential house of the turn of the century (19th/20th century—XIXB) and the buildings of the interwar period (built between the two world wars—WWB), see Fig. 4.

The *medieval arcade houses* (MB) can be found in Bolzano/Bozen, Merano/Meran, Bressanone/Brixen, Vipiteno/Sterzing, Egna/Neumarkt and Glorenza/Glurns. This characteristic architectural typology is composed of a system of houses with narrow facades and a continuous arcade on the front. The serial repetition of this compact type of building forms a consistent structure, interrupted only by a system of atria that provide daylight and fresh air to the dwellings. Core buildings were built in the late 12th century, while greater extensions and the present appearance of the facades are from the Renaissance and Baroque periods.

Fig. 4 Urban residential aggregated buildings, from the left: medieval Laubenhäuser/Portici (MB) in Bolzano/Bozen historic city center; buildings of the end of the XIX century (XIXB) in the Sparkassenstraße/Via Cassa del Risparmio of Bolzano/Bozen; and buildings built between the two world wars in the Siegesplatz/Piazza Vittoria of Bolzano/Bozen (WWB).
Source Left figure: Wikimedia Commons, the free media repository. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=14019. May 05, 2017. Middle figure: Monumentbrowser. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=13959. May 05, 2017. Right figure Monumentbrowser. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=14873. May 05, 2017

The main buildings are usually constructed of natural stones, while the adjoining stable building on the backside—where existing—are built mostly in wood. Freestanding medieval urban houses are rather rare and therefore not considered as a separate category.

Towards the end of the 19th century, the living space in the medieval town centers became scarce and, for example, Bolzano was extended by a characteristic road, the Sparkassenstraße/Via Cassa di Risparmio with a closed four- to five-floor development along the road. The houses, specified as *urban residential buildings from the turn of the century (XIXB),* were built in Nuremberg late-Gothic style, partly in neo-Baroque style, central and lateral risers, square and triangle bays, as well as corner turrets and window framing characterize the facades (Mumelter 1990; Raifer 2005). The natural stone used in the Middle Ages were replaced by bricks.

Another characteristic representative of the urban residential building over the centuries are the buildings of interwar period (WWB), such as the ones of Corso della Liberta/Freiheitsstraße in Bolzano, with a continuous block construction along the street, constructed in concrete and brick. Awareness of their importance and worthiness for preservation is rising.

3.2.3 Freestanding/Detached (Rural) Dwelling Houses—Ansitz, Palais, Villa, Widum

Freestanding residential buildings of the middle ages were more likely to be found in rural areas, usually located on a larger plot, since originally the residential building was accompanied by the use of surrounded areas as farmland for supplying for supplying the inhabitants with food. Within the medieval freestanding residential building, we distinguish the palace building *Palais/Palazzo* (PAL) and the residence *Ansitz* (ANS). In the meantime, a large part of these freestanding "rural" houses have been included in the expanded area of city centers. From the second

Fig. 5 Urban residential isolated buildings: from the left: the Ansitz Hörtenberg (ANS), Palais Rottenbuch (PAL), the Villa Clara (VIL) in Bolzano/Bozen and the old Widum (WID) of Gais. *Source* Left figure: Monumentbrowser. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=14019. May 05, 2017. Middle figure: Monumentbrowser. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=13959, http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=50310. May 05, 2017. Right figure: Monumentbrowser. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=14873. May 05, 2017

half of the 19th century, the building type *Villa* (VIL) was added. The parsonage *Widum* (WID) can be classified as a further sub-category of this typology, since this is also a freestanding rural residential house (of the church), see Fig. 5.

3.2.4 Stand-Alone Categories: Schools, Hotels, Rural Restaurants

Numerous Schools (SCH) were built in South Tyrol in the larger communities in the late 19th century and early 20th century, all similar in shape and construction (Fig. 6).

Hotels (HOT) as an historic building category are meant to be buildings specifically built as hotels in the second half of the 19th century: for example, the hotel "Drei Zinnen", the hotel "Pragser Wildsee" and hotel "Laurin". In contrast to the earlier occurring guest houses, they differ in that they were planned with larger accommodation facilities, with a larger building volume or a larger number of guest rooms.

Also for the rural restaurants (RR) or inns, we can distinguish between "urban" and "rural" historic restaurants. However, this typology can be neglected or assigned to the urban dwelling, since the urban restaurant is mostly housed in an urban agglomerated residential building (apart from freestanding urban restaurants such as the Batzenhäusl of Bolzano) and the rural inn resembles the rural residential building.

Fig. 6 (left to right): School building (SCH) Goetheschule of Bolzano/Bozen; hotel (HOT) "Drei Zinnen" of Sesto/Sexten; and rural restaurant (RR) "Schwarzer Adler" of Salorno/Salurn. *Source* Left figure: Monumentbrowser. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=13947. May 05, 2017. Middle figure: Monumentbrowser. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=17342. May 05, 2017. Right figure Monumentbrowser. Accessed at: http://www.provinz.bz.it/denkmalpflege/themen/1071.asp?status=detail&id=50551. May 05, 2017

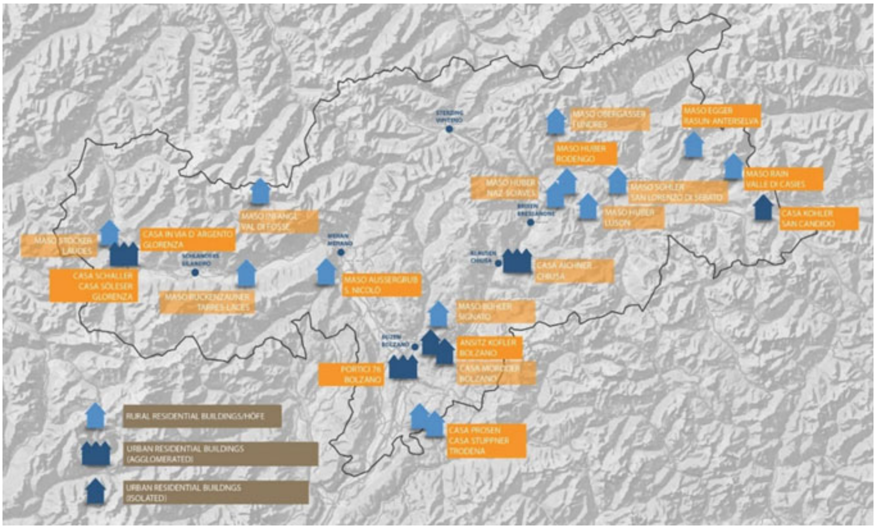

Fig. 7 Geographical distribution of the *best practices* in South Tyrol according to their typology. *Source* EURAC

3.3 Identified "Best Practice"

The identification of *best practices* is still in progress. As a result of the current work, we have documented 20 buildings: 14 rural residential buildings, three urban aggregated buildings and three urban freestanding buildings. Figure 7 shows the geographical distribution of the now identified best practices in South Tyrol, divided by building typology.

Of these 20 buildings, data on energetic behavior have currently been collected in ten cases. Figure 8 shows the results of energy demand and energy consumption for these ten *best practices* before and after their renovation. Energy demand after refurbishment is generally available from an energy calculation. This is performed either with the KlimaHaus software (used to certify the building according to the local classification of the Klimahouse Agency) or with the PHPP software (used to certify buildings according to the standards of the Passive House Institute), which consistently referred to the Bolzano/Bozen climate. Energy demand before the retrofit and real-energy consumptions before and after the retrofit are more difficult to estimate and calculate. For energy demand and consumption before the retrofit, this is the case, because buildings could be damaged and therefore unused, only partially used or could have been partially retrofitted through the years without an holistic intervention but only with spot alterations (e.g. changing windows). For the real energy consumption, the reason is that, most of the time, the owner's own wood or pellets are used as heating fuel, and the building owners do not know the exact quantity they used during one heating season. Moreover, comparisons between before and after the renovation are affected by the frequent intervention of

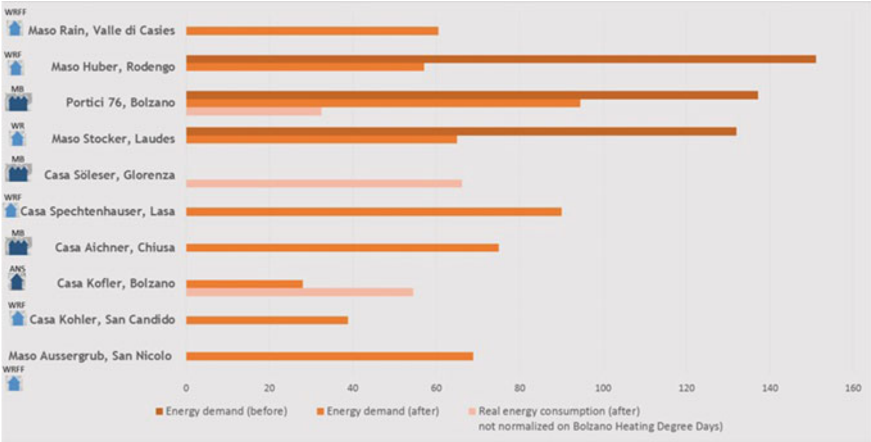

Fig. 8 Energy demand and energy consumption of the best practices before and after the refurbishment. *Source* EURAC

increasing the building volume, or by the heating of the entire volume instead of only some parts (only the *Stube* for example). Energy consumptions reported in Fig. 8 are based on energy bills or on the data from the district heating provider.

Looking at Fig. 8, data on energy demand before the renovation are available for rural residential buildings in two cases, and they range from 130 to 150 kWh/m^2 per year. After the refurbishment, rural residential buildings decreased their energy demand to 62 kWh/m^{2}a (the average of the four available examples), which is more than 50%. For this typology, real energy consumptions were not available as owners could not estimate the quantity of wood they had used as fuel.

For urban aggregated residential buildings, data on energy demand before the refurbishment are available only in one case. After the refurbishment, this kind of typology decreases the energy demand to a range of 58–95 kWh/m^{2}a. Real energy consumptions were available only for two best practices. Normalizing the real energy consumption of the building in Glorenza/Glurns to Bolzano´s Heating Degree Days, the average value is 41kWh/m^{2}a.

For freestanding urban residential buildings, only data on energy demand after the refurbishment were available. They range from 28–39 kWh/m^2. Energy consumption was available for one building in Bolzano/Bozen, i.e. 54 kWh/m^2 per year.

Results on energy demand and consumption have always to be coupled with analysis of internal comfort before and after the building refurbishment. As for energy demand, also comfort before the refurbishment is not easy to be assessed, as buildings were usually not in use. This is, however, in most cases an indirect indicator for the comfort, since they were not used because of their not satisfying comfort expectations. After the refurbishment, inhabitants of all best practices reported being completely satisfied with indoor climate conditions both during summer and winter.

3.4 *Database Structure and* Best-Practice *Example*

Documents of all investigated best-practice buildings are collected in the open database. The following table explains the database structure with its six main chapters: *Architecture, Thermal Envelope, Building Services, Energy Efficiency, Comfort* and *Products/Refurbishment Solutions* by means of one *best-practice* example—the *Rainhof/Maso Rain* of San Maddalena in Val di Casies (Fig. 9).

Section ***Architecture*** displays photos of the exterior, architectural details and interiors of the building. The text section provides general information on the building: Besides a general description mainly regarding building history, construction method and architectonical particularities, the aim of retrofitting is explained, as well as a short overview on the energy interventions. Every building is assigned to one of the four main building typologies. The building category can be expressed more in detail, selecting other parameters (e.g. use or construction method) in order to enable the filtering to identify similar buildings.

Thermal Envelope is the core chapter to convey all retrofitting interventions on the thermal envelope. Plans and sections of the implementation planning and detail drawings explain the single retrofitting solutions. The text section shows a list of the single interventions, for every relevant building component the stratigraphy is listed with relevant parameters of the building material and the total thermal conductivity of the component. Hygrothermal calculations of the details, connections and technical datasheets of the building material can be linked (Fig. 10).

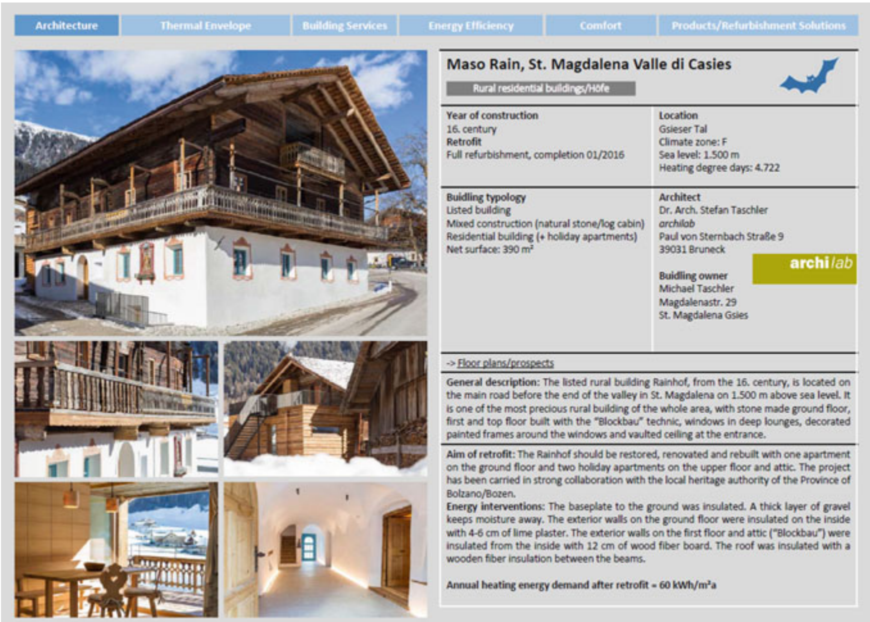

Fig. 9 Section ***Architecture*** of the Database

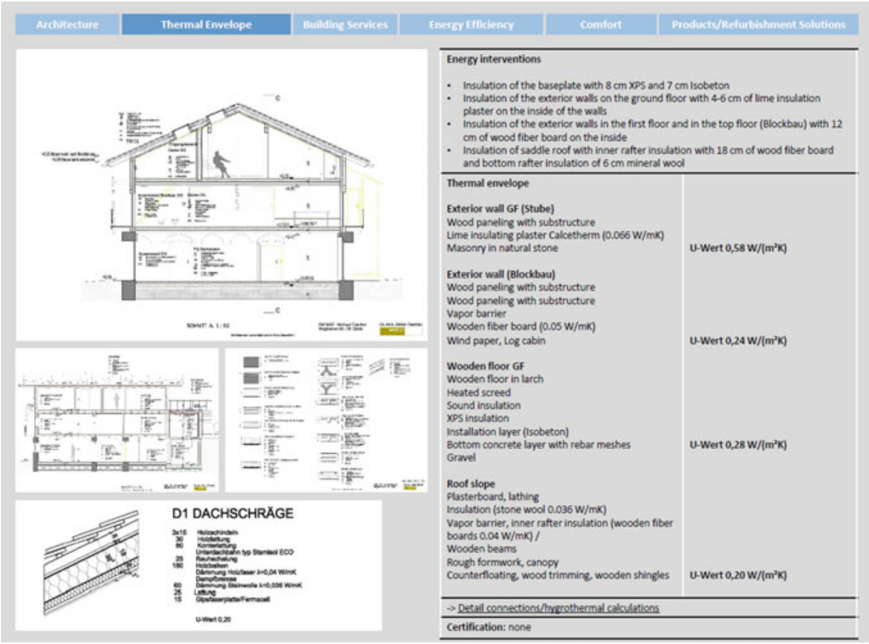

Fig. 10 Section ***Thermal Envelope*** of the Database

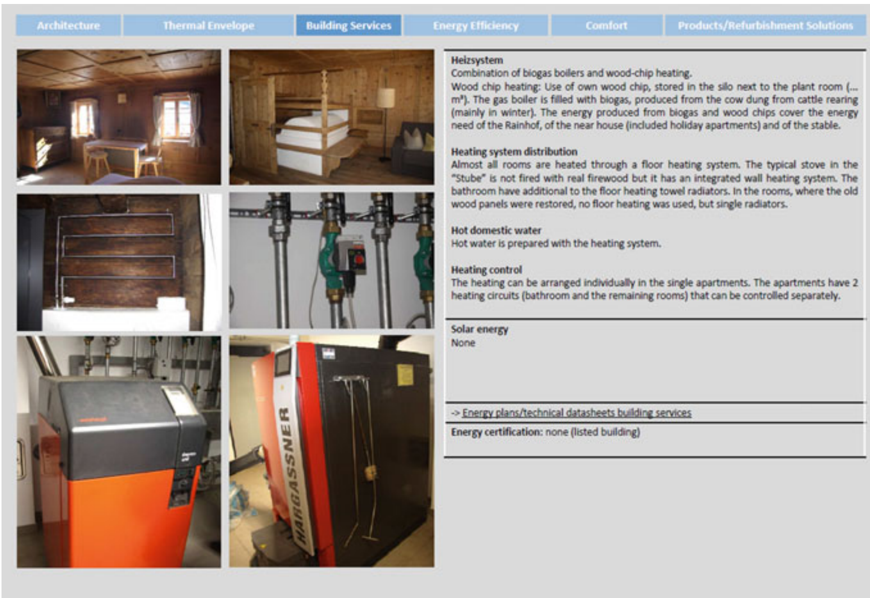

Fig. 11 Section ***Building Services*** of the Database

Building Services: In text and pictures, information is given on the main devices for building services: heating/cooling system and the heating/cooling system and the related distribution system, as well as on the production of hot domestic water and the control system. The integration of solar energy can be explained here. Energy plans and technical datasheets on technology devices and installations can be linked (Fig. 11).

Under ***Energy Efficiency*** the energy performance of the building before and after retrofitting is shown here, as well as details of the energy balance: annual monthly distribution of energy demand, percentage of transmission heat losses of the single-construction component, and percentage of heat losses and gains. If available, the calculated energy demand is compared with real energy consumption from energy bills (or monitoring). The proportion of renewable energy sources and the percentage of energy production from solar energy can be added. Documents on energy calculation and certification can be uploaded.

Section ***Comfort***: Besides the improvement of energy efficiency and the utilization of spaces, the improvement of comfort is a criterion to valorize the retrofitting measures. Here results of the inquiry to the building users is shown with regard living quality and perception of the indoor climate, as well as the user satisfaction with regard to living comfort, ventilation, daylight and acoustic comfort. Information on the user behavior collected (use of natural ventilation, shading, heating/cooling system) can be inserted, which helps to interpret the data on energy consumption.

Products/Refurbishment Solutions gives the opportunity to introduce more detailed specific solutions, where individual questions have been successfully resolved from building physics point of view (e.g. thermal bridges, moisture problems etc.), but also especially transferable architectural solutions that fit well into the historic appearance of the building, where the historic building structure has been preserved and at the same time improved energetically. Also, innovative building materials or the adaption of an existing material to the individual conditions of the building can be presented.

4 Conclusion

We explained a methodology to characterize typical energy consumption in refurbished historic buildings, and we started to apply it for South Tyrol. Up to now, results show that, after the refurbishment, energy demand can decrease by up to 50%. Further work will include the analysis of more buildings to amass a significant sample population and to be able to define, for each building sub-typology, the typical energy demand before and after the retrofitting intervention. Moreover, we started to document refurbished buildings in an open database. The aim is to make building owners and technicians aware of the possibility to reduce energy needs and improve thermal comfort while maintaining their original historic building with all its heritage values. The database will be improved and made available on line.

References

Economidou, M., Laustsen, J., Ruyssevelt, P., Staniaszek, D., Strong, D., & Zinetti, S. (2011). Europe's buildings under the microscope.

Province of Bolzano-Bozen. (2001). 14° Allgemeine Volkszählung -Band 2: Gebäude und Wohnungen, 14° Censimento generale della popolazione—tomo 2: edifici e abitazioni.

Province of Bolzano-Bozen. (2011). Monumentbrowser. Retrieved February 10, 2017 from http://www.provincia.bz.it/beni-culturali/temi/1071.asp.

Troi, A. (2011). *Historic buildings and city centres—the potential impact of conservation compatible energy refurbishment on climate protection and living conditions*. Dubrovnik, Croatia: In Energy Management in Cultural Heritage.

Saheb, Y. (2016). Energy Transition of the EU Building Stock.

Mumelter, N. (1990). *Bozner Geschichte am Straßenrand*. Bolzano/Bozen, Italy: Athesia.

Raifer, I. (2005). *Die Entstehung der Sparkassenstraße in Bozen*. Austria: Innsbruck.

Experimentation of a Smart-Planning Approach for the Sustainable Renewal of the Building Heritage of Smaller Sardinian Historic Centers

Stefano Pili

Abstract The contribution discusses the results of an experiment on smart-planning approach configured as a territorial observatory. The definition of a methodological approach for an observatory for sustainable regeneration of the building heritage of Sardinian Historical Centers (HC) is the main target of the research work. The observatory aims to support the Local Administrations (LA), mainly of the small communities characterized by a lack of resources, in designing, assessing and monitoring policies and actions, providing a tool to build shared knowledge for stakeholders. The general framework of the observatory is consistent with the drawing process of the Detailed Plans of the Historic Centers—DPHC—(Piani Particolareggiati del Centro Storico—PPCS). It is configured as a multi-customer Web-GIS portal that encompasses a set of multidisciplinary indicators based on Open GeoData and baseline DPHC knowledge, combined with the Voluntary Geographic Information (VGI) derived from the feedback of the portal users. Thanks to recent funding for the DPHC, some extraordinarily detailed studies on the historical building heritage are now available, characterized by a certain uniformity that can be an excellent baseline data to identify a shared set of indicators. The definition of a dynamic, multidisciplinary and multi-scalar set of indicators is one of the key issues of the research work. Such set should be consistent with the local development strategies and with the specific regulatory context. The set of indicators outlines a “BASE Scenario” that could be adopted for the monitoring of the effectiveness of the plan and for the creation and assessment of several scenarios. The spatial structure of the indicators is formulated to embrace several levels of detail: aggregated indicators could be used for HC benchmarking and more detailed indicators could be a useful resource for designing scenarios and monitoring the plan. After a short presentation of the observatory framework, the paper focuses on the indicators and methodologies adopted for the energy efficiency and use of the building heritage. The energy-efficiency indicators are mainly

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calculated by a GIS procedure that is capable of performing Standard calculations (UNI 11300: 2014) for each building using the DPHC baseline data. The indicators about the use of the building are a synthesis of the results of a questionnaire survey addressed to the inhabitants of the historic centers. Finally, the paper reports the results of an experiment carried out on a Sardinian center. The experiment identifies some critical points and potentialities about the adopted energy-efficiency indicators and about the observatory's general framework that will be the base for further developments.

Keywords Territorial observatory · Historic centre detailed plan
Heritage building · Energy efficiency

1 Introduction

SMART Planning or SMART Governance approaches use open data and geographic information produced in land-administration processes to implement tools that could help in drawing scenarios and developing strategies and their implementation. This paper is a result of an ongoing research, it aims at defining and testing a Territorial Observatory (Farinós 2011) that, adopting some appropriate spatial indicators for representing the actual condition, could be a SMART planning tool for supporting the implementation of recovery and enhancement policies of the Historical Centres (HC), especially those oriented to energy-efficiency improvement.

Tools and methodologies based on a more or less complex set of indicators have a key role in supporting the enhancement of an historic city (Girard 2013; Rosales 2011). The indicators could be used to support the early design phases by comparing the scenarios of various projects, to monitor the actual state of some urban qualities or to support the implementation of a specific project or action. The values measured by the indicators could be related to various issues (urban resilience or sustainability, environmental and landscape qualities, cultural heritage protection and valorization, energy efficiency etc.) (Braulio-Gonzalo et al. 2015; Hiremath et al. 2013). Some methodologies are developed within the contexts of important cultural heritages (such as UNESCO cities) (Losasso and D'Ambrosio 2014); it is therefore highly unlikely that these methodologies can be directly transferred to other contexts that are different in terms of the importance and the characteristics of the heritage, system of laws and social expectations, as one would probably find in the smaller HCs. Others methodologies are based on a set of indicators with a more general structure in order to support the benchmarking of various contexts (Kılkıs 2015), but sometimes they are not properly addressed for the priorities of local communities with limited data availability and resources. Recent experience in the field of environmental certification protocols (GBC LEED; ITACA; CASBEE; BREEAM) measure a number of qualities relevant to the "sustainability" of buildings, neighborhoods or districts, via hierarchical systems of multidisciplinary indicators and indices that are a reference for the benchmarking of various different contexts (Sharifi and Murayama 2014). Procedures could require the calculation of many indicators but are structured to produce a few brief labels of sustainability that are also aimed at promoting communication with non-technical audiences. The research work aims to define a smart planning tool based on a set of hierarchical and multidisciplinary indicators (Gregorio and Seixas 2017; Mascarenhas et al. 2010) consistent with the availability of local baseline data and directly related to the local development strategies and planning instruments that focus on landscape enhancement and the re-use of the building heritage of the HCs.

2 Methodology

The methodological approach is adaptable to various contexts, but the algorithms and procedures are specifically studied to be integrated with the drafting process of the Detailed Plans of the Historic Centers (DPHC), which is an instrument that is coming into quite common use nowadays in the Autonomous Region of Sardinia (RAS). The RAS has developed an extensive Spatial Data Infrastructure (SDI),[1] precise guidelines for the DPHC drafting and some comprehensive reference manuals.[2] For that reason, one can actually find available some extraordinarily detailed studies on the historical building heritage, characterized by a certain uniformity, which can be excellent baseline data to identify a shared set of indicators. The DPHC guideline requires the definition of a number of characteristics of the built heritage (landscape value, structures, materials, conservations, use etc.) for each building of the HC and requires the study of the tangible and intangible values of the context by defining some spatial elements (HC margins, scenes, squares, alleys, cultural and architectural goods etc).

The observatory concept (Fig. 1) is a multi-user Web-GIS portal that contains geographic information (maps) and other documentation (reports, graphs, statistics etc.) that can be defined as a "Territorial Observatory." A set of multi-scalar and multidisciplinary indicators defines the "Base Scenario" that represents and measures the values of the HC, helping to generate a process of information sharing and creation between the Local Administration (LA) and various stakeholders (building owners, companies, practitioners, researchers etc.). The research also focuses on the design of interfaces capable of collecting and arranging the voluntary information feedback—Volunteer Geographic Information (VGI) specific for the various players involved in the planning process. This flow of data could be used to dynamically update the "BASE Scenario" or to create new knowledge (Fig. 1).

The "BASE scenario" is summarized by specific algorithms and qualitative procedures that use official SDIs and the background knowledge from the DPHC as

[1]www.sardegnageoportale.it.

[2]http://www.sardegnaterritorio.it/urbanistica/pianiparticolareggiati.html.

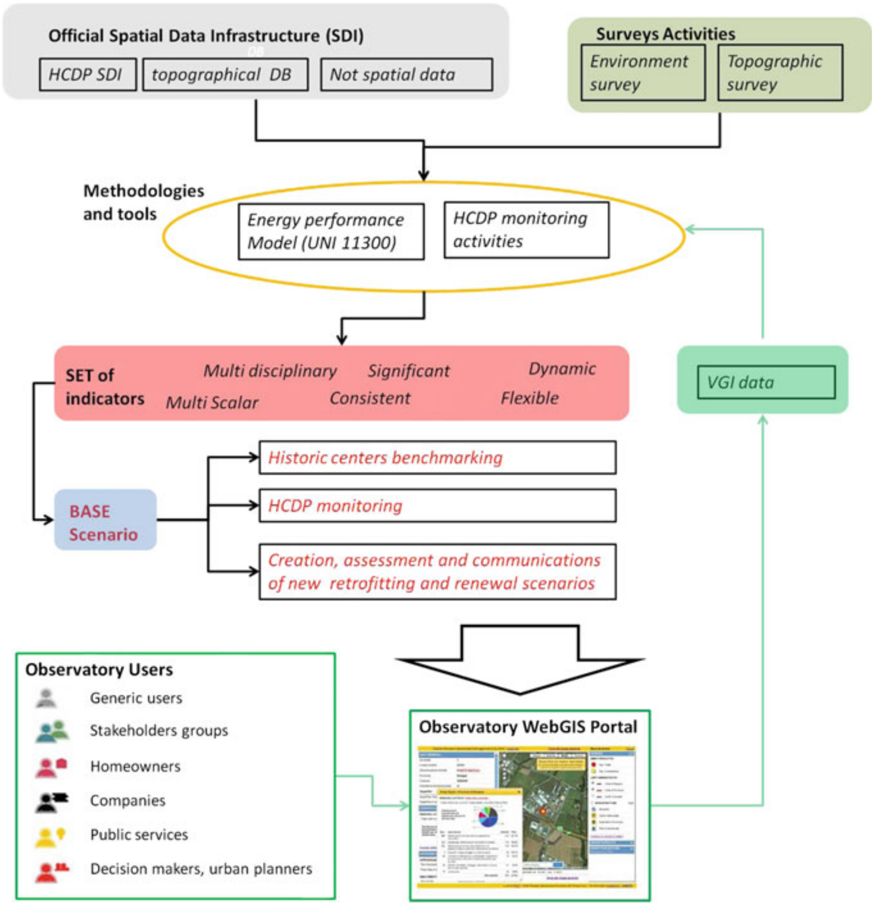

Fig. 1 Framework of the Observatory. *Source* author elaboration

baseline data. The spatial representation is structured on three scale levels: single-building scale, HC scale, and territorial scale.

The single-building scale is the maximum spatial detail of the data, and it could be used as: base data for the design of alternative scenarios; baseline information for the interface setting for homeowners, spatial detail for updating the indicator values.

At the HC scale, the “BASE scenario” is represented by the average value of a set of significant indicators. This representation aims to support local authorities in the DPHC monitoring activities and in the assessment and communication of the design strategies.

The territorial scale represents the “BASE scenario” through a number of aggregated or summary indices. This representation could be a shared methodology for the benchmarking of Sardinian HCs aimed at the dissemination of the best practices and the definition of territorial-development policies.

The indicators of the observatory consider various values of the historic center (HC importance, urban landscape quality, building landscape quality, sustainability etc.), but this paper focuses on the results of the experimentation of the indicators related to energy efficiency and to the use of the built heritage.

2.1 Energy-Performance Indicators

The adoption of a GIS-based hybrid analytical model (Swan and Urgursal 2009), for the synthesis of a number of aggregated indicators about the energy performance of the heritage, is one of the innovative aspects of the research work. The model can perform calculations that are consistent with the standard procedure for the Energy Performance Certification (EPC)[3] at the scale of the single building (Pili 2013). The value obtained for each building can be aggregated spatially at the HC level in order to calculate the indicators. A number hypothetic energy-performance indicators related to various aspects have also been defined (Table 1): envelope, technical installations and actual use. The envelope parameters could be calculated, adopting as baseline data the knowledge that is commonly developed for the DPHC: building geometries (i.e., external surfaces, facade azimuth direction and shading) can be obtained from topographic DB and the thermal characteristics of the buildings are defined through a typological approach based on an analysis carried out using the background studies of the DPHC.

The calculation of the energy performance requires data about the HVAC technical installations and data on the profiles of energy consumption that are not, generally, present on the background knowledge studies of the DPHC. In the conception phase of the methodology, data should be obtained by customized, eco-feedback (Jain et al. 2011) interfaces that are incorporated within the observatory; but, in our experimentation, we used a questionnaire which was submitted directly to the residents of the HC.

In the most common situations, the energy performance indicators of technical installations and of the actual CO_2 emissions, cannot be calculated for each building or Real Estate Unit (REU), because it would require an onerous survey activity, even if it is performed during the drafting of the DPHC. For the HC scale, these indicators are calculated as average values and stats based on the voluntarily acquired data. The benchmarking between the HCs should be based on Global Primary Energy from non-renewable sources (PEgl, nr) and on Greenhouse Gas emissions calculated from the consumption data. These parameters summarize the building energy performance in a few values and should become common knowledge for technicians and ordinary citizens.

[3]UNI ISO 11300 TS 2014 (Italian specification of EU Standard) and DL 192/2006 and following amendments.

Table 1 Indicators for energy performance.

Envelope	Envelope-plant system	Actual use
Average U value	Average seasonal efficiency of heating systems	Actual CO_2 emission/inha
Solar gain in winter season/m^2	Average seasonal efficiency of cooling systems	Yearly operative cost of the units
Solar gain in summer season/m^2	Average efficiency of DHW production	
Winter neat energy need/m^2	Yearly global Primary energy/m^{2}[a]	
Summer neat energy need/m^2	Yearly theoretical CO_2 emission/m^2	

[a]It is the main parameter for the Energy Performance Certificate labeling: The EPgl, nren (kWh/m^2) parameter from Dl. 26/06/2015 (Requisiti minimi/APE)
Source Author's elaboration

2.2 Indicators of the Building Use

In the concept of the observatory, the indicators related to the use of the building heritage should be completely based on VGI data obtained from the feedback interface dedicated to the residents of the HC. The feedback interface about the building use could concern the following issues: intensity of use (presence, heating volume, HVAC use profile); apartment conservation; indoor thermal comfort (winter–summer); willingness to invest. Some indicators at the HC scale could be summarized (Table 2) from the feedback data and could be adopted to benchmark the various HCs via a simple comparison or via the definition of an aggregate multi-criteria index. In our experiment, this data was obtained using a questionnaire addressed to the inhabitants of the HC.

2.3 The Experiment's Approach

The experiment concerned the Municipality of Assolo (Prov. Oristano, Sardinia, Italy). It is a small Sardinian rural community (about 500 inhab. and 1303° days.)

Table 2 Indicators for the use of buildings.

Intensity of use (presence)	Indoor comfort	Willingness of investment
No. of apartments permanently used/total no. of apartments	No. of apartments with at least "average" winter comfort/total apartments	No. of apartments with a scheduled investment/total no. of apartments
	No. of apartments with at least an "average" summer comfort/total apartments	

Source Author's elaboration

which is involved in the DPHC design process. The main targets of the experiment can be summarized in three points:

- calculate the energy-performance indicators in order to test the algorithms and the base data;
- present the research work to the local community in order to test the significance of the observatory approach and of the indicators;
- implement a questionnaire survey addressed to the inhabitants of the HC in order to simulate the contents of the observatory feedback interfaces.

The background knowledge of the DPHC has been used as input data for the analytical model of the energy performance. The observatory framework and purpose and a number of preliminary results of the calculation of the indicators was presented to the local community during a public event. During the following weeks, two questionnaires were submitted: one for the HC general user, which concerns the perception of the environmental and architectural quality of public space, including a number of possible enhancement strategies; the other, for the HC residents which concerns information about the Real Estate Unit (REU). This paper presents a summary of the results of the questionnaire addressed to the residents of the HC that has been used to obtain data on the HVAC technical installations and to profile the use of the building (energy consumption, presence, indoor comfort, willingness to invest, etc).

3 Results

3.1 Calculation of the Energy-Performance Indicators

The envelope-performance indicators can be represented on a map and summarized on graphs and with statistics (Fig. 2), the others indicators require VGI data on HVAC technical installations. The background spatial knowledge of the DPHC, concerning typologies and building structures (roofs, walls, windows etc.), was used to define various abacuses of the thermal characteristics of materials (Table 3) and to perform the calculation of the envelope performance for each building (Fig. 2). This spatially referenced data on building structures could be used to make statistics useful for the definition of strategies for energy retrofitting and heritage renovation. In our experiment, the most common wall structure is a mixed type combining the traditional stone wall with some recent superimpositions.

Fig. 2 Some results of the envelope analysis. *Source* author's elaboration

Table 3 Sample of the thermal characteristics of wall structures.

Wall typologies	U value (W/m^2 k)	Heat bridge incidence (%)	Thick
Traditional wall: irregular stone masonry	1.8	0.05	0.7
Traditional wall: adobe masonry	0.8	0.15	0.6
Traditional wall: stone masonry	2	0.15	0.45
Traditional wall: mixed stone–adobe	1.4	0.15	0.6
Brick masonry/Concrete block masonry	1/1.6	0.1/0.15	0.35/0.35
Mixed wall: stone–brick masonry–others	1.9	0.2	0.6
Concrete structure and light/heavy bricks	1.2/1.9	0.2/0.2	0.25/0.35
Post 2005 wall	0.38	0.05	0.35

Source Author's elaboration

3.2 Presentation and Questionnaire Results

The research work was presented to the local community in the Environmental Education Center of Assolo, where about 35 people, a mix of technicians and citizens, were present. The audience appreciated the multi-dimensional and multi-scalar structure of the indicators of the observatory. However the high number of values and indicators analyzed[4] was criticized because they make the

[4]We calculated about 60 indicators for all the values of the observatory.

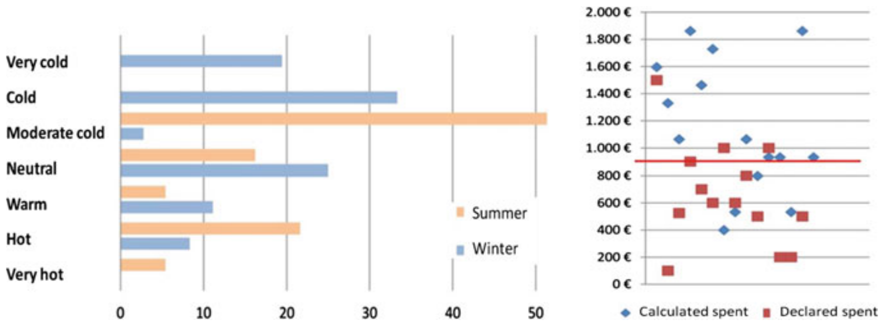

Fig. 3 Some questionnaire results: indoor comfort and operative cost. *Source* Author's elaboration

observatory consultation confusing. Some technicians from the neighboring municipalities suggested that we focus more closely on the indicators concerning the implementation of the DPHC, leaving out the indicators on the environmental issues.

The built heritage is characterized by a high number of unused or temporally used REUs, mainly for short summer holidays (46%): 43 questionnaires were completed, constituting responses on more than 50% of the used buildings. The preponderance of the REUs (70%) was considered in good state of conservation (21% quite good, 9% poor). This question mainly referred to indoor finishings and to electrical and water systems. In the winter season, more than 50% of the sample declared poor indoor comfort (cold, very cold). Thanks to the high thermal inertia of the massive stone walls, in the summer season, good indoor comfort prevailed (moderately cool) (Fig. 3). We must point out that many of the positive answers should be carefully considered, because the majority of the REUs is inhabited by just one resident who, often, only uses the most comfortable rooms and abandons the other spaces of the house for the whole season. The typical example is the traditional attic that is abandoned during the summer period, due to overheating by the sun, while the only room used is the kitchen, and therefore the only one to be heated during winter. About 50% of the sample had made at least one refurbishment during the past 20 years, and about 40% of the sample wants to perform renovation works in the next five years. Often, renovation works involve the roof (about 35%), and a significant share of the REU (about 25%) had the interior completely renovated. These renovations never involved the HVAC technical installations: fireplaces remains the only heating system. Likewise, about 45% of the sample wants to refurbish the roof in order to fix water infiltration issues or improve the summer comfort in the upper floors. No one has in mind a heating system improvement, but 25% of the sample thinks about general indoor refurbishment.

The majority of the REUs uses the fireplace as the sole heating system (72%), and 26% combines it with technical heating installations (mainly traditional boilers with radiators) that are generally used for a few hours during the night as an integrative heating system for the bedrooms. Cooling systems are basically not present or generally not used, due to the good summer comfort. Almost the whole sample adopts an electrical boiler for the production of Domestic Hot Water (DHW). The fireplace seems to also have an important social function: the elder residents often gather in small groups in the more comfortable houses, or where young relatives are, and spend all day looking after the fire.

The heating energy consumption is almost totally based on local wood, the DHW production affects the energy consumption and the other energy expenses are negligible (less than 5%). The wood consumption and the operative cost for the heating were not simple to detect: in fact, the shape of the fireplace, wood quality, indoor temperature and room dimensions often have a significant influence. The interviewed homeowners couldn't give a precise answer because they generally don't have bills or a fixed price for wood. They gave an average grossly estimate of a typical seasonal expense for heating, by adopting various measure units or indicating a lump sum. An average operational heating cost of 900 EUR was defined by adopting an empirical methodology to compare various different measures (Fig. 3).[5] In any case, this average data shows a high variance with some very low expenses because many homeowners own plots of land and fields and, if they can, they provide their own supply of wood.

4 Discussion: Learned Lesson

The experiment was made in partnership with the practitioners in charge for the DPHC planners; so the spatial DB of the background knowledge of the plan has been developed by taking into account the data required for the model and the other observatory indicators. The indicators can be summarized using common geo-processing algorithms without generating further burden for the ordinary analysis and survey activities for the designing process of the DPHC. In order to facilitate the use of the model for the energy performance calculation, a GIS toolbox has been implemented.

One of the most interesting results of the experiment is the reconsideration of the VGI role in the methodology of the observatory: the target community is composed mainly of elderly people with a low level of schooling who are unlikely to be able to use any sort of web-based interface. It was not therefore possible to proceed with an autonomous compilation of the questionnaire: the survey campaign was carried out through interviews conducted by a technician and supported by an "expert of the place", who facilitated the creation of the trust relationship with the interviewed person. The interviewed homeowners answered readily about the indoor comfort or about the renovation expectations, but, for the more technical questions (envelope renovation, technical installations, consumptions etc.), they needed the support of

[5] 1 m^3 of wood = 7 quintals; 1 cargo trainer of wood = 30 quintals; 18,50 EUR per quintal.

the interviewer. This is a critical point for developing a HC-resident targeted interface aimed to collect the feedback on building characteristics that are useful for the dynamic update of the values of the indicators. It could maybe be more appropriate to adopt a practitioner-oriented interface that asks for such information within the building permission process. The HC-resident feedback interface could be more useful for educational purposes, preferences and expectation studies.

The energy-efficiency indicators calculated by the model have also a number of critical aspects. They were considered "too technical and complex" by the parties concerned (even by technicians), but the most important aspect is that their relevance seemed to be limited in relation to the context characteristics. In agreement with the standard purposes, the main focus of these indicators is to promote efficiency improvements for the reduction of GHG emissions. In our case, due to the widespread use of local biomass, the GHG emissions are very low, while the priority is clearly represented by the improvement of indoor comfort during the winter period. In addition, the standard calculation considers as "heated volume" all the building's residential volume, but generally only the kitchen is heated; so the estimation of the Primary Energy indices is also very far from the actual conditions of use. The main problem in our context is that the fireplace has a very low seasonal average efficiency (20–30%), which brings the operating costs to 800–900 EUR per year. In our climate, the cost can be compared to the yearly expense incurred for an apartment of 80 m^2, built during the 1970–1980s with a traditional boiler and radiator heating system fuelled by GAS. Moreover, homeowners don't consider that the fireplace-heating system is a source of indoor pollution such as PAH and particulate matter. The design strategy is to improve winter indoor comfort while maintaining the operating costs through the installation of biomass boilers or stoves (possibly integrated with the fireplace) at to improve conditions in the parts of the REU that are actually used (kitchen and a bedrooms), generating a high increase in the seasonal average efficiency. The energy model could be used to calculate the values of the indicators generated by various design solutions, and the spatial structure of the information could facilitate the representation and communication with the local stakeholders.

The survey doesn't collect enough data to produce a reliable estimation of the actual GHG emissions. Although residents had been warned previously, the search for documents and bills (electric, wood gas etc.) is very time-consuming for an expeditious survey such as the one that can be carried out during the project phase. The HC benchmarking can't use data on final use and has to be established by adopting only performance indicators such as the PEgl, nr coupled with some index of seasonal average efficiency (winter and summer) in order to better represent the characteristics of the context.

5 Conclusion

A methodological approach and a number set of indicators was developed and tested on a Sardinian local community. The experiment shows that the background knowledge of the DPHC could be an effective baseline data to define the indicators relevant to the envelope energy performance but, in order to calculate the other indicators, we need more data about the HVAC technical installations and the use profile of the building heritage. The specificity of the HC inhabitants underlines that the feedback interfaces, outlined during the concept phase of the methodology, can't be used to obtain all the missing data; so more appropriate indicators and a different approach to involve local citizens must be defined.

Taking to account the critical aspects that surfaced in the Assolo experiment, more case studies that involve others municipalities are under development. These further studies focus mainly on the following issues:

- study of a more appropriate set of indicators by testing other municipality contexts;
- the experiment on a new methodology to involve local citizens and obtain the missing data that could be a mix of web-based interfaces and personal interviews;
- tests the use of the GIS model and the indicators to support the definition and representation of retrofitting strategies;
- experiment on an effective procedure for the comparison of the various historical centers.

References

Braulio-Gonzalo, M., Bovea, M. D., & Ruá, M. J. (2015). Sustainability on the urban scale: Proposal of a structure of indicators for the Spanish context. *Environmental Impact Assessment Review, 53*(2015), 16–30. https://doi.org/10.1016/j.eiar.2015.03.002.

BREEAM documentations, http://www.breeam.com/technical-standards.

CASBEE documentations, http://www.ibec.or.jp/CASBEE/english/index.htm#.

Farinós, J. (2011). Inteligencia territorial para la planificación y la gobernanza democráticas: los observatorios de los territorios., in Proyección, revista periódica digital. Publicación del Instituto CIFOT, Universidad de Cuyo, Mendoza, Argentina.

GBC LEED documentations, http://www.gbcitalia.org/.

Girard, L. F. (2013). The cultural base of cities for improving their resilience, creativity and sustainability. In T. Coletta (a cura di.), *The role of the integrated conservation of cultural heritage for a creative, resilient and sustainable city, ACTA of the ICOMOS-CIVVH symposium, Naples 2012* (pp. 17–24). Milano Italy: Franco Angeli.

Gregorio, V., & Seixas, J. (2017). Energy savings potential in urban rehabilitation: A spatial-Based methodology applied to historic centres. *Energy and Buildings, 152,* 1123. DOI:http://dx.doi.org/doi:10.1016/j.enbuild.2017.06.024.

Hiremath, R. B., Balachandra, P., Kumar, B., Bansode, S. S., & Murali, J. (2013). Indicator-based urban sustainability—A review. *Energy for Sustainable Development, 17,* 555–563. https://doi.org/10.1016/j.esd.2013.08.004.

ITACA documentations, http://www.itaca.org/valutazione_sostenibilita.asp.

Jain, R. K., Taylor, J. E., & Peschiera, G. (2011). Assessing eco-feedback interface usage and design to drive energy efficiency in buildings. In *Energy and Buildings* (Vol. 48, pp. 8–17).

Kılkıs, S. (2015). Composite index for benchmarking local energy systems of Mediterranean port cities. *Energy, 92,* 622–638. https://doi.org/10.1016/j.energy.2015.06.093.

Losasso, M.V., & D'Ambrosio, V. (2014). Progetto ambientale e riqualificazione dello spazio pubblico: il grande progetto per il centro storico di Napoli sito Unesco. *In TECHNE 07* (pp.64–74).

Mascarenhas, A., Coelho, P., Subtil, E., & Ramos, T. B. (2010). The role of common local indicators in regional sustainability assessment. *Ecological Indicators, 10,* 646–656. https://doi.org/10.1016/j.ecolind.2009.11.003.

Pili, S. (2013). Defining a methodology to integrate energy savings and renewal processes in the urban planning: a case study in the Italian context. In *Proceeding of the 13th International Multidisciplinary Scientific GeoConference—& EXPO SGEM2013*. https://doi.org/10.5593/sgem_geoconference.

Rosales, N. (2011). Towards the modeling of sustainability into urban planning: Using indicators to build sustainable cities. In *International conference on green buildings and sustainable cities procedia engineering 21* (pp. 641–647). https://doi.org/10.1016/j.proeng.2011.11.2060.

Sharifi, A., & Murayama, A. (2014). Neighborhood sustainability assessment in action: Cross-evaluation of three assessment systems and their cases from the US, the UK, and Japan. *Building and Environment, 72*(2014), 243–258. https://doi.org/10.1016/j.buildenv.2013.11.006.

Swan, L. G., & Urgursal, V. I. (2009). Modeling of end use Energy consumption in the residential sector: A review of modelling techniques. *Renewable and Sustainable Energy Reviews, 13,* 1819–1835.

Assessing Urban System Vulnerabilities to Flooding to Improve Resilience and Adaptation in Spatial Planning

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Abstract Fluvial, pluvial and coastal flooding are the most frequent and costly natural hazard. Cities are social hubs and life in cities is reliant on a number of services and functions such as housing, healthcare, education and other key daily facilities. Urban flooding can cause significant disruption to these services and wider impacts on the population. These impacts may be short or long with a variably spatial scale: urban systems are spatially distributed and the nature of this can have significant effects on flood impacts. From an urban-planning perspective, measuring this disruption and its consequences is fundamental in order to develop more resilient cities. Whereas the assessment of physical vulnerabilities and direct damages is commonly addressed, new methodologies for assessing the systemic vulnerability and indirect damages at the urban scale are required. The proposed systemic approach recognizes the city as a collection of sub-systems or functional units (such as neighborhoods and suburbs), interconnected through the road network, providing key daily services to inhabitants (e.g., healthcare facilities, schools, food shops, leisure and cultural services). Each city is part of broader systems—which may or may not match administrative boundaries—and, as such, needs to be connected to its wider surroundings in a multi-scalar perspective. The systemic analysis, herein limited to residential households, is based on network-accessibility measures and evaluates the presence, the distribution among urban units and the redundancy of key daily services. Trying to spatially sketch the existence of systemic interdependences between neighborhoods, suburbs and municipalities, the proposed method highlights how urban systemic vulnerability spreads beyond the

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flooded areas. The aim is to understand which planning patterns and existing mixed-use developments are more flood resilient, thereby informing future urban development and regeneration projects. The methodology has been developed based on GIS and applied to an Italian municipality (Noale) in the metropolitan area of Venice, NE Italy.

Keywords Flood impact modeling · Urban systems · Systemic vulnerability Spatial planning · Adaptation

1 Introduction

Flooding from a wide range of sources is the most frequent and costly natural hazard (IPCC 2012). It is commonly accepted that flood risk is growing, as a consequence of both climatic and non-climatic factors (Ronco et al. 2014). Several studies state that most of this increase has to be attributed to non-climatic factors, showing that the majority of losses arise in urban areas (Jongman et al. 2012). As a consequence, the improvement of society's resilience or the reduction of its vulnerabilities is the main objective, as tackled by several papers and governmental policies (Djordjević et al. 2011; Thieken et al. 2014; DEFRA 2004; UNISDR 2004; EEA 2005; EC 2013).

As recently stated by De Moel et al. (2015), among the existing risk-assessment methods there is a clear need for information on indirect flood impacts—understanding how failures within a system can cascade through a system—and a critical need to improve the understanding of the effects of flooding on critical infrastructures and facilities, given their importance to society and economy. Others (Merz et al. 2010) highlighted the relevance of indirect damage—especially in large disasters—and the difficulty in their economic evaluation with the current methods. A new simple, quantitative, flood-impact assessment methodology—focused on the indirect impact produced by a flood over the functioning of an urban area as a whole—is then proposed.

2 Theoretical Framework

2.1 Flood Risk and Vulnerability Assessment

Risk assessment represents the necessary first step of any serious risk-reduction strategy. The classical formalization of the risk concept (as a function of hazard, exposure and vulnerability) is assumed. If hazard and exposure are straightforward concepts, a brief note about the more complex notion of vulnerability is required. Vulnerability is recognized as reflecting both fragility in the face of external stress (receptors' susceptibility) and the processes that deprive people of the means of coping, without incurring damaging losses (receptors' coping capacities and resilience) (UNISDR 2009; IPCC 2012). Systemic vulnerability and resilience are strongly related concepts: resilience, in fact, emerged as a way to understand how systems prepare for, respond to and recover from shocks (Zhou et al. 2010). Quoting the UNISDR (2012) definition, a flood-resilient city is assumed to "resist, absorb, accommodate to and recover from the effects of a flood hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic functions". On the contrary, urban-system vulnerability is here understood as the inability to continue providing efficient support for citizens' daily activities when some urban components have been flooded.

Systemic impacts are understood to mean how the direct losses caused by a hazard propagate within and between various systems, generating other losses beyond the hazard areas. A system refers in general to a set of elements interconnected and somehow organized, providing functions and outputs. They are usually approached through the characterization of their single, elementary units, the disclosure of their physical and functional interconnections and the definition of their boundaries (Viavattene et al. 2015). The spatial distribution of these elements defines the existing relationships, the uniqueness and the adaptability of the system.

2.2 *Urban System Theories*

Urban system theory was first developed by geographers and economists: in the 1930–40s, Christaller (1933) and Lösch (1940) developed the 'central place theory', conceiving of urban settlements in terms of a hierarchy, in which each place provides the majority of goods and services to be found in places lower down the hierarchy, plus an additional range of more specialized ones. Over time, emerging gaps between the model and real-world led to the theory almost being abandoned, but its essence evolved into the urban systems approach (Berry 1964; Pred 1977). Urban systems theory conceives of urban places as forming an interdependent hierarchy, the structure of which is determined by the spatial distribution of centers of production and consumption (e.g., factories, offices, shops, cultural and leisure activities) (Aiken et al. 1987). Being part of a system, each city interacts with the other centers on a similar level, but also cities at different levels are dependent upon one another (e.g., for specialized services and commodities). Improvements in transport and communications, together with "the blurring and rearticulation of urban territories" (Brenner and Schmid 2012), have extended the range of influence of urban centers: contemporary cities exist in a world of flows, linkages and connections, being relationally networked with other cities via transnational webs of capital, labor and communication infrastructures. Nowadays, the explosion of the city outwards from traditional spatial and theoretical frameworks makes it more difficult to model contemporary urban systems and their operation mode. Despite this, a method to assess how flood impacts spread within a city beyond the flooded areas will be developed. The articulation of urban areas—in fact—somehow determines the organizational pattern and the spatial distribution of urban functions, conditioning both the accessibility to facilities and inhabitants' adaptation capacities (Marinosci et al. 2015).

3 Assessing Systemic Flood Impacts Over Urban Areas

Urban areas are served by a wide variety of infrastructures providing the services of modern urban life. Their flood-induced impairment can be highly impactful, given that the gradual increase of interdependence between urban units has multiplied the effect of disturbances on systems across the scales (Finka and Kluvánková 2015). These infrastructures include—among others—utilities (power, water, telecommunications, etc.), transport services and public facilities; the proposed method addresses the last two elements. The aim is to focus on how direct flood impacts on public services and the road network may influence the system as a whole. As a result, the model provides a quantitative evaluation of the functional loss of each urban unit, precious information for spatial planners and decision makers to prioritize mitigation measures and foster adaptation strategies.

3.1 Literature Review

From a review of the literature, Penning-Rowsell et al. (2013) explored indirect losses to inhabitants' daily lives accrued through the flooding of transportation networks, utilities and public services (i.e., schools and hospitals). In their assessment, based on UK data, potential losses to the provision of public services are appraised in economic terms. Indirect losses generated by the flooding of schools, for instance, are assessed through the loss of parents' earnings due to the need to take time off to care for their children. They provide some methods to estimate indirect losses, but without analyzing the role of the spatial distribution of urban systems. Menoni et al. (2002) attempted to evaluate the systemic vulnerability of a territorial system (at the regional scale) by assessing lifeline failures due to earthquakes. Their model, focusing on a large number of indirect damages, aims to define where to engage in more detailed studies (such as towns and cities most affected). The study highlighted the need to quantify, through spatial analysis, the contribution of infrastructure (e.g., road networks) and structures (hospitals, industries, schools etc.) in a city system to support decision making regarding the type and location of mitigation interventions. Pascale et al. (2010) and Sdao et al. (2013) focused on the estimation of dependencies within an urban system in terms of physical damage and functional relationships between operative centers and industries at risk or roads and private buildings at risk, due to landslide or flood events. However, they did not analyze the spatial accessibility and operability relationships—based on path connections—within the urban system. Albano et al. (2014) developed a methodology based on GIS to estimate flood consequences on the urban scale with a model that estimates the degree of accessibility between strategic emergency structures and exposed receptors. The approach makes possible defining a hierarchy among various roads, but just in the emergency-management perspective and in the emergency phase.

3.2 The Proposed Assessment Method

This study tries to overcome the limitations of the approaches just discussed. The assessment is limited to the impacts suffered by the residential households of a given municipality, analyzing the spatial distribution of some facilities and their redundancy. It is based on GIS, essentially working on accessibility measures through road-network analysis. As highlighted by Lotfi and Koohsari (2009), the use of public facilities can be linked to accessibility, and thus residential proximity to facilities and services can be theorized as contributing to health and well-being. The practical importance of service distribution in urban areas is based on the need for services underpinning the viability of urban life (Erkip 1997), and the distribution of the benefits of consuming them is distance dependent (White 1979).

The proposed method has been applied in the municipality of Noale, a small town (16,000 inhab.) that is part of the Venice metropolitan area, whose area is characterized by a flat morphology and a significant exposure to fluvial and pluvial flood. Furthermore, Noale is part of one of the most well-known examples of Italian urban sprawl (Indovina 1990; Fregolent and Tonin 2010), possessing high urbanization rates and a complex system of functional interdependencies with the surrounding urban areas.

The following main steps have been addressed for modeling urban systems:

- Defining and classifying urban units: urban areas are recognized as a collection of sub-systems or units (e.g., urban centers, suburbs, villages). Since the most detailed information on population is at the census-tract level, census tracts are assumed as reference units; furthermore, given that Italian census tracts are grouped in localities (ISTAT 1992, 2012) according to their physical and socioeconomic features, this classification is used as a basis for the identification and demarcation of the urban units within the case-study area.
- Defining urban system boundaries: each unit is home to its inhabitants, whose demand for services cannot be usually satisfied within the same unit. In order to tackle the daily-life dynamics of citizens, the scale of analysis is widened beyond the municipal boundary, using data on work-commuting flows to contain the wider urban system where inhabitants seek the various types of services. Across many socioeconomic issues—in fact—the labor market is the most crucial domain within which the life chances of people are shaped, representing their geography of opportunity (Coombes et al. 2012).

- Defining the key daily services: the service equipment of each urban unit determines its role within the system. Spatial-planning practices have traditionally addressed the issue through a careful allocation of public services, implicitly assuming that the public provision of services is beneficial to residents' well-being (Witten et al. 2003). Through a literature review mainly related to spatial equity issues (Tsou et al. 2005; Lotfi and Koohsari 2009; Taleai et al. 2014), recurrent categories of basic facilities have been identified. These same categories largely correspond with those set by the Italian town-planning legislation. Despite a great variety of facility types that can be included in these broad categories, the focus has been kept on really essential daily facilities, grouped into four main categories (see Table 1).
- Measuring accessibility in normal conditions: Accessibility is commonly defined as the ease with which activities can be reached from a certain place and with a certain transport system (Morris et al. 1979; Johnston et al. 2000). Several alternative measures of accessibility can be used, including the consideration of various transport modes, the issue of multipurpose travels etc.; in this study, these complicating factors are ignored, using simple road-distance metrics. Furthermore, several methods (or indices) to measure accessibility can be used (Talen and Anselin 1998): a travel-cost approach has been chosen, averaging only the closest facilities (stopping at the first natural discontinuity in their distance ranking).[1] Accessibility values (in meters) to each type of facility are hence calculated and assigned to each urban unit.
- Measuring accessibility in case of flood: To this extent, the flood-hazard scenario can be added and the distance calculation repeated, at first excluding both flooded services and roads (thus representing the flooding phase)[2] and after excluding only flooded services (thus trying to mimic the recovery phase and implicitly assuming a faster recovery capacity for roads than for services).[3] The new accessibility values (in meters) to each type of facility for both flooding phases are calculated and assigned to each urban unit.
- Defining an impact-scoring method: The flood-induced impacts suffered by the inhabitants of each urban unit are finally calculated through a scoring method

[1]Travel-cost indexes measure the mean distance between each unit and all facilities, thus assuming citizens travel anywhere to visit any facility regardless distances. Since this assumption is unrealistic, the previously mentioned rule was introduced, reflecting the fact that households are likely to use the closest facilities. In practical terms, once the distance records of all facilities from each urban unit are sorted in ascending order, if the distance between two consecutive facilities increases more than half compared to the previous value, the farthest of the two and the following facilities must be ignored.

[2]Distances increase because residents have to travel both longer alternative routes to access the usual facilities and longer itineraries for replacing the flooded ones.

[3]Distances increase only because of the longer routes to be travelled for reaching alternative facilities.

Table 1 The 12 types of basic daily facilities (and their weights) as identified by the authors (Sect. 3.2, 3rd bullet point)

Category	Facility type	Category weights	Facility weights	Overall weights
Health	Hospital	0.35	0.50	0.175
	Pharmacy		0.30	0.105
	General practitioner's surgery		0.20	0.070
Education	Nursery	0.25	0.30	0.075
	Primary school		0.30	0.075
	Secondary school		0.20	0.050
	High school		0.20	0.050
Material needs	Food shop & supermarket	0.30	0.30	0.090
	Post office		0.20	0.060
	Bus and train stations		0.50	0.150
Social life	Square	0.10	0.60	0.060
	Playground & sport field		0.40	0.040

based on the relative change between the accessibility values in case of flood compared to those in normal conditions ($[X_{flooded}-X_{normal}]/X_{normal}$).[4] In this way, the increased distances between units and services in the two flooding phases are used to indirectly map the existence of interdependencies among the various urban units, as well as their different degrees of vulnerability.

- Weighting each facility type by means of multicriteria analysis techniques: In doing so, each urban unit gets a single accessibility (or impact) value in each phase, representing its overall situation with respect to all types of services; an hypothetical weights distribution is shown in Table 1.
- Multiplying urban-units' impact scores by their population (used as exposure factor), thus achieving a realistic representation of the risk.

[4]Accessibility values obtained during the two flooding phases were compared with those in normal conditions, both in absolute and relative terms. The relative change ratio (0 = no increase; 1 = doubled distance; etc.) has been preferred: it can be assumed that inhabitants are used to travel certain distances according to their location within the system. As a result, a distance increase of 1000 m is not a big issue for citizens accustomed to live far from all services, while it can be a real problem for those used to have all facilities within 500 m. However, relative change values have been capped at one, thus fixing an upper-impact threshold. In other words, if the worsening of the accessibility value of a unit is equal to or greater than double the 'normal-condition' value, the maximum impact score is assigned. In fact, once the access paths have changed and trips prolonged (leading perhaps to transport-mode shifts), it is no longer the additional distance to be travelled that worsens the impact.

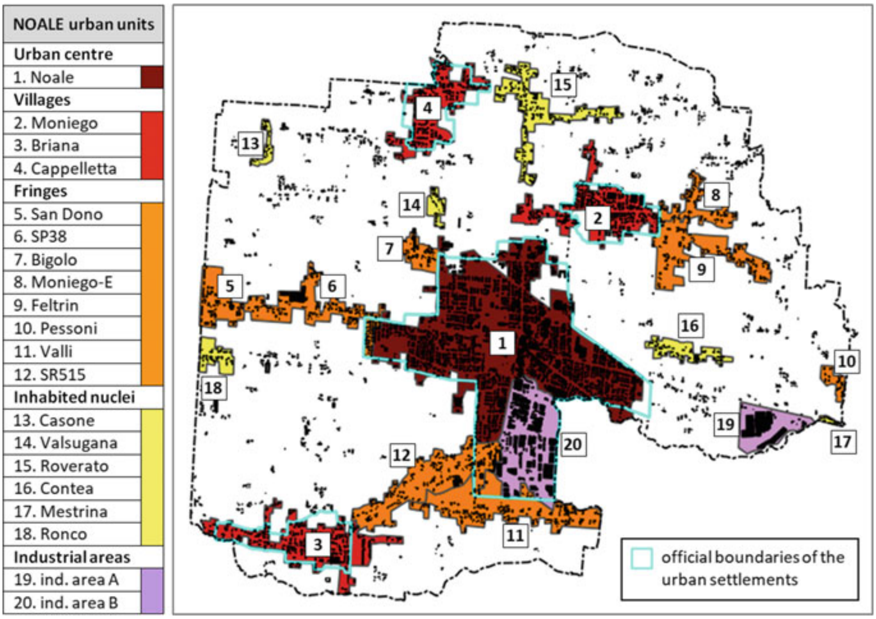

Fig. 1 The urban units of Noale municipality, classified in the five locality types

3.3 The Implementation in the Case-Study Area

The case-study area is the Italian municipality of Noale, part of the Venice metropolitan area.

For the definition of Noale urban units, the ISTAT (2012) classification of census tracts in localities, the layer with the official boundaries of the main settlements of Noale (provided by city officials) and some basic photo-interpretation techniques have been used. Five types of urban units—for a total of 20 units—were identified (see Fig. 1):

- the urban center (Noale), i.e., the main clustered settlement characterized by a compact building fabric, several squares and street, and a wide range of urban services;
- the villages (Moniego, Briana, Cappelletta) that are the minor clustered settlements, physically separated from the urban center, and typically equipped with a parish and few local services;
- the rural-urban fringes, identified as those linear settlements extending along the main roads and physically adjacent to a clustered settlement, usually not containing any service;

- the inhabited nuclei, made up of a few grouped buildings that do not generate any socioeconomic attraction on the surroundings and do not host any public space or service;
- the industrial areas, recognizable by the typical shapes, sizes and geometries of industrial buildings, and randomly serviced by some types of facilities (especially commercial ones).

For the definition of the urban system of Noale, a subset of eleven municipalities—all belonging to the local labor-market area of Venice (ISTAT 2015)—have been chosen on the basis of commuting data.[5]

For the identification and localization of the existing services and facilities, a field survey was carried out; however, much of the geo-localization work has been done remotely using free web directory lists, public authority websites and web applications (i.e., Google Maps and Google Street View).

For obtaining accessibility values in normal conditions, distances have been measured based on the road network by means of a shortest-path algorithm applied between the centroid of each urban unit (thus assuming residents as homogeneously distributed inside each unit) and the exact location of each facility. To this purpose, the centroid of each urban unit and each facility node-point was associated with a road-network node; the road network of the whole urban system was hence built within a GIS environment as a graph. In the case-study area, the road-network graph was primarily built with official data provided by the regional spatial data repository (IDT),[6] later edited and refined—especially within the Noale municipality—in order to add all the missing minor roads necessary to connect all the node-points of the urban units and services (see Fig. 2).

At this point, the method was applied in two different flood-hazard scenarios: one stemming from the main river network (the river flood, as modeled and mapped by the Eastern Alps river-basin district authority) and the other originating from local drains and channels (the pluvial flood, obtained by working with the extent of the historical events occurred in the last 20 years as recorded by the local land-reclamation authority). The two flood layers have been separately overlaid on the road-network graph and to the service-point shapefile; through simple spatial-analysis techniques, the exposure of road segments and service points has been detected (see Fig. 3). Edges and nodes of the road graph have been considered affected if intersecting any hazard area (regardless of both flood-water depths and structural features of roads); the same has been done for services. As a result, each facility has been assumed as affected if touched by any hazard area, and this information (i.e., flooded/not flooded) has been encoded in the attribute tables of all shapefiles, for both scenarios.

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[5]Commuting flows are freely available at http://gisportal.istat.it/bt.flussi/.

[6]http://idt.regione.veneto.it/app/metacatalog/—c0107024-Grafo strade, extracted on municipal base.

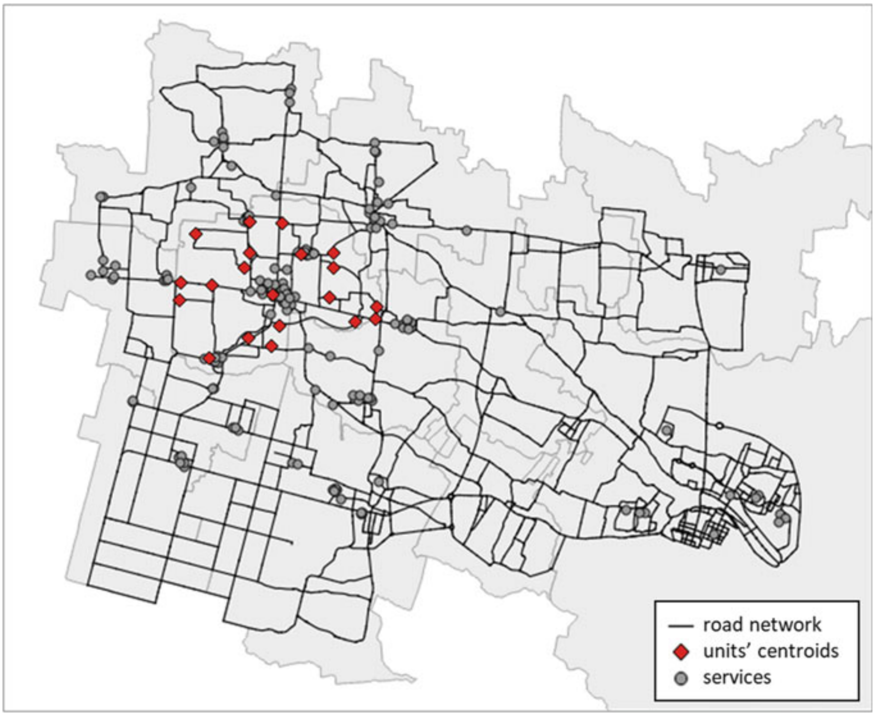

Fig. 2 The road network and the 131 facilities identified within the wider urban system (made up of eleven municipalities), together with the centroids of the 20 urban units of Noale municipality

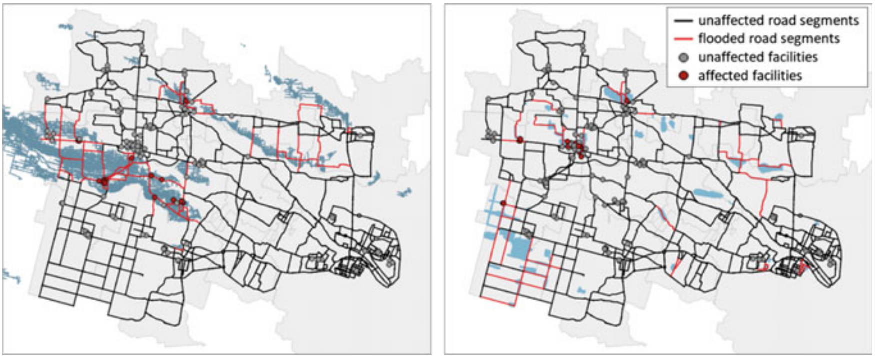

Fig. 3 The two flood hazard scenarios (river flood [L], pluvial flood [R]) and the affected urban system elements

4 Results and Discussion

The first hazard scenario affects 17 facilities, while the second one 18. Despite their spatial extents being very different, the two flood scenarios are comparable in terms of affected facilities. This is the first important lesson to be learned: flood potential effects can never be judged by the spatial extent of the flooding. Furthermore, through a spatial visualization of the impact scores (see Fig. 4), it emerges that Noale would suffer greater impacts and more problems for the functioning of the city as a whole from the pluvial flooding than from the river one. The first flood scenario mainly strikes suburban areas (the village of Briana, some southern fringes and the main industrial area), leaving them with no access. Being a wide flood, it affects several roads and produces a negative impact on all urban units. However, the impact suffered outside the flood areas is limited, except for some eastern localities (being closer to the adjacent urban center than to Noale, the impacts they suffer come from there). Once flood waters have receded, impacts too are greatly reduced. The worst scores remain inside the affected units, being particularly high in Briana (the village); many units do not even suffer from any inconvenience, except again for some peripheral units that suffer the flooding accrued outside Noale. The second flood scenario is much less extensive, but affects Noale's urban center. As a result, almost all units suffer significant impacts, except for a few eastern settlements.[7] Even if small, the flooded areas cause the interruption of some main roads, again producing negative impacts on all units. However, the increase in distances due to road-network disruption is not decisive, given that higher impact scores persist after flood-water withdrawal. All units experience trouble during the recovery phase: the major impacts remain inside Noale (and its adjacent industrial area); the urban fringes of the town center and its nearest inhabited nuclei suffer more than the three villages and the farthest inhabited nuclei. The only exception is a western urban fringe, whose medium-high impact score is due to the partial flooding of the urban fabric of the adjacent municipality.

Judging from the case-study evidence, urban centers and villages seem to be the most vulnerable unit types, whereas urban fringes and peripheral nuclei show less vulnerability. Having based the systemic vulnerability appraisal on service accessibility and having measured flood disruption in relative terms (compared to normal conditions), there is no doubt that in clustered urban settlements—where the majority of services are located—people are prone to suffer substantial levels of disruption given their high accessibility levels, whereas in fringe and scattered units—being already relatively far from any facility—residents are less sensitive to a flood-induced increase in the distance to be travelled to access facilities. However,

[7]As already said, and in line with the previous findings, these neighborhoods are quite dependent on adjacent municipalities (Scorzé and Robegano), thus being less sensitive to what happens in Noale.

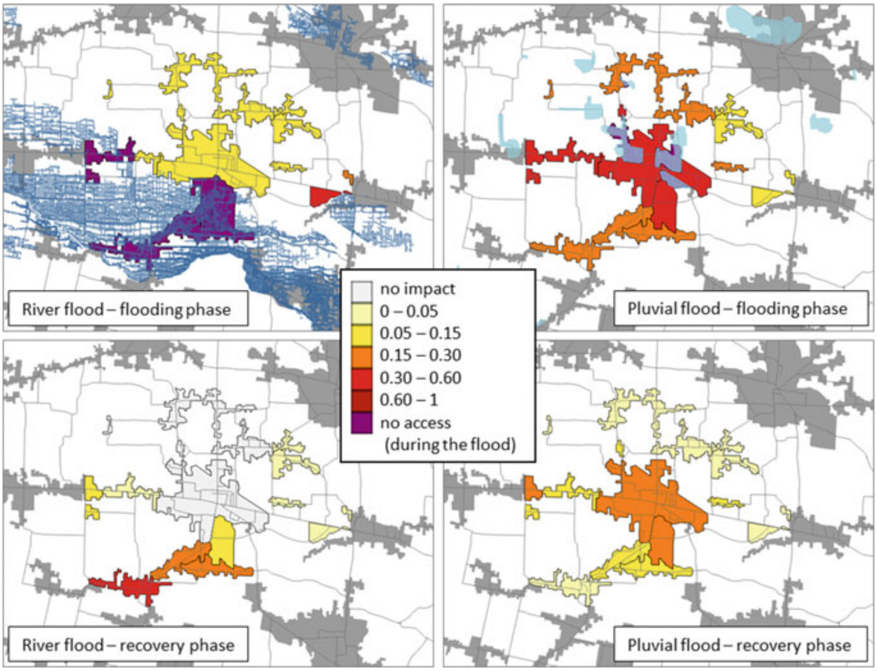

Fig. 4 A spatial visualization of the impact scores suffered by Noale urban units in both flood scenarios and phases

on closer inspection, their resiliency is only apparent and is the result of poor accessibility to all services. More than being resilient or non-vulnerable, these types of settlements can be defined as non-sensitive. Good evidence of this can be found in their radical change of response if, hypothetically, a new facility is located close to one of them: following the method assumptions, their behavior would suddenly become similar to that of urban center and villages, showing the highest vulnerability rate. As a result, it can be deduced that increasing the number of services anywhere is not the right choice: increasing their redundancy, instead, is an efficient strategy, thus ensuring the inhabitants the opportunity to find many alternatives for replacing flooded facilities. But given the real-world constraints (e.g., resource scarcity, scale economies, the need for adequate demand etc.), a full and redundant range of services cannot be achieved everywhere. Municipal authorities should then support the concentration of services in the main residential areas, where some facilities already exist, pushing for the creation of one or more cores in the provision of services.

5 Conclusion

Resilience thinking is becoming an important way for city planners to manage flood risks (Hammond et al. 2015); hence they need to assess and understand flood impacts—even the indirect ones—at the local level in order to build (and retrofit) flood-resilient cities. As highlighted by Musco (2012), adaptation actions need a strictly urban and extremely localized approach: there are no one-size-fits-all policies, given that adaptation is a complex mechanism based on local peculiarities. Despite many efforts to determine vulnerability, there is little agreement about what is the most appropriate scale, level of (dis-) aggregation, functional relationship and trade-off between its various constituents (Mysiak et al. 2013).

Assuming a multi-scalar and multidisciplinary approach, a quantitative method has been created to measure the systemic vulnerability of the urban fabric on the municipal level. Its main strength lies in the originality of the proposed approach: as far as it is known, it is the first time that urban system theories have been applied to depict citywide indirect flood impacts. On the other hand, many limitations affect the proposed method, such as: the assumption of service accessibility as the main indicator to depict indirect impacts on the urban scale; the lack of validation in a strict quantitative sense, given the lack of historical flood-damage records in the case-study area; and the lack of sensitivity analyses on the methodological choices assumed throughout the assessment steps. As a consequence, even if the proposed method has been developed in accordance with the literature, expert opinions and semi-structured interviews with local stakeholders, caution should be applied to interpretation of the results. Further research developments should address the robustness of the method and evaluate how results would differ if the previous methodological steps are changed. At the same time, further research is needed to reinforce the main findings of the work. The unresponsiveness to urban disruption of scattered and peripheral settlements, for example, should be further investigated in other territorial areas in order to verify its causes (is it a general feature of all inhabited nuclei or an outcome of the sprawling nature of the case-study area?). Furthermore, large towns and cities—having a full and redundant range of services—should exhibit a more resilient response, thus reversing the previous vulnerability ranking of urban units. Further research in different urban areas is required to prove this hypothesis.

However, from the evidence gained in the case-study area, Noale officials should pursue the following strategies for reducing the flood risk in their municipality:

- to invest in protection measures in the urban center (in order to reduce flood likelihood), given that it hosts most of the existing facilities used by the inhabitants of the wider urban area;
- to reduce the physical vulnerability of the buildings containing flood-prone facilities through retrofitting projects, thus ensuring a quick recovery of the system. This strategy should be followed in Briana, where an increase in service redundancy (thus reducing its systemic vulnerability) would be unwise given the high exposure to river flooding of this area;

- to increase service redundancy within the main residential areas. Two alternatives may be considered here: if the pluvial-flood hazard affecting the urban center can be reduced, the first option should be to increase the number of facilities (and the future urban growth) within the urban core; otherwise, the best solution is to increase service redundancy within the village of Moniego, thus creating a second urban core, complementary to (and not far from) the main one, where the inhabitants of both units might find nearby alternative facilities in case of a flood.

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References

Aiken, M., Newton, K., Land, R. F., & Martinotti, G. (1987). Urban systems theory and urban policy: a four-nation comparison. *British Journal of Political Science, 17*(3), 341–358.

Albano, R., Sole, A., Adamowski, J., & Mancusi, L. (2014). A GIS-based model to estimate flood consequences and the degree of accessibility and operability of strategic emergency response structures in urban areas. *Natural Hazards and Earth Systems Sciences, 14,* 2847–2865.

Berry, B. (1964). Cities as systems within systems of cities. *Papers of the Regional Science Association, 13*(1), 147–163.

Brenner, N., & Schmid, C. (2012). Planetary urbanisation. In M. Gandy (Ed.), *Urban Constellations* (pp. 10–13). Berlin: Jovis.

Christaller, W. (1933). *Die Zentralen Orte in Suddeutscland* (L. W) Jena: Fischer. (1966) English translation by L. W. Baskin, Central places in Southern Germany. Englewood Cliffs, NJ: Prentice Hall.

Coombes, M., Casado-Diaz, J. M., Martinez-Bernabeu, L., & Carausu, F. (2012). *Study on comparable Labour Market Areas—Final Research Report*. Eurostat. http://www.istat.it/it/files/2014/12/Final-Report_LMA-v1-0-17102012.pdf Accessed October 21, 2017.

De Moel, H., Jongman, B., Kreibich, H., Merz, B., Penning-Rowsell, E., & Ward, P. J. (2015). *Flood risk assessments at different spatial scales*. Mitig: Adapt. Strateg. Glob. Change. https://doi.org/10.1007/s11027-015-9654-z.

DEFRA. (2004). *Making space for water: developing a new government strategy for flood and coastal erosion risk management in England*. Food and Rural Affairs, London: Department for Environment.

Djordjević, S., Butler, D., Gourbesville, P., Mark, O., & Pasche, E. (2011). New policies to deal with climate change and other drivers impacting on resilience to flooding in urban areas: the CORFU approach. *Environmental Science & Policy, 14,* 864–873.

EC. (2013). *An EU strategy on adaptation to climate change (COM 216 final)*. Brussels: European Commission.

EEA. (2005). *Vulnerability and adaptation to climate change in Europe* (EEA Report No. 7/2005). European Environmental Agency, Copenhagen.

Erkip, F. (1997). The distribution of urban public services: the case of parks and recreational services in Ankara. *Cities, 14*(6), 353–361.

Finka, M., & Kluvánková, T. (2015). Managing complexity of urban systems: A polycentric approach. *Land Use Policy, 42,* 602–608.

Fregolent, L., & Tonin, S. (2010). The cost of sprawl: an Italian case study. In *XXXI Conferenza Italiana di Scienze Regionali, 20–22 September 2010*. Aosta: Tamil Nadu.

Hammond, M. J., Chen, A. S., Djordjević, S., Butler, D., & Mark, O. (2015). Urban flood impact assessment: a state-of-the-art review. *Urban Water Journal, 12,* 14–29.

Indovina, F. (1990). *La città diffusa*. Quaderno DAEST n. 1, Università IUAV di Venezia, Venice.

IPCC. (2012). *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change*. Cambridge and New York: Cambridge University Press.

ISTAT. (1992). *Anagrafe della popolazione: legge e regolamento anagrafico—Avvertenze, note illustrative e normativa AIRE*. Istituto Nazionale di Statistica, Metodi e Norme, serie B, n. 29, Roma.

ISTAT. (2012). *Descrizione dei dati geografici e delle variabili censuarie per sezione di censimento—Anni 1991, 2001, 2011*. Roma: Istituto Nazionale di Statistica.

ISTAT. (2015). *La nuova geografia dei sistemi locali*. Roma: Istituto Nazionale di Statistica.

Johnston, R. J., Gregory, D., Pratt, G., & Watts, M. (2000). *The dictionary of human geography*. Oxford: Blackwell Publishing.

Jongman, B., Kreibich, H., Apel, H., Barredo, J. I., Bates, P. D., Feyen, L., et al. (2012). Comparative flood damage model assessment: towards a European approach. *Natural Hazards and Earth Systems Sciences, 12*(12), 3733–3752.

Lösch, A. (1940). *Die Raeumliche Ordnung der Wirtschaft*. Jena: Fischer. (1954) English translation by W. H. Woglom and W. F. Stolper, The economics of location. New Haven: Yale University Press.

Lotfi, S., & Koohsari, M. J. (2009). Measuring objective accessibility to neighbourhood facilities in the city—A case study: Zone 6 in Tehran, Iran. *Cities, 26,* 133–140.

Marinosci, I., Assennato, F., Luti, T., Munafò, M., Congedo, L., & Riitano, N. (2015). Forme di urbanizzazione e tipologia insediativa. In *Qualità dell'Ambiente Urbano—XI Rapporto ISPRA* (pp. 156–173).

Menoni, S., Pergalani, F., Boni, M. P., & Pertini, V. (2002). Lifelines earthquake vulnerability assessment: a systemic approach. *Soil Dynamics and Earthquake Engineering, 22,* 9–12.

Merz, B., Kreibich, H., Schwarze, R., & Thieken, A. (2010). Assessment of economic flood damage (review article). *Natural Hazards and Earth Systems Sciences, 10,* 1697–1724.

Morris, J. M., Dumble, P. L., & Wigan, M. R. (1979). Accessibility indicators for transportation planning. *Transportation Research A., 13,* 91–109.

Musco, F. (2012). I piani clima, nuovi strumenti per la pianificazione locale: dalla mitigazione all'adattamento. In S. Verones & B. Zanon (Eds.), *Energia e pianificazione urbanistica. Verso un'integrazione delle politiche urbane*. Milano: FrancoAngeli.

Mysiak, J., Testella, F., Bonaiuto, M., Carrus, G., De Dominicis, S., Ganucci Cancellieri, U., et al. (2013). Flood risk management in Italy: challenges and opportunities for the implementation of the EU Floods Directive (2007/60/EC). *Natural Hazards and Earth Systems Sciences, 13,* 2883–2890.

Pascale, S., Sdao, F., & Sole, A. (2010). A model for assessing the systemic vulnerability in landslide prone areas. *Natural Hazards and Earth Systems Sciences, 10,* 1575–1590.

Penning-Rowsell, E., Priest, S., Parker, D., Morris, J., Tunstall, S., Viavattene, C., et al. (2013). *Flood and coastal erosion risk management: a manual for economic appraisal*. London: Routledge.

Pred, A. (1977). *City systems in advanced economies*. London: Hutchinson.

Ronco, P., Gallina, V., Torresan, S., Zabeo, A., Semenzin, E., Critto, A., et al. (2014). The KULTURisk regional risk assessment methodology for water-related natural hazards—Part 1: Physical–environmental assessment. *Hydrology and Earth System Sciences, 18,* 5399–5414.

Sdao, F., Albano, R., Sivertun, A., Sole, A., Pascale, F., & Giosa, L. (2013). Model of systemic vulnerability assessment in urbanized areas exposed to combined risk of landslide and flood. In G. Borruso, S. Bertazzon, A. Favretto, B. Murgante, & C. Torre (Eds.), *Geographic information analysis for sustainable development and economic planning: New technologies*. IGI Global: Hershey.

Taleai, M., Sliuzas, R., & Flacke, J. (2014). An integrated framework to evaluate the equity of urban public facilities using spatial multi-criteria analysis. *Cities, 40,* 56–69.

Talen, E., & Anselin, L. (1998). Assessing spatial equity: An evaluation of measures of accessibility to public playgrounds. *Environment and Planning A, 30,* 595–613.

Thieken, A. H., Mariani, S., Longfield, S., & Vanneuville, W. (2014). Preface: Flood resilient communities—managing the consequences of flooding. *Natural Hazards and Earth Systems Sciences, 14,* 33–39.

Tsou, K. W., Hung, Y. T., & Chang, Y. L. (2005). An accessibility-based integrated measure of relative spatial equity in urban public facilities. *Cities, 22,* 424–435.

UNISDR. (2004). *Living with risk*. Geneva: United Nations International Strategy for Disaster Reduction.

UNISDR. (2009). *UNISDR terminology on disaster risk reduction*. Geneva: United Nations International Strategy for Disaster Reduction Secretariat.

UNISDR. (2012). *Making cities resilient report: my city is getting ready—A global snapshot of how local governments reduce disaster risk* (2nd ed.). Geneva: United Nations International Strategy for Disaster Reduction Secretariat.

Viavattene, C., Micou, A. P., Owen, D., Priest, S., & Parker, D. (2015). *Coastal vulnerability indicator library*. Deliverable 2.2—FP7 EU Project RISC-KIT 603458.

White, A. N. (1979). Accessibility and public facility location. *Economic Geography, 55*(1), 18–35.

Witten, K., Exeter, D., & Field, A. (2003). The quality of urban environments: Mapping variation in access to community resources. *Urban Studies, 40,* 161–177.

Zhou, H., Wang, J., Wan, J., & Jia, H. (2010). Resilience to natural hazards: A geographic perspective. *Natural Hazards, 53,* 21–41.

Place-Based Policy-Making and Community Security: A Decision Support System for Integrated Planning of Urban Ecosystem Services and Disservices

Sandro Sacchelli, Sara Fabbrizzi, Francesco Geri and Marco Ciolli

Abstract The objective of the work is to implement a model based on Geographic Information System (GIS) to develop best-management strategies for urban trees. In the model, various objectives, such as the maximization of population security and the optimization of intervention on trees (i.e., economic improvement of Visual Tree Assessment and pruning operation), are considered. The Decision Support System (DSS) uses dynamic simulation able to take into account annual growth of single plants, as well as annual budgets devoted to green urban care by a local administration. The intervention priority concerning trees was based on a model that evaluates two opposing lines of services/disservices: the first is the potential value of single trees and green areas for recreational aspects based on a multicriteria approach to merge various indicators; the second is represented by the probability of falling trees and branches that can cause damage to people, vehicles and buildings, as well as other facilities. Cascine's Park in the city of Florence (Italy) was selected as study area. Results highlight the priority of intervention over a period of five years and their spatial distribution. The main strengths, as well as the weaknesses of the model, are also addressed in the paper. In particular, economic and managerial benefits in case of DSS' application are stressed.

Keywords Urban green management · Landscape perception · Trade-off evaluation · Complex system analysis · Economic planning

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1 Introduction

Urban trees can potentially improve the livability of cities via a range of positive externalities. On the other hand, several risks and costs are related to the presence of vegetation in urban areas. These negative impacts can affect both management practices at the administrative level and citizen's security and well-being. A literature review of scientific works indicates that the integrated evaluation of urban-tree ecosystem services and disservices is a recently treated issue. In addition, a lack of specific models and Decision Support Systems (DSS) capable of determining suitable actions for trade-off management among positive and negative impacts is highlighted.

The ecosystem-services concept that is defined as the direct and indirect benefits provided by ecosystems for human well-being (De Groot et al. 2010) makes it possible to respond to these criticalities, directing policies towards smart planning and sustainable management of cities (Griggs et al. 2013). Urban-ecosystems services improve resilience and the quality of life of the residents (Gómez-Baggethun and Barton 2013). Urban forests comprise one of the main suppliers of ecosystem services in urban areas (Dobbs et al. 2011). Such provided benefits are identified in the functions of: (i) provisioning (e.g., wood residues for bioenergy production; Sajdak et al. 2014); (ii) regulating, like climate mitigation (Escobedo et al. 2010) and drainage (Radford and James 2012); (iii) supporting, like habitat provision (Vogt et al. 2009); (iv) cultural, like recreation (Fuller et al. 2007); and (v) maintenance of natural heritage (Frank et al. 2006). Ecosystem disservices could be defined as "functions of ecosystems that are perceived as negative for human well-being" (Lyytimäki and Sipilä 2009, p. 311). Urban-ecosystem disservices can be exemplified by the pollen of plants that could provoke allergies (Dobbs et al. 2011); expansive green areas or non-illuminated parks perceived as unsafe (Douglas 2012); the costs to maintain green areas (Escobedo et al. 2011); and damage to people and infrastructure due to biological activity or meteorological events (Roy et al. 2012; Conway and Yip 2016); as well as abundances of unwanted species (pests and nuisance animals) (Azmy et al. 2016).

In the scientific literature, there is a knowledge gap about the interaction between urban-ecosystem services and disservices and respective trade-offs and synergies (Raudsepp-Hearne et al. 2010). The Millennium Ecosystem Assessment (2005) adopts an anthropocentric perspective to assess the above mentioned trade-offs. Therefore, the subjective perception of the effects of ecosystems, which might be positive for someone and negative for someone else, may cause social conflict (von Döhren and Haase 2015). The awareness of these conflicts leads to the adoption of participative approaches in order to incorporate citizens' perceptions and expectations (Fagerholm et al. 2012). Spatial multi-criteria analysis, based on Geographic Information System (GIS) techniques, has been adopted in many studies in order to integrate geographic data and stakeholders' perceptions, preferences and attitudes (Torabi Moghadam et al. 2016; Malczewski 2006).

Another challenge of urban-forest systems is the balance between the increasing demand for their benefits and the limited financial resources for their maintenance (Kirnbauer et al. 2009). In fact, important institutional failures regarding the preservation and the maintenance of urban tree are related to insufficient funds during a period of financial constraints on public policy (Kronenberg 2015).

To cope with the above limits, in this work an innovative DSS able to assess the trade-off between various urban trees functions was developed. The DSS enables integration of open data and expeditious image collection in open-source environments. To assess the model, one service as well as one disservice concerning urban trees were aggregated. The first considered recreational functions of green urban areas; the latter took into account potential risks due to tree instability. The aggregation of the above criteria and the introduction of economic constraints lead to a categorization of each tree into various classes of risk to establish overriding interventions (i.e., Visual Tree Assessment and pruning). Based on available annual budget, a program of multi-year plant management and planning was proposed. The model was developed using GIS software (GRASS GIS v.7; Neteler et al. 2012).

2 Materials and Methods

2.1 Study Area

The study area was selected in Cascine's Park, in the city of Florence (central Italy). This green space is, in fact, the largest urban park of the area, and it is representative of the general characteristics and conditions of the nation's. The park had been part of the estate of Medici family and mainly used as a game reserve and for bovine farming. In the course of the 19th century, the park became a public once it was acquired by the Florence Municipality in 1869.

The geospatial localization of single trees and specific characteristics of plants (i.e., diameter and species) have been collected and supplied as open data by Florence Municipality (Florence Municipality 2016). A total of about 7600 trees on an area of 130 ha were analyzed. They are categorized into 106 different species, mostly represented by European hackberry (*Celtis australis* L.), common lime (*Tilia x europaea* L.) and holm oak (*Quercus ilex* L.). The registered diameters range from a minimum of 0.01 m to a maximum of 1.95 m.

2.2 Recreational Function Suitability

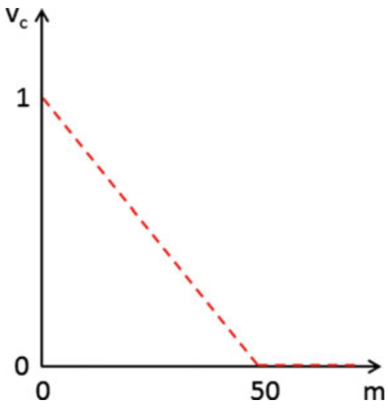
The suitability score for recreation was based on various criteria: (i) accessibility of the area due to density of main roads; (ii) presence of Place or Point of Interest (POI) such as monuments, cycle paths and recreation grounds; and (iii) aesthetic perception. Criteria (i) and (ii) were computed through a GIS-based distance modeling on maps derived from cartographic open data of the Florence Municipality service. Aesthetic value must take into account the holistic framework of the system and the affective aspects of public perception. Landscape perception was evaluated for a series of locations in the park to clearly exemplify the emotional aspect regarding urban green. Thirty face-to-face interviews were carried out among a stratified sample of potential visitors. The questionnaire defined general characteristics of interviewees, such as age, gender, and range of yearly income, as well as a residence category (urban center with more than 5000 inhabitants; urban center with less than 5000 inhabitants; urban sprawl; or scattered house). Respondents were asked to rate their perception on a seven-point Likert scale (Likert 1932). The random points were selected along internal roads of the park through the *v.random* module of GRASS GIS. For each random point, the aesthetic function was analyzed based on the Street View functionality of Google Map (Google 2016); the main difference between this approach and traditional photo-based, stated-preferences surveys is the interactive and 360° visualization. Average evaluations for each point were spatially interpolated through a kriging operation based on *v.surf.idw* module of GRASS GIS (for more details, please see Huang et al. 2011). Criteria (i), (ii) and (iii) were then normalized in the range 0–1 by means of fuzzy logic and linear functions (Chen and Hwang 1992; Fig. 1) to be merged by a raster-based, (1 m of resolution) spatial, multicriteria analysis (S-MCA) model.

S-MCA model can be represented as in Eq. 1.

$$\alpha_i = \frac{\sum_{c=1}^{C} v_{c,i}}{C} \tag{1}$$

where α_i is the score for recreational function in *i-th* pixel, c is the *c-th* indicator considered to compute recreational score, C is the total number of indicator and $v_{c,i}$ is the normalized value of the *c-th* indicator in *i-th* pixel.

Fig. 1 Normalization of recreational function criteria (distance from roads, monuments, cycle paths and recreation grounds)



The indicators *c* can be assumed as: (i) the distance from main roads; (ii) the distance from monuments, (iii) the distance from cycle paths, (iv) the distance from recreation grounds and (v) aesthetic perception.

2.3 Instability Analysis

The criteria associated to urban-tree disservices is the potential for tree instability. A literature review reveals a lack of model and methods to associate a stability index with a tree in an automatic way. Thus, a simplified approach has to be developed for use. In this sense, dimension and typology (species) of trees, as well as annual growth, were considered to compute a quantitative indicator related to single plant. Stability was considered as a dynamic variable, changing (decreasing) year by year. To compute that variation, a classification of trees in the fast and medium-slow class of increment was carried out. For each class, an annual yield—dependent on diameter at year *y-1*—was defined by basing it on data of Coder (1996). Also, in the case of this indicator, a linear normalization was applied to diameters to constrain the single-tree stability index in the range 0–1. Normalization was based on a *rescaling* technique by means of minimum and maximum values of the diameters for each year.

2.4 Risk Analysis and Intervention Planning

Normalized values of recreational function and potential tree instability were categorized in five classes (low, medium-low, medium, medium-high and high) by means of an equal-interval classification. A cross product defined the risk class ($R_{i,y}$) for each tree *i* in every year *y* (in our case from year 1 to year 5) (Fig. 2). The cross product represents a combination of all unique category values in the two maps of input (recreation and instability criteria). In Fig. 2, moving from low to high level of risk, the priority of intervention on each plant increases.

Intervention planning was determined by taking into account the annual financial budget of local authorities (source: masterplan for Florence urban green management,

		Potential tree instability				
		low	*medium-low*	*medium*	*medium-high*	*high*
Recreational function	*low*	**low**	**medium-low**	**medium-low**	**medium**	**medium**
	medium-low	**medium-low**	**medium-low**	**medium**	**medium**	**medium-high**
	medium	**medium-low**	**medium**	**medium**	**medium-high**	**medium-high**
	medium-high	**medium**	**medium**	**medium-high**	**medium-high**	**high**
	high	**medium**	**medium-high**	**medium-high**	**high**	**high**

Fig. 2 Risk classification of single tree from the cross product

parcodellecascine.comune.fi.it/export/sites/cascine/materiali/masterplan/gestione_del_verde.pdf), as well as the costs associated with the Visual Tree Assessment and pruning operation. These costs were derived from local price lists relevant to urban-tree maintenance. The costs are differentiated according to plant size. Scheduling of tree maintenance was eventually computed with an optimization procedure applied to risk class, according to Eq. 2.

$$\begin{aligned} & MAX(AR_y) \\ & s.t. \\ & I_{i,y} = binary \\ & \sum \omega_{i,y} < B_y \\ & if\ I_{i,y-x} = 1\ then\ I_{i,y} = 0 \end{aligned} \tag{2}$$

where AR_y is the avoided risk represented by intervention on trees at year *y-th*—in formula $AR_y = \sum (R_{i,y} \cdot I_{i,y})$—$I_{i,y}$ is a dummy variable representing the absence (0) or the presence (1) of intervention on tree *i-th* at year *y-th*, $\omega_{i,y}$ is the cost of intervention on *i-th* tree at year *y-th*, B_y is the budget early available for green care of the studied area (for the case study: 100,000 €/y); conditional statement [if… then] hypothesizes that if an intervention has been carried out in previous years *x* (i.e., at year 1 or 2 or 3 or 4) then no additional interventions are possible.

3 Results

The hypothesized input data yielded a total of 737 trees on which it is possible to carry out maintenance intervention in the 5-year period (Fig. 3). This number corresponds to 10% of the total number of trees in Cascine's Park. That limited percentage is mainly due to the low annual budget for plant management. The yearly distribution of intervention on trees is equal to 129 at year "1" and "2", 177 at year "3", 161 at year "4" and 141 at year "5". VTA and pruning in the 5-year period can improve the park's security with about a 15% risk reduction.

The distribution of trees per risk class and year is reported in Table 1. Per each year, a Gaussian distribution shifted to a lower class of risk is highlighted. A limited number of plants is depicted in the "High" category. Table 1 also highlights the moving of a tree to higher risk classes in subsequent years. This aspect strictly depends on the application of the dynamic model to quantify single increments.

Table 2 focuses on specie partition in respect to total intervention during the management period. Although the most frequent species are Celtis australis and Tilia x europea (see Sect. 2.1), several intervention are related to Quercus Ilex, probably because of its widespread localization close to areas with high recreational

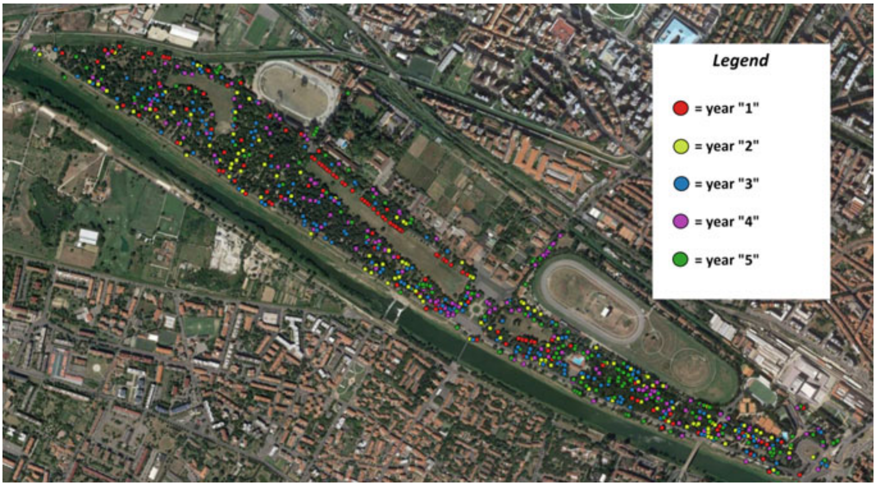


Fig. 3 Intervention planning for a 5-years period

Table 1 Number of trees per risk class and year

Risk class	Year 1	Year 2	Year 3	Year 4	Year 5
Low	1393	1360	1340	1303	1288
Medium-low	3598	3562	3536	3491	3473
Medium	2135	2190	2220	2288	2315
Medium-high	436	449	463	476	480
High	36	37	39	40	42

Table 2 Intervention characteristic per species

Species	Number of tree managed in the 5-year period	Average year of intervention
Quercus ilex	179	3.1
Celtis australis	163	3.1
Tilia × europaea	99	3.5
Platanus × acerifolia	88	1.9
Quercus pedunculata	57	2.8
Populus canescens	39	3.2
Ulmus minor	23	3.7
Pinus pinea	19	3.9
Cedrus atlantica	9	3.8
Ulmus (other species)	9	3.6

function. Platanus x acerifolia is the species with the higher priority of intervention because of: (i) the presence of tree lines close to roads and other facilities and (ii) relevant diameters generally associated to that species.

4 Discussion and Conclusion

One strength of the proposed DSS is the implementation on open-source software capable of analyses based on the mix-method. As matter of fact, different techniques can be merged in the model to lead to single-tree categorization. Spatial multicriteria analysis (S-MCA) facilitates the integration of data characterized by the various units of measure; the growth model improves dynamic analysis of output and the scheduling of intervention for a multi-year framework. The operational research approach (i.e., optimization procedure) allows for best practices implementation; the GIS tool promotes visualization of results to stimulate communication with stakeholders and focus group for participatory discussions of the output. A relevant positive outcome of the DSS with respect to available software and tools for urban-green analysis is the opportunity for prioritization of urban tree maintenance, taking into account planning and economic constraints. This aspect confronts the challenge of going beyond the traditional data collection and monitoring of trees. In fact, although several tools that make data entry of geospatial data easier for each tree are available (Boyer et al. 2016), a paucity of research involving data management is evident in the literature. The DDS application in this case study (Cascine's Park, Florence, Italy) highlights how best practices and interventions are strictly related to local conditions and budgets available to decision and policy-makers. However, the flexible internal structure of the model can be adapted to further study this area. Some improvements can be introduced in future analysis to update the model. First of all, a Graphical User Interface (GUI) can be developed. GUI will be crucial to make the model useful and available for various classes of users, with diverse backgrounds and skills. The GUI will be intuitive and will lead the user through the logical steps of the process. Evaluation of additional ecosystem services and disservices should be introduced to deal with the complex nature of urban green systems. Collaboration with specialists can enable handling the simplified version of the tree-instability sub-model. The cost of maintenance and intervention on single trees could take into account an in-depth analysis of spatial distribution and resulting scale-economies (e.g., for plants in rows or groups). The number of interviewees for assessment of scenic perception should be increased to go beyond the exploratory nature of the presented evaluation.

In conclusion, the introduction of suggested improvements in the DSS can make the model a valid tool to guide policy—as well as for decision makers in the management of public green areas in the framework of socioeconomic and environmental sustainability.

References

Azmy, M. M., Hosaka, T., & Numata, S. (2016). Responses of four hornet species to levels of urban greenness in Nagoya city, Japan: Implications for ecosystem disservices of urban green spaces. *Urban Forestry and Urban Greening, 18,* 117–125.

Boyer, D. J., Roman, L. A., Henning, J. G., McFarland, M., Dentice, D., Low, S. C., et al. (2016). *Data management for urban tree monitoring—Software requirements*. Azavea, Philadelphia, PA. 124 p. Available online at http://azavea.com/research/urban-tree-monitoring/.

Chen, S. J., & Hwang, C. L. (1992). *Fuzzy multiple attribute decision making: Methods and applications*. Berlin: Springer.

Coder, K. D. (1996). *Tree growth rate table: Annual percentage growth*. Accessed at: https://urbanforestrysouth.org/resources/library/citations/tree-growth-rate-table-annual-percentage-growth [07/10/2016].

Conway, T. M., & Yip, V. (2016). Assessing residents' reactions to urban forest disservices: A case study of a major storm event. *Landscape and Urban Planning, 153,* 1–10.

De Groot, R. S., Alkemade, R., Braat, L., Hein, L., & Willemen, L. (2010). Challenges in integrating the concept of ecosystem services and goods indicators. *Journal of Ecological Complexity, 7,* 260–272.

Dobbs, C., Escobedo, F., & Zipperer, W. (2011). A framework for developing urban forest ecosystem services and goods indicators. *Landscape and Urban Planning, 99,* 196–206.

Douglas, I. (2012). Urban ecology and urban ecosystems: Understanding the links to human health and well-being. *Current Opinion in Environmental Sustainability, 4,* 385–392.

Escobedo, F. J., Kroeger, T., & Wagner, J. (2011). Urban forests and pollution mitigation: Analyzing ecosystems services and disservices. *Environmental Pollution, 159,* 2027–2087.

Escobedo, F. J., Varela, S., Zhao, M., Wagner, J., & Zipperer, W. (2010). Analyzing the efficacy of subtropical urban forests in offsetting carbon emissions from cities. *Environmental Science & Policy, 13*(5), 362–372.

Fagerholm, N., Käyhkö, N., Ndumbaro, F., & Khamis, M. (2012). Community stakeholders' knowledge in landscape assessments-mapping indicators for landscape services. *Ecological Indicators, 18,* 421–433.

Florence Municipality. (2016). *Open data of Florence municipality*. Available online at: http://opendata.comune.fi.it/index.html.

Frank, S., Waters, G., Beer, R., & May, P. (2006). An analysis of the street tree population of greater Melbourne at the beginning of the 21st century. *Arboriculture and Urban Forestry, 32*(4), 155–163.

Fuller, R. A., Irvine, K. N., Devine-Wright, P., Warren, P. H., & Gaston, K. J. (2007). Psychological benefits of greenspace increase with biodiversity. *Biology Letters, 3*(4), 390–394.

Gómez-Baggethun, E., & Barton, D. N. (2013). Classifying and valuing ecosystem services for urban planning. *Ecological Economics, 86,* 235–245.

Google. (2016). *Street view service*. Available online at: http://maps.google.it.

Griggs, D., Stafford-Smith, M., Gaffney, O., Rockström, J., Ohman, M. C., Shymsundar, P., et al. (2013). Policy: sustainable development goals for people and planet. *Nature, 495,* 305–307.

Huang, F., Liu, D., Tan, X., Wang, J., & He, B. (2011). Explorations of the implementation of a parallel IDW interpolation algorithm in a Linux cluster-based parallel GIS. *Computers & Geosciences, 37*(4), 426–434.

Kirnbauer, M. C., Kenney, W. A., Churchill, C. J., & Baetz, B. W. (2009). A prototype decision support system for sustainable urban tree planting programs. *Urban Forestry and Urban Greening, 8,* 3–19.

Kronenberg, J. (2015). Why not to green city? Institutional barriers to preventing urban ecosystem services. *Ecosystem Services, 12,* 218–227.

Likert, R. (1932). A technique for the measurement of attitudes. *Archives of Psychology, 140,* 1–55.

Lyytimäki, J., & Sipilä, M. (2009). Hopping on one leg—The challenge of ecosystem disservices for urban green management. *Urban Forestry and Urban Greening, 8,* 309–315.

Malczewski, J. (2006). GIS-based multicriteria decision analysis: A survey of the literature. *International Journal of Geographical Information Science, 20,* 703–726.

Millennium Ecosystem Assessment. (2005). *Ecosystems and human well being: Current state and trends*. Washington, DC: World Resources Institute.

Neteler, M., Bowman, M. H., Landa, M., & Metz, M. (2012). GRASS GIS: A multi-purpose open source GIS. *Environmental Modelling and Software, 31,* 124–130.

Radford, K. G., & James, P. (2012). Changes in the value of ecosystem services along a rural-urban gradient: A case study of Greater Manchester, UK. *Landscape and Urban Planning, 109*(1), 117–127.

Raudsepp-Hearne, C., Peterson, G. D., & Bennett, E. M. (2010). Ecosystem service bundles for analysing tradeoffs in diverse landscapes. *Proceedings of the National Academy of Sciences, 107*(11), 5242–5247.

Roy, S., Byrne, J., & Pickering, C. (2012). A systematic quantitative review of urban tree benefits, costs and assessment methods across cities in different climatic zones. *Urban Forestry and Urban Greening, 11*(4), 351–363.

Sajdak, M., Velázquez-Martí, B., López-Cortés, I., Fernández-Sarría, A., & Estornell, J. (2014). Prediction models for estimating pruned biomass obtained from Platanus hispanica Münchh. Used for material surveys in urban forests. *Renewable Energy, 66,* 178–184.

Torabi Moghadam, S., Delmastro, C., Lombardi, P., & Corgnati, S. P. (2016). Towards a new integrated spatial decision support system in urban context. *Procedia Social and Behavioral Sciences, 223,* 974–981.

Vogt, P., Oudenhoven, A. P. E., Petz, K., Alkemade, R., Hein, R., & de Groot, R. S. (2009). Mapping functional connectivity. *Ecological Indicators, 9*(1), 64–71.

Von Döhren, P., & Haase, D. (2015). Ecosystem disservices research: A review of the state of art with a focus on cities. *Ecological Indicators, 52,* 490–497.

Integrated Planning Policies for the Ecological Territories and Ecocities: Implementation of a Smart Sustainable Approach

Stefano Aragona

Abstract The paper, which reports research started in 1987 and extending until the recent ERSA Congresses, about innovation and anthropization processes, focuses on the word *crisis*. This offers a chance to move from the industrial and mass town towards a more sustainable way of anthropization. Our wisdom—Sapienza is the name of the first University in Rome—must consist of considering local conditions, not as design constraints, but as suggestions for plans and projects: i.e., starting from the *place*, from geomorphologic elements, historical events etc., with the responsibility of all actors involved in the organization and physical structure of territory and towns. This concept developed by Settis in his Lectio Magistralis (L'etica del architetto e il restauro del paesaggio. University Mediterranea of Reggio Calabria, Reggio Calabria, 2014) for "Ad Honrem" Degree in Architecture, titled *The ethic of the architect and restoration of landscape* (L'etica dell'architetto e il restauro del paesaggio). He reminded us of Vitruvius' approach that today we call multidisciplinary, with the fundamental role played by context. It means overcoming the industrial paradigm—recalling metaphorically the word that Khun (The structure of scientific revolutions. Chicago University Press, Chicago, 1962) used for scientific revolutions —evolving over 350 years to built another developmental path. Calabria presents an important opportunity to propose novel territory based on man—nature alliance (E. Scandurra in L'ambiente dell'uomo. Verso il progetto della città sostenibile. Etas Libri, Milano, 1995): an unedited and unique landscape. This can be accomplished in harmony with the philosophy of *Smart city*, i.e., realizing local inclusive communities that are sustainable, both materially and socially. The paper illustrates this general picture, highlighting opportunities for a different scenario by referring to the Reggio Calabria Metropolitan case. It stresses the need for a "cultured technology" Del Nord (L'immaginario tecnologico metropolitano. Franco Angeli, Milano, 1991) to overcome the unsustainable development that was identified first in The Limits to Growth (Meadows D.H. Mondadori, 1972). Such a culture must be based on integrated planning, as required by the Leipzig Charter (2007)—but it seems forgotten—able to

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connect rural and not rural areas, small, medium, big towns and metropolitan areas. Moreover this requires diffusion of those fundamental elements to continue advocacy of an "ecological approach" based on knowledge of local conditions, both material and social. After a short introduction, the paper, using the "phenomenological" methodology, describes facts and provides scenarios and operative hypotheses.

Keywords Ecological approach · Integrated town planning · Crisis as opportunity

1 Introduction

The ways of anthropization undergirding the First Industrial Revolution are showing all their limits, and the publication of the *The Limits to Growth*[1] was an emblematic moment highlighting that fact. The scaled economy becomes the basic criteria in building the industrial city, alongside those that have always been among the formative elements of each associated settlement, i.e., agglomeration economies. The elements, however, are also of a broader and different nature, as Appold and Kasarda (1990) pointed out regarding *human ecology*.[2] In Italy, beginning with its unification, building has been one of the main economic engines, and it has become even more powerful since its industrialization. After the World War II, cities have continued to expand, whether legally or illegally. But the destruction of territorial structures accelerated in the mid-1970s, as the distinctive landscapes characterizing the "Land of 100 Campaniles" were lost in un undifferentiated sea of construction. In the South of Italy, this is all the more significant because of the lack of other economic activities. Industrialization of those areas, thanks to Casmez (National Agency to support industrial development of less developed areas), started but then stopped[3] for exogenous and endogenous reasons. Destruction of landscape must be stopped, and other development paths, compatible with an environmentally sustainable context and social equality, must be sought.[4]

[1]Book commissioned by the President of the Club of Rome at the MIT of Boston.

[2]The same word used in many pages of Encyclical *Laudato Sii* by Pope Francis, elaborated by a group of 40 scientists (2015: p. 5, 115, 118, 119, 120). It talks of integral ecology, i.e. economic, social and cultural, and also requires "Educate to Alliance between Humanity and Environment" (pp. 209–215), similar to man—nature alliance required by Scandurra, mentioned previously. Among its references this paper includes the *anthropocosmos model* by Doxiadis (1968) based on the relations between οίκος, environment, λόγος, analysis, and behavior.

[3]Many "remnants" of dismantled industrialized plants remain in these territories and also pose high environmental hazards.

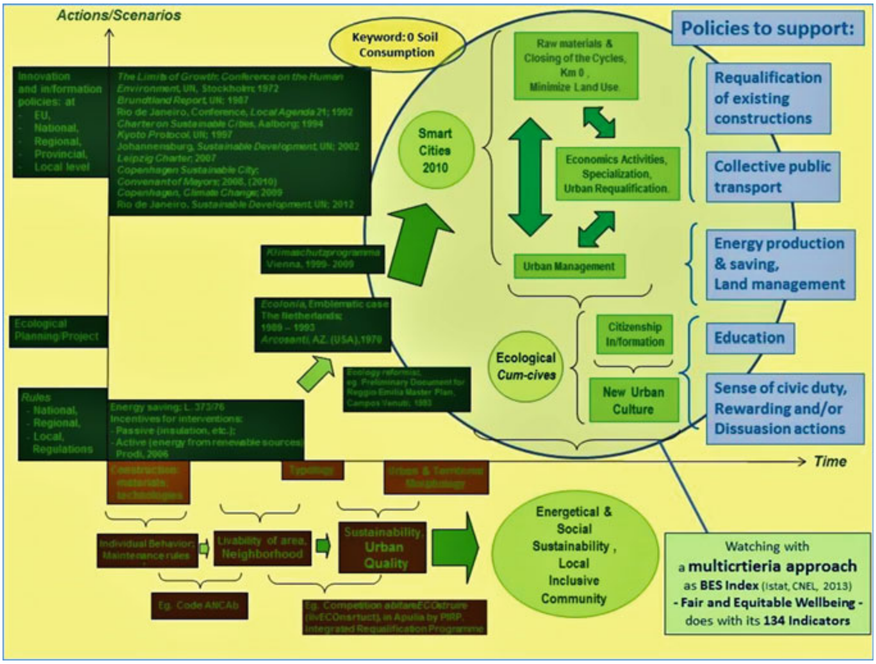
[4]This contribution continues a path started (1988) with participation in MPI research project INTRA *Technological Innovation and Territorial Transformations*, DipPiST, Fac. of Engineering, Naples, and in the programs (1989) *Technological innovation, territorial transformations and protection of the natural and anthropic environment* and *Technological innovation, territorial transformations*, Dep. TECA, Fac. of Engineering, Rome. Starting in 1987, with S. Macchi, we began to publish papers at AISRe Conferences about *Telematics and Territory*. Subsequent

Fig. 1 Devastated landscapes in the Metropolitan area of Reggio Calabria (*Source* S. Aragona)

Reggio Calabria, one of newly institutionalized metropolitan areas, is an emblematic case illustrating this challenge (Fig. 1).

Phenomenological thinking guides the study—considering local, natural, historical, and landscape resources—and suggests a possible, diverse, and very original ecological scenario. That scenario must be based on the idea of territory, city, and landscape, that contains the local social context (Barca 2010). This implies the importance given to environmental sustainability by the population: knowledge and awareness of the possibility/need for a different development path from that there pursued over the recent 40 years (Scheme 1).

research studies available in *La città virtuale: Trasformazioni urbane e nuove tecnologie della informazione* (The Virtual City: Urban Transformations and New Information Technologies 1993) and *Ambiente urbano e innovazione. La città globale tra identità locale e sostenibilità* (Urban Environment and Innovation. The Global City between Local Identity and Sustainability 2000).



Scheme 1 The overall ecological scheme (*Source* Aragona 2015a)

2 I Have a Town Planning Dream…, A Story to Be Resumed

Between beginning of the 18th century and 1861, the Bourbon Kings in Mongiana and Ferdinandea created industrial settlements[5] in which the iron extracted from the area of the Serre (VV) was utilized. The same iron was used to forge coins at Kroton, *Κρότων*, which had been founded by Achaean settlers in the second half of the 7th century BC. The Borbonia issued laws to protect local forests because wood was indispensable for the production ovens. An industrial port in Pizzo (VV), and an “ad hoc” road to reach more market areas and lower transport prices were built. All this, in today’s language, means creating local multipliers, synergies, based on use of local resources—iron and timber—safeguarding, with planning and management, a renewable resource, i.e., the trees. Moreover, the trees with tall trunks and with deep roots, served to diminish hydro-geological risk, in accord with the criterion of *naturalistic engineering* (Fig. 2).

[5]The Borbona, who erected San Leucio and the Royal Palace of Caserta, and sponsored many eminent innovators in science and technology, were at the forefront of productive and cultural innovation (Aragona 2012: cap. 1).

Fig. 2 The industrial plants in Mongiana (VV): the current state (left); the original (center); the geographical location (right) (*Source* Bivongi e Dintorni)

After 1861, the two new ovens were never inaugurated and, a few years later, the production infrastructures were decommissioned, while others sprouted in North Italy: it was the era of the great growth of UK industry that became major industrial competitor of the Bourbon State.[6] In this industrial area, there had been about 4000 employees, much more than the total of entire Sabaudo Kingdom at that time.

History contains yet another fascinating fact: modern ecological thinking originated in Calabria, between Cosenza, city of Bernardino Telesio, and Stilo (RC) from which his disciple Tommaso Campanella comes. The former wrote, from the mid 16th century—in more times—*De rerum natura juxta propria principia* (The nature of things according to their own principles). The latter wrote in 1602 *La città del sole* (The city of the sun): he went back to Platone (V century AC) and was strongly influenced by thinkers such as Thomas More with his *Utopia* of 1517, while the II edition (1623) *Civitas Solis idea republicae philosophica*, written in vulgar Florentine, edited in Freiburg, was coeval of *New Atlantis* written in 1624 and published in 1627 by F. Bacon. While Saint Francis of Paola created a monastic order, practically vegetarian, and the Certosa of Serra of Saints Stefano and Bruno in the Calabria Ulteriore—at the present the central-south part of Region (VV)—despite many destructive events, becomes well known in Europe[7] (Fig. 3).

With the beginning of the travels of education/exploration of the *Grand Tour,* in the 18th century, foreigners discovered wonderful landscapes,[8] to use that romantic term. The Flemish painter Escher, during his trip to the South in 1931, saw and

[6]It is not a mystery that the UK supported Garibaldi's adventure.

[7]Founded by Bruno of Cologne in 1091 as the Hermitage of Santa Maria di Turri or of the Wood, the church was consecrated solemnly on August 15, 1094, with Ruggero I of Calabria and Sicily present. During this occasion, the king extended the land donated to Bruno, by including further areas of Stilo and the farmhouses of Bivongi and Arunco, which, centuries later, became the sites of the iron industry. Often it was almost abandoned and many reconstructions had to be undertaken, especially due to earthquakes that struck Calabria.

[8]As well illustrated in the events (2015), by T. Manfredi, *Che bel Paese. Esplorazioni nell'Italia del sud sulle tracce della spedizione Saint-Non* (What a beautiful country, Explorations in Southern Italy on the traces of Saint-Not expedition) and *Old Calabria* by C. Malacrinò and A. Quattrocchi.

Fig. 3 Certosa of Serra Saints Stefano e Bruno (*Source* 3bmeteo.com)

drew many of them[9]: The fascination was so strong that he preferred Southern architecture, so rich with Arabian influences, in confront with the Renaissance or Baroque style that he also knew very well after the many visits to Italy.[10]

These historical/cultural riches are spread over a sparsely populated territory. Reggio Calabria, the most important town, has only about 185,000 inhabitants. So it is medium/small town on the Italian scale, even more so at the European level. Catanzaro, a region capital, does not have even 100,000 citizens, among the other provincial capital towns, Cosenza has about 70,000 residents and with nearby Rende only 104,000 inhabitants, Crotone 61,000 and Vibo Valentia 34,000. Lametia Terme is the other unique center which reaches 70,000 residents. There are just six centers between 35,000 and 20,000 inhabitants, seven between 18,000 and 15,000. All the remaining urban centres—i.e., just a little less 400 of the 409 total—have population below that figure, often amounting to only a few hundred residents. Such a territorial context would suggest the proposition of a landscape characterized by a strong historical-naturalistic value, based on protection and enhancement of local resources.

Reggio Calabria's metropolitan area, i.e., the 97 Municipalities of its Province, in this respect is a great opportunity to propose an "original" metropolitan city whose originality is based on cultural heritage, deriving from the ancient history of its territorial anthropization. And, thanks to the magnificent naturalistic resources, though strongly compromised, there are other important potentialities for building the above said characterization. In the meravilious Natural Park of the Aspromonte,

[9]Quoting one for all Tropea (VV), cover of the book *Costruire un senso del territorio* (Building a sense of territory) by Aragona (2012).

[10]See the video "*M.C. Escher e le visioni mediterranee*" (M.C. Escher and the Mediterranean Visions) by A. Fiorista, produced for the National Design Workshop *Idee e progetti per il recupero e la riqualificazione in aree minori e non nell'epoca della globalizzazione* (Ideas and projects for recovery and retraining in minor areas and not in the era of globalization), S. Aragona as Scientific Manager, held in 2005 in Tropea (VV).

Fig. 4 Gambarie (RC), skiing watching the sea (*Source* S. Tocco)

the mountains are so high that it is possible to ski in places such as the Gambarie ski resort (1350 m. ASL), only 35 km away from Reggio Calabria and the sea (Fig. 4).

Considering all this, regional planning requires the ecological approach as a basic philosophy: that is, having local conditions as "design suggestions" and avoiding choices that may be useful in the short period but not valid in the medium or long term. This metropolis must be a "network of innovation, history and territories" (Fig. 5). It must be able to be built as a regional-scale network. Thus, with Messina, it must become a reference for the entire Mediterranean area (Aragona et al. 2014).

It must contain the Gioia Tauro Harbour, until a few years ago the main HUB for Mediterranean container ships, as essential infrastructure for the regional and national economy. The network of the three universities present in the region, i.e., in Reggio Calabria itself, in Cosenza and in Catanzaro, must become more effective as they are among the main resources of the territory. Thanks to the limited size, the mentioned cities could characterize themselves as university towns similar to those in other parts of the world. Tourism must become a driving force for enhancing and protecting these territorial resources.

3 The Great Difficulties

But all the previously mentioned centers do not possess other urban realities similar to those of other Italian regions, e.g., Marche or Toscana. Reggio Calabria has only Messina as a neighbouring town, 3 km distant across the Strait.

There are not, in many cases, some of the conditions that Dematteis (1990) identifies to form *territorial reticles* and thus specializations: the presence of primary urbanization is not always guaranteed (Fig. 6); the financial system is not adequate; the administrative/policy level is often low; local knowledge is being lost itself; the absence of organized crime. On the regional scale, 1999 POR (Operative Regional Plans), with *Small Municipalities Network* Action has already tried to trigger virtuous processes of collaboration/competition between the small cities, i.e., the majority of its cities.

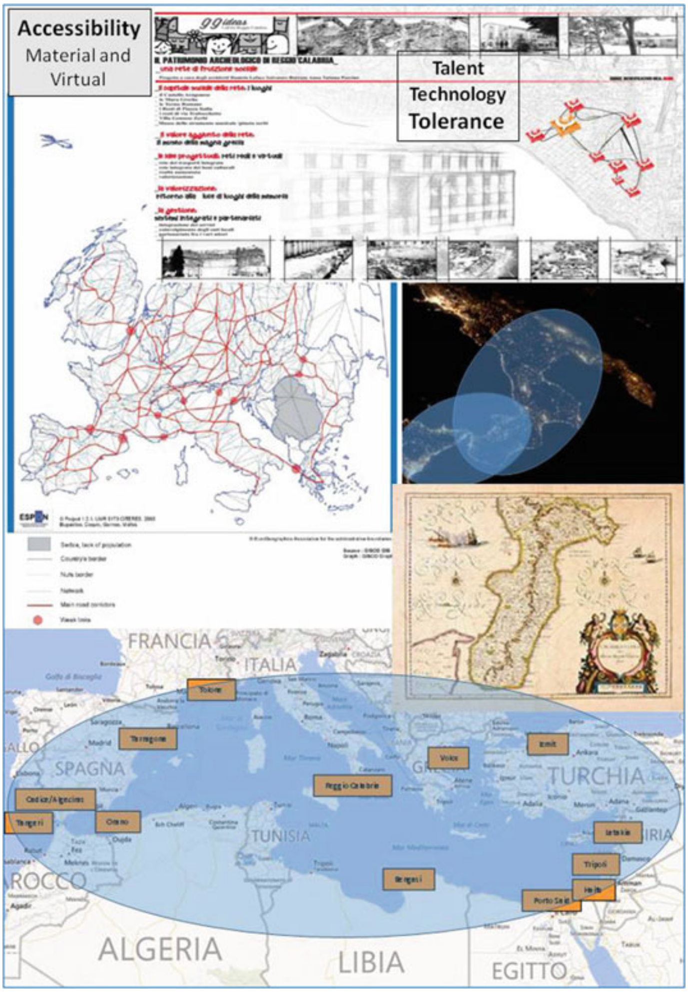


Fig. 5 Reggio Calabria, network of innovation, history and territories (Aragona 2015b)

But the outcome has been not satisfactory, as well as other instruments, e.g., the Territorial Integrated Projects, did not achieve significant results in terms of synergic strengthening between the centers. In addition, southern cities sit among the lowest rankings for *Tolerance*, one of the three elements—together with *Talent* and *Technology*—the bases of creativity and therefore of competitiveness.[11] Instead, according to the canonical geographic indicators, they should have higher rankings. The closure of territorial systems is among the various elements that determine this

[11]Methodology proposed by prof. Florida of Carnegie Mellon University in Pittsburgh (2003) and tested by experiment between 2004 and 2005 by Tinagli (2006)—of Florida research group—on the 103 Italian Provinces.

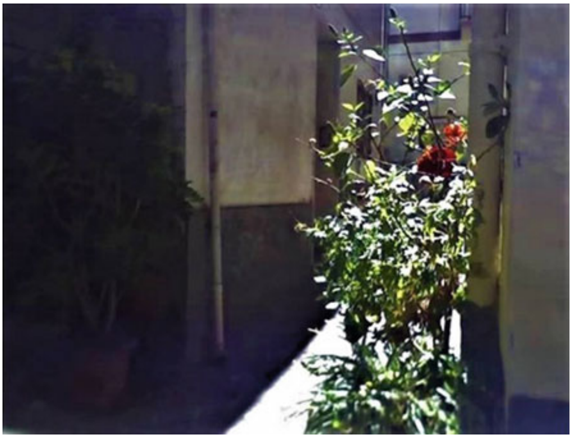


Fig. 6 Collection of rain water in Reggio Calabria (*Source* S. Aragona)

poor result: the more a territory is inaccessible to cultural exchange, the less it is open to novelty and change.[12] This social closure is associated with the problem of individualism, that, according to some (Cananzi 2016), in Reggio Calabria is "anthropological", although it would be interesting to learn how it was before the unification of Italy.

Reggio Calabria, even if institutionally considered a metropolitan city, has not one characteristic of a city with this status: neither the population[13] nor the relevant economic activities.[14] It has also a geographical isolation, its remoteness from other important centres: a fact that does not characterize the other metropolitan areas. The only two promising realities are, as mentioned before, Messina[15] beyond the homonymous Strait and Gioa Tauro with its port. The port is currently (mid 2017) in a crisis—of the total 1000 workers, 400 have been laid off—although its potential is great, as evidenced by the primacy it had until recently with container-ship traffic as already mentioned. But there are no effective links with the territory, and no horizontal multipliers, or intermodal exchange nodes have been realized.

The morphology of the territory and infrastructure shortage, associated with the lack of services,[16] cause the limited accessibility. The Regional Transport Plan

[12]One of the elements of tolerance is the percentage acceptance of homosexuality (Turani 2005).

[13]The metropolitan area has only 566,507 inhabitants, just over the 559,820 of Cagliari, the smallest of all metropolitan areas (Cittalia 2013).

[14]The numerous activities related to spinning have never recovered significantly after the earthquake of 1908: with Villa San Giovanni, there were about 10,000 employees. The railway repair site, a major economic center of the city, was closed and the entire industrial area—the only one in the city—is being dismantled.

[15]The combined population of the metropolitan areas of Reggio Calabria and Messina is about 1,100,000 (Cittalia 2013).

[16]Only Reggio Calabria has six daily high-speed trains to Rome. Except for one that takes five hours and ten minutes, all others require a journey of more than six hours: carriages are not new (often recycled) and without services such as the internet (in any case there is none after Salerno).

Fig. 7 Along the river, next to the Eurac (left) in Bolzano and below the faculties of Reggio Calabria with the ruin of the student's house (*Source* S. Aragona)

2016, almost 20 years after the previous one, offers hope for improvement, also because a third of its recommendations are part of the National-level Strategies of 2015 (Malara 2016). The high-speed line should have a substantial upgrade; an intermodal HUB for railway is planned in Gioia Tauro Harbour; and a connection axis with Bologna is proposed through the Adriatic line. If Reggio Calabria wants to become a metropolitan area, it must have the Port of Gioia Tauro as one of its internal reference poles and create fast connections with it. This is also the thought of the Assessor to the *System of Logistics, Regional Ports System and Gioia Tauro System* of Calabria Region F. Russo, professor of Transport of the University of Reggio Calabria.

Since seismic and hydro-geological risks are strongly present throughout Calabria, studying and experimenting with solutions to deal with these risks would be an opportunity to create poles of excellence related to local universities.[17] A strategy of information/education for inhabitants, technicians, and politicians needs to explain the effects between localizations and risks in the short, medium, and long-term period (Fig. 7). Moreover, rethink territory and cities using indicators as the ones of the "Environmental Energy Certification, Towards a Concordat Code for Sustainable Development" (*Certificazione Energetico Ambientale, Verso un Codice Concordato per lo sviluppo sostenibile*, ANCAb—Legacoop 2008a). It was used, e.g., in abitaECOstruire Contest of ideas (ANCAb—Legacoop 2008b) and it was 2008!. All this, in a wider scenario of integrated ecological town planning, as in Faenza with its strategy of urban sustainable regeneration as illustrated by E. Nanni, head of Town Planning Dep. of the city, at the Congress of Italian Society of Town Planners (SIU) in 2016. Considering that questions are related at quantity but, with growing importance, involve the quality of life: for that ISTAT and CNEL since 2013 elaborated the 134 indicators of the Fair and Equitable Wellbeing and (*BES*) going beyond per capita income and GDP.

But in Italy, especially in the south, there is a big problem: the failure to consider territory and town as a public goods. One of our first missions as town planners and

There are no high-speed trains either from and to Catanzaro, regional capital, or to Cosenza. In recent years, night trains that linked for years the Region, and Sicily, with Northern Italy were cancelled. On the long-distance Intercity trains, there are no longer any refreshment services.

[17]Experiences made have been abandoned, as the case of *Seismic Risk Laboratory* of prof. Fera with the collaboration of arch. De Paoli, Dep. of Environmental and Territorial Sciences, Reggio Calabria University.

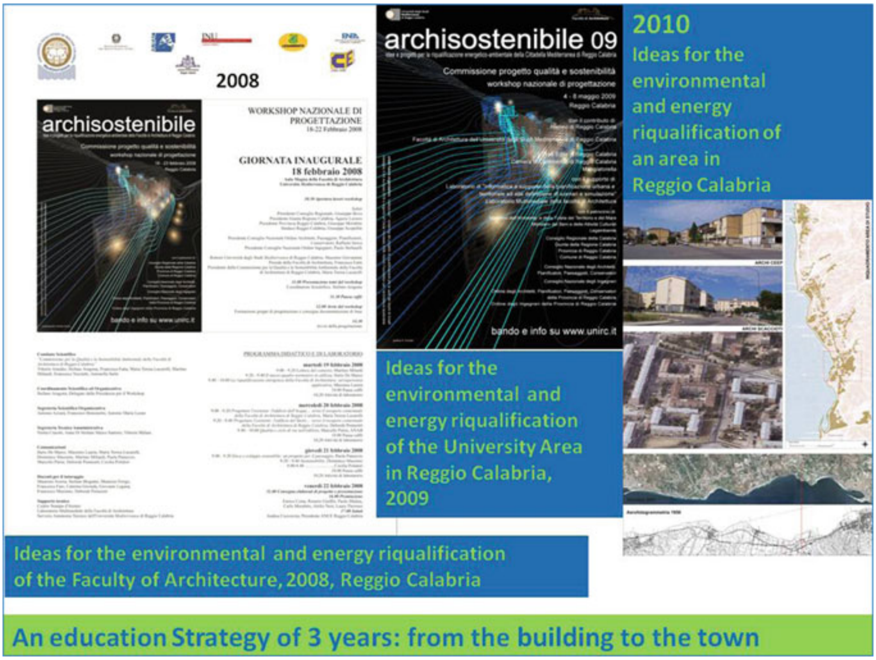


Fig. 8 Archisostenibile (*Source* S. Aragona)

teachers of urbanistic studies consists of making information and education about all this and in supporting the civic sense of the *cum-cives*, i.e., of citizens that share a common idea of *civitas* (Cacciari 1991). We have to build up smart and sustainable territories and towns using political strategies remembering that the word politics comes from *polis*, i.e., the art of managing the city: the first smartness is to help citizens to become “ecologicus” people. At the Faculty of Architecture of Reggio Calabria some time ago there has been a three-year initiative, called *Archisostenibile* (Sustainable architecture), to in/form awareness about these issues (Fig. 8).

These are topics on which the University of Reggio Calabria is at the forefront and participates in the European Universities Network for Energy.[18] Equally innovative is NOW’s REWECH experimental project, *Laboratory for Electric Power Conversion of the sea waves*,[19] one of the priorities in EU energy policy.

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[18]In 2016 Prorector C. Morabito participated at the meeting *Human resources and new knowledge to build the future energy system* held in Trondheim (N).

[19]Founded by prof. P. Boccotti and directed by prof. F. Arena, with researchers and young collaborators, from the *Mediterranean* University of Reggio Calabria is one of its spin-off activities.

4 Political Choices Change the Territories: This Is the Final Note

It is then evident that the national and of wide area—such as the Region and/or the Province—policy strategies and those of the municipal level and, in the future, the metropolitan, guide the territorial transformation trajectories. This means that the *vocation* of a territory is also the consequence—but in a very relevant dimension—of man's action.[20] Beware, however, because that may be unsustainable or became unsustainable, since sustainability must always be considered with respect to the specific context and the degree of scientific knowledge and technological level. The case of marble quarries is one of the most obvious examples of how, over the millennia, the landscape can be transformed, and more and more, quickly surrendered the advancement of extractive capabilities. And how all this creates many—increasing well known—risks for the health of both workers and residents of these extraction territories.[21]

But the cultural component is essential. In the case of the metropolitan area of Reggio Calabria, next to the necessary infrastructure for making and building networks, inhabitants, local and regional authorities must be convinced of the unsustainability of continuing to cement over the territory. This not only to avoid the disappearance of the opportunities offered by the magnificent panoramas, but also for reasons related to seismic and geomorphologic risk. Starting from these elements, many of the cities must be rethought and mobility must become sustainable, while now it is based on the use of the private car. As previously stated, the main task for us as town planners and urbanists is to better explain why the "ecological approach" is needed for a smart and sustainable city: relying on implementation of the many proposals and education of the local urban inhabitants. So, this means following the lesson of Gennari (1995) when he talks about "city pedagogy".

One last consideration is about metropolitan areas in general. They have large peripheral areas, mostly lacking in urban quality. The main motivation for their creation is the hypothesis that this enlargement increases competitiveness. But this is for whose benefit? Is it really convenient for citizens to be part of a vast and barely liveable territory? It is time to ask whether the evolution of the modern city, with its focus on large urban areas, metropolitan areas, is effective: whether the well-being of local residents and communities is growing or not. A "sui generis" metropolitan area such as Reggio Calabria could be an example of a "different" response that is really useful to citizens rather than the globalized economy without

[20]Erba (1988) highlighted the essential role of political choices in addressing territorial transformations.

[21]The *Carrara Thermal Baths* International Competition shows that the opinion, even with regard to these activities, is radically changing (reTH!NKING ARCHITECTURE COMPETITIONS 2016).

control, so it could be an example of the "smart globalization" required by Rodrik in 2011.

… and when it is raining this can been thought of as good weather: this is a basic change of perspective for progressing towards an ecological vision of territorial and town planning.

References

ANCAb—Legacoop. (2008a). *Verso un Codice Concordato per lo sviluppo sostenibile.*

ANCAb—Legacoop. (2008b). *National competition of ideas abitarECOstruire*. Accessed at: www.abitarecostruire.it [05/07/2010].

Appold, S. J., & Kasarda, J. D. (1990). Concetti fondamentali per la reinterpretazione dei modelli e dei processi urbani. In A. Gasparini & P. Guidicini (Eds.), *Innovazione tecnologica e nuovo ordine urbano*. Milano: Franco Angeli.

Aragona, S. (1993). *La città virtuale: Trasformazioni urbane e nuove tecnologie della informazione*. Roma, Reggio Calabria: Gangemi Editore.

Aragona, S. (2000). *Ambiente urbano e innovazione. La città globale tra identità locale e sostenibilità*, Roma, Reggio Calabria: Gangemi Editore.

Aragona, S. (2012). *Costruire un senso del territorio Spunti, riflessioni, indicazioni di pianificazione e progettazione*. Roma, Reggio Calabria: Gangemi Editore (chp. 1).

Aragona, S. (2015a). Ecological city between future and memory: A great opportunity to rethink the world. In M. Cerasoli (Ed.), *Cities, memory, people. Book of acts of the 9th congress "Virtual City and Territory*". Sessione I Architettura, Sostenibilità, Energia. Italy: RomaTrePress.

Aragona, S. (2015b). Reggio Calabria: metropoli in rete di innovazione, storia e territori. In C. Fallanca (Ed.), *100IDEEpeReggiCalabriaCittàMetropolitana*. Roma: ARACNE.

Aragona, S., Calabrò, F., & Della Spina, L. (2014). The evaluation culture to build a network of competitive cities in the Mediterranean. In *New metropolitan perspectives—The integrated approach of urban sustainable development* (Vol. 11, pp. 476–482). Reggio Calabria: Trans Tech Publications.

Barca, F. (2010). *UN'AGENDA PER LA RIFORMA DELLA POLITICA DI COESIONE. Una politica di sviluppo rivolta ai luoghi per rispondere alle sfide e alle aspettative dell'Unione Europea.* capp. I e V del Rapporto "An Agenda for a Reformed Cohesion Policy", 2009.

Biovongi e Dintorni. *Le Reali Ferriere ed Officine di Mongiana*. Accessed at: http://bivongitheristis.altervista.org/it/vie-della-fede-e-del-ferro/le-vie-del-ferro/le-reali-ferriere-ed-officine-di-mongiana/ [05/03/2017].

Cacciari, M. (1991). Aut civitas, aut polis. In E. Mucci & P. Rizzoli (Eds.), *L'immaginario tecnologico metropolitano*. Milano: Franco Angeli.

Campanella, T. (1602, 1623). *La città del sole*, IX Edizione (G. Ernst & L. Salvetti Firpo, Curatori). Bari: Laterza, 2006.

Cananzi, D. (2016). "Intervento" alla *Tavola rotonda REGGIO 1946-REGGIO 2016. Dalla ricostruzione della città di 70 anni fa alla costruzione della città Metropolitana. Un percorso comune di riflessione tra ricordi del dopoguerra e la prospettiva del futuro.* Officine Miramare, Reggio Calabria, Centro Internazionale Scrittori della Calabria, 12 febbraio.

Cittalia. Fondazione ANCI Ricerche. (2013). *Rapporto Citalia 2013. Le città Metropolitane.* Roma: Digitalia Lab srl.

Del Nord, R. (1991). Presentazione. In E. Mucci & P. Rizzoli (Eds.), *L'immaginario tecnologico metropolitano.* Milano: Franco Angeli.

Dematteis, G. (1990). Modelli Urbani a Rete: Considerazioni Preliminari. In F. Curti & L. Diappi (Eds.), *Gerarchie e Reti di Citta': Tendenze e Politiche*. Milano: Franco Angeli.

Doxiadis, C. (1968). *Ekisticks: An introduction to the science of human settlements*. New York: Oxford University Press.

Encyclical Letter. (2015). *Laudato Be of the Holy Father Francis on the care of the common house*. Tipografia Vaticana: Città del Vaticano.

Erba, V. (1988). L'Efficacia dello strumento 'piano regolatore' letta attraverso la produzione di modelli e di generazioni di piano. In M. C. Gibelli & I. Magnani (Eds.), *Pianificazione Urbanistica come Strumento di Politica Economica*. Coll. Scienze Regionali. Milano: Franco Angeli.

Fiorista, A. (2005). MC. Escher e le visioni mediterranee. *Workshop Nazionale di Progettazione Idee e progetti per il recupero e la riqualificazione in aree minori e non nell'epoca della globalizzazione*. Aragona Scientific manager, Tropea, marzo 30–aprile 3, 2005. Accessed at: https://www.youtube.com/watch?v=_TzGmFMiYPM&feature=youtu.be [09/12/2005].

Florida, R. (2003). *L' ascesa della nuova classe creativa. Stile di vita, valori e professioni*. Milano: Mondadori.

Gennari, G. (1995). *Semiologia della città*. Padova: Marsilio.

ISTAT—CNEL. (2013). *Bes 2013. Il Benessere Equo e Sostenibile in Italia.* Roma: Tipolitografia CSR.

Khun, T. S. (1962, 1970). *The structure of scientific revolutions*. Chicago: Chicago University Press [tr. it della II ed., (1979) *La struttura delle rivoluzioni scientifiche*. Torino: Einaudi].

Malacrinò, C. G., & Quattrocchi, E. A. (2015). *Old Calabria. Viaggiatori in Italia meridionale e Sicilia tra il XIX secolo e gli inizi del secolo XX.* Reggio Calabria. December 3–4.

Malara, M. *Russo: Tra un mese pronto il Piano dei Trasporti. Lavoriamo per l'Alta Velocità.* Accessed at: http://www.strill.it/citta/2016/01/tra-un-mese-presentiamo-il-piano-dei-trasporti-lalta-velocita-puo-arrivare-in-calabria/ [19/12/2016].

Manfredi, T., Laboratorio CROSS Storia dell'Architettura e Restauro – Dip. PAU Università Mediterranea Reggio Calabria. (2015). *Che bel Paese. Esplorazioni nell'Italia del sud sulle tracce della spedizione Saint-Non.* Reggio Calabria. April 15–16.

Meadows D. H. (1972). *I limiti dello sviluppo*. Club di Roma. Milano: Mondadori [Meadows, D. L., et al. (1972). *The Limits to Growth*. New York: Universe Books].

Nanni, E. (2016). "Il caso di Faenza", II Sessione Plenaria Le città nel cambiamento, buone pratiche ed esperienze in corso. *XIX Conferenza Nazionale della Società italiana degli urbanisti*, *Cambiamenti. Responsabilità e strumenti per l'urbanistica al servizio del Paese*, Catania, June 16–18.

reTH!NKING ARCHITECTURE COMPETITIONS. (2016). *Carrara thermal baths competition*. Accessed at: http://rethinkingcompetitions.com/project/carrara-thermal-baths [25/06/2016].

Rodrik, D. (2011). *La globalizzazione intelligente*. Bari: Laterza [or. ed. *The globalization paradox. Democracy and the future of the world economy*. Oxford University Press, WW. Norton & Company].

Scandurra, E. (1995). *L'ambiente dell'uomo. Verso il progetto della città sostenibile*. Milano: Etas Libri.

Settis, S. (2014). *L'etica del architetto e il restauro del paesaggio*. Lectio Magistralis for the award of Honorary Degree in Architecture. Reggio Calabria: University Mediterranea of Reggio Calabria.

Telesio, B. (1565, 1570, 1586). *De rerum natura iuxta propria principia*, libri IX (rist. anast.) (G. Giglioni, curator). Roma: Carocci editore, Collana Telesiana (2013).

Tinagli, I. (2006). *Creatività ed Innovazione: Le nuove sfide del sistema economico globale.* Convegno APQ_Firenze. May, 13. Accessed at: http://www.online.cisl.it/qattualita/I04724173.6/Convegno%20APQ_Firenze%202006.doc [05/06/2017].

Tocco, S. (2009). *Sciare a Gambarie nel Comune di Santo Stefano in Aspromonte.* Accessed at: https://www.villaggiotramonto.it/gambarie-di-santo-stefano-daspromonte.html [05/08/2017].

Turani, G. (2005). *Italia, il paese dei creativi poco istruiti*. Affari e Finanza, 4 luglio.

UE Regional Operative Plan (POR) Calabria, Structural Funds, Axis City, Measures 5.1, Action 5.1.c - Networks of small municipalities, 1999–2006.

3bmeteo.com: *La Certosa dei Santi Stefano e Bruno*. Accessed at https://www.3bmeteo.com/ [09/06/2017].

Part II
Information and Communication Technologies (ICTs), Space and Society

Open Data Assessment in Italian and Spanish Cities

Raffaele Sisto, Javier García López, José Manuel Paéz and Elena Maté Múgica

Abstract Citizens' attention to Open Data initiatives and Open Government policies is growing rapidly, but fragmentation in their implementation makes for a confusing approach. This research aims to bring structure to their assessment by analyzing 63 selected Spanish cities and 110 selected Italian cities and mapping their content. The analysis shows that (i) Open Data portals are not developed consistently; (ii) the various levels of public administration are not coordinated in their Open Data strategies; (iii) however, there are some good practices to be followed and underlined. Research into Open Data initiatives could benefit from previous examples regarding the success and failure factors of an Open Government. This paper highlights the main trends for an Open Data portal strategy in Spanish and Italian cities from the citizens' point of view. The basic content, structure of the websites, quality, accessibility, crosscutting nature and data visualization of the datasets have been assessed from the user's perspective. Currently, Spain has 115 open-data portals embedded in datos.gov.es (Government of Spain 2016), and Italy has 40 open-data portals at the city level. Open Data initiatives are the basis to achieve transparency, participation and collaboration, and also to establish the pillars for the integration of intelligent policies.

Keywords Smart city · Open government · Open data · Transparency
Urban level

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1 Introduction

In recent years, governments at the national, regional and local levels have acquired a new commitment towards horizontal strategies and performances, a trend known as Open Government. The number of Open Government initiatives has grown rapidly in the last ten years: Hundreds of government data catalogues have been published and over a million datasets have been released by governments around the world, spawning new businesses and social projects (Dawes and Parkhimovichc 2016). This idea of governance is based on policies that promote three main fields —Open Data, Transparency and Interaction with Citizens—by supporting the ongoing collaboration through bottom-up strategies. An Open Government is commonly seen as a driver of efficiency and a vehicle for increasing transparency, citizen participation and innovation in society (Jetzek et al. 2012).

This transition from passive to active citizenship needs information and communications technology (ICT) that is a powerful tool for triggering interactive, participatory and information-based urban environments (Garau et al. 2017). In fact, as shown in this study, public administrations, mainly municipalities, are increasingly opening specific websites dedicated to Open Government or any of its fields.

In a forecasting effort, Misuraca (2010) defined new government scenarios by 2030. They affirmed that ICT is changing the government system and defined four scenarios according to the level of transparency and openness and the level of integrated policy intelligence: Open Government, Leviathan Government, Privatized Government and Self-Service Governance. With regard to the Open Government, they defined:

An Open Government counts with a high level of both transparency and openness and integrated policy intelligence. Open Government will bring unprecedented access to knowledge, a shift of cognitive capacities, allows to personalized public services, increases the online engagement of citizens, new options or molecular democracy and improves risk management (Misuraca 2010).

Open Data, Transparency and Participation are not new concepts, they are as old as Democracy, but it is now, thanks to ICT advantages, when Government may afford a massive inclusion of citizens in the decision-making process (Calderon and Lorenzo 2010).

This Open Government scenario is considered the most likely model to be achieved. Thereby, following the Open Government principles, the vast majority of public administrations are trying to improve citizen information through openness, transparency and participation. In this context, the Open Data strategy has emerged for the promotion of free access to public-sector data, which can be reused by others to attract and serve citizens, businesses, and any other institution (García 2015), or to improve decision making and the quality of life (Rojas et al. 2017).

This paper aims to assess one of the most basic tools to continue on the path of the Open Government: Open Data. It is the basis of the two analyzed concepts—transparency and openness—and the support for integrated policy intelligence. As a transparency tool for citizens, Open Data portals provide a framework to make government information available and to open the decision-making processes to citizens. Open-city data can help app developers, urban planners, and others understand the problems of a city and manage city services in ways that improve the quality of life and business prospects for its residents (Gurin 2014).

Governments generate and collect a vast quantity of data from many different domains (Janssen 2011). Urban space has become one of the leading data generators worldwide. Open Data is the true catalyst for Smart Services in the city (García 2015). Over recent years, various municipal departments have stored large amounts of data related to the city-government activity, but this information does not have a crosscutting nature. Open Data faces this issue and provides a return on public investment. “The release of this information is gaining increasing attention due to its potential to stimulate economic growth, support good governance and facilitate social innovation. Motivated by these benefits, several governments around the world have begun to include Open Data topics in their e-government strategies” (Rojas et al. 2017).

Data are a fundamental pillar of the Open Government strategy. It should be understood as an institutional, political and democratic innovation. Access to this information is not easy, and there is not a national consensus. In fact, many obstacles appear when these information sources are used: (i) data availability, (ii) willingness to use it, (iii) accessibility, usability and quality of data and (iv) the ability to collect, manage and use data (Stephenson et al. 2016).

In the case of Europe, the quality of Open Data varies depending on the country. In 2015, the European Data Bank conducted an assessment of where European countries stood with regard to Open Data. It showed that European public authorities had unequal levels of development in Open Data initiatives. Some countries are still in the process of launching a national Open Data portal, while other countries are already improving their portals and are starting new projects. As a conclusion, Italy and Spain are identified as the main trendsetters in the EU28+ Open Data Maturity clusters.

As required by the Digital Agenda for Europe, Italy has implemented policies for Open Data promotion through the Smart City National Observatory and the *Agenda Digitale Italiana*. Similarly, Spain approved in 2015, through AENOR (Spanish Association for Standardization and Certification), the standard UNE 178301 *Ciudades Inteligentes. Datos Abiertos* (*Open Data*). It is the first code that establishes a set of requirements for Open Data reuse in the public sector.

Therefore, the authors have chosen the cities from these countries in order to evaluate the main characteristics to be followed by the Open Data city managers.

This paper is structured as follows: Sect. 2 identifies the framework and describes of the fieldwork methodology. Section 3 shows the main results and a summary of all the analyzed fields; finally, Sects. 4 and 5 present the discussion and conclusions of this study.

2 Method

The main objectives of this study are: (i) to obtain a true and updated overview of the status of Open Data initiatives in the local administration of Spanish and Italian cities; (ii) to identify best practices within their efforts and strategies through an in-depth analysis of the characteristics of their official Open Data websites; (iii) to reveal gaps, such as the lack of standardization or homogeneous structure and the lack of a common strategy among various administrations to publish data openly; (iv) to assess the quality of Open Data regarding incorrect formats and useless or outdated data that do not meet the requirements in order to qualify as Open Data; (v) to help with the improvement of open-data strategies.

Thereby, it assesses the best portals in order to understand which data are more valuable and which are the most adequate techniques and technologies for both data scientists and citizen use.

As for the fieldwork methodology, the present study only analyzes official websites of local authorities. Central or regional government websites have not been considered. First of all, the Spanish and Italian provincial capitals and cities of over 200,000 inhabitants have been identified (the minimum size appropriately representative). After that, the Open Data portals of these cities have been assessed based on the following criteria: the presence of an official Open Data portal and/or a statistics website at the municipal level.

2.1 Open Data Assessment

After obtaining the state of the art of the preliminary Open Data portals, the quantity of datasets was analyzed. The structure and the general presentation of the portals of the selected cities were then analyzed as follows:

- Presentation: the access to datasets should be plain and functional, easy for any user to see. It should describe the mission and vision, the goals and the metrics to assess their achievements.
- Datasets: it should contain a search for keywords, filters, topics, tags, formats, and updated frequency to ensure maximum accessibility and navigability, plus a brief description of the formats used.
- Best Practices: the participation of third parties should be promoted and measured through the publication apps, best practices and examples of development based on datasets applications.
- Citizen Participation: it should include sections like Frequently Asked Questions, Contact and Tips, and provide a specific area for publishing applications developed by/for citizens.
- General Information: the terms, licenses and conditions of use of the datasets should be listed.

Table 1 Quantity of datasets

Range	Score	Cities (quantity of datasets)
0–49	0	Italy: Asti, Bergamo, Cagliari, Catania, Enna, Ferrara, Foggia, Forlì, Frosinone, Monza, Piacenza, Sassari, Siracusa, Verona; Spain: Albacete, Badalona, Cáceres, Ciudad Real, Cuenca, Girona, Lleida, Lugo, Santa Cruz de Tenerife, Tarragona
50–99	1	Italy: Ravenna (90), Livorno (88), Udine (80), Genova (74), Bari (57), Rimini (50), Napoli (50); Spain: Las Palmas (91), Sevilla (75), Santander (73)
100–199	2	Italy: Reggio di Calabria (160), Treviso (154), Venezia (152), Modena (150), Matera (138), Reggio Emilia (136), Pavia (119), Vicenza (118), Trento (106); Spain: Bilbao (174), Tarrasa (158), Sabadell (148), Cartagena (120), Valencia (113), Zaragoza (112), A Coruña (111)
200–299	3	Italy: Milano (291), Torino (263), Bolzano (212), Siena (207); Spain: Madrid (230), Pamplona (225)
More than 300	4	Italy: Bologna (1848), Firenze (1392), Roma (923), Pisa (606), Palermo (487), Lecce (344); Spain: Málaga (633), Gijón (564), Barcelona (331)

Table 1 shows the results of the first steps of the analysis: the quantity of datasets and the structure of the websites (Fig. 1).

The cities excluded in these two steps (20 Italian cities and 14 Spanish cities) are those with less than 50 datasets and those without an adequate website structure considered as a suitable Open Data portal (less than six points).

Finally, the 11 finalist Spanish cities and the 20 finalist Italian cities were fully assessed with regard to the following four dimensions: content quality, content accessibility, crosscutting nature of the content and content visualization.

2.1.1 Content Quality

In order to evaluate how the content of the dataset can be used and how reliable the data is, the quality of the data has been assessed with regard to the following criteria:

- The data available is "open source": the license of datasets must comply with the concept of Open Definition (reuse, redistribution and free use are permitted).
- The data available is free: a payment of a fee is not necessary in order to access to the datasets.
- The data available comes from an official source: the datasets must come from a government source or an officially recognized source. Otherwise, datasets are not considered reliable.
- A format based on "the 5-star Open Data" (Berners-Lee and O'Reilly 2009): it is a one-to-five-star scale that attempts to define the degree of reuse and openness of data depending on its format. Level 3 is the lowest for a dataset to be considered "open".

Cities selected	Presentation	Finder	Filters	Formats description	Best Practices	Data requests	Ideas and results	Terms of uses	Contact	Legal warning	Total
Lecce	★	★	★	★	★	★	★	★	★	★	10
Milano	★	★	★	★	★	★	★	★	★	★	10
Reggio di Calabria	★	★	★	★	★	★	★	★	★	★	10
Reggio Emilia	★	★	★	★	★	★	★	★	★	★	10
Treviso	★	★	★	★	★	★	★	★	★	★	10
Vicenza	★	★	★	★	★	★	★	★	★	★	10
Pisa	★	★	★	★	★	★	☆	★	★	★	9
Siena	★	★	★	★	★	★	☆	★	★	★	9
Torino	★	★	★	★	☆	★	☆	★	★	★	8
Bolzano	★	★	★	★	☆	★	☆	★	★	★	8
Matera	☆	★	★	★	★	★	☆	★	★	★	8
Bologna	☆	★	★	☆	★	★	★	☆	★	★	7
Venezia	★	☆	★	★	☆	★	☆	★	★	★	7
Ravenna	★	★	★	★	☆	☆	☆	★	★	★	7
Rimini	★	★	★	★	☆	☆	☆	★	★	★	7
Palermo	★	★	☆	★	★	☆	☆	★	★	★	7
Firenze	☆	★	☆	☆	★	★	☆	★	★	★	6
Roma	☆	★	☆	★	☆	☆	★	★	★	★	6
Pavia	★	★	★	☆	☆	☆	☆	★	★	★	6
Udine	★	☆	☆	★	☆	★	☆	★	★	★	6
Modena	★	★	★	☆	☆	☆	☆	★	☆	★	5
Trento	★	★	☆	☆	☆	☆	☆	★	★	★	5
Livorno	☆	★	☆	☆	☆	★	☆	☆	★	★	4
Bari	★	★	★	☆	☆	☆	☆	☆	★	☆	4
Genova	☆	★	★	☆	☆	☆	☆	☆	★	☆	3
Napoli	★	☆	☆	★	☆	☆	☆	★	☆	☆	3

Cities selected	Presentation	Finder	Filters	Formats description	Best Practices	Data requests	Ideas and results	Terms of uses	Contact	Legal warning	Total
Zaragoza	★	★	★	★	★	★	★	★	★	★	10
Madrid	★	★	★	★	★	★	★	★	★	★	10
Bilbao	★	★	★	★	★	★	★	★	★	★	10
Sevilla	★	★	★	☆	★	★	★	★	★	★	9
Santander	★	★	★	☆	★	★	★	★	★	★	9
Barcelona	★	★	★	☆	★	★	★	★	★	★	9
Valencia	★	★	★	★	★	★	☆	★	★	★	9
Las Palmas	★	★	★	☆	★	★	★	★	★	★	9
Malaga	★	★	★	☆	★	★	☆	★	★	★	8
Gijón	★	★	★	★	★	☆	☆	★	★	★	8
Tarrasa	★	★	★	★	☆	☆	☆	★	★	★	7
Sabadell	☆	★	☆	★	☆	☆	☆	★	★	★	5
A Coruña	☆	★	★	☆	☆	☆	☆	★	★	★	5
Cartagena	☆	★	☆	☆	☆	★	☆	★	★	★	5
Pamplona	☆	★	★	☆	☆	☆	☆	☆	★	★	4

Fig. 1 Website structure. Each star equals one point. Cities with less than six stars were excluded

Level 1—Open License: format files such as PDF, DOC, etc.
Level 2—Readable: format files such as XLS, etc.
Level 3—Open Format: format files such as CSV, XLM, etc.
Level 4—Resource Format: format files such as HTTP, RDF etc.
Level 5—Linked Data: published data linked and pointed to other data sources and contexts.

- The data available is updated: the updating of the datasets is evaluated taking into account metadata, file name description, data tags and date of publication.

2.1.2 Content Accessibility

The user accessibility to the data included in the datasets were assessed with regard to the following five criteria:

- Download grouping: all datasets can be downloaded, at once and in single file (RDF, XLS, etc.).
- SPARQL/API Service available to be used by robots.

- Languages: the availability of different languages has been assessed. It has been graded depending on the number of languages. The native language has not been considered.
- City-council website: a direct link to the portal from the city-council website has been considered.
- Online and downloadable data: if the data can only be sent by mail, it is not considered available.

2.1.3 Cross-Cutting Nature of the Content

The distributed datasets have been evaluated according to the government areas and their association, using the classification from "Ranking of European medium-sized cities" (Giffinger and Fertner 2007) as follows:

- Economy: commerce, finances, employment, taxes, industry, tourism and housing.
- Mobility: transport and urban infrastructure.
- Environment: energy and environment.
- Citizens: demography and education.
- Quality of life: sciences, technology, culture, leisure, safety, health, sport, society and wellness.
- Governance: law, justice, public sector.

2.1.4 Content Visualization

An interactive platform or an online dashboard was used to analyze the ability to visualize each dataset before downloading it, taking into consideration the following four aspects:

- Online Dashboard (four points): if there is an online dashboard available for several datasets.
- Data Pre-visualization (three points): if several datasets can be previewed before downloading.
- Readable Format (two points): if the dataset formats are accessible for non-professional users (file formats such as xls, XML etc.). Only Open-source formats have been considered.
- Download Average (one point): if the average download of datasets is displayed (Fig. 2).

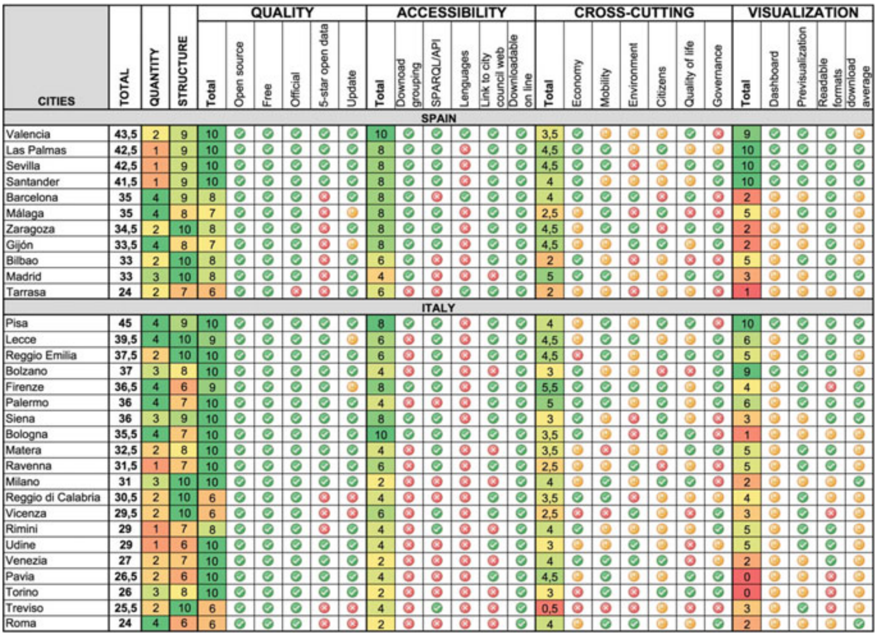

Fig. 2 Total results for Spain and Italy. Green circle = maximum score; yellow circle = medium score; red circles = minimum score (for more information about scoring, see Sect. 2)

3 Results

Table 2 shows the results for each area analyzed. Valencia and Pisa are the best-valued cities and have an excellent score in all areas. Virtually all the portals respect the basic concepts (quality and content of website). On the contrary, there is a huge difference between the Spanish and the Italian portals in terms of accessibility: more than half of the Italian cities do not guarantee the minimum requirements to be considered accessible. Málaga, Tarrasa and Treviso do not include a variety of datasets; they focus the data mainly in one or two domains instead. With regard to the visualization, there is no uniformity in the display method.

Table 2 The average percentage of the datasets for every area and a range have been established

Economy	Mobility	Environment	Citizens	QoL	Governance	Score
0–4.7%	0–6.0%	0–2.4%	0–8.5%	0–5.8	0–5.3	0
4.7–9.4	6.0–11.9	2.7–5.3	8.5–17.8	5.8–11.5	5.3–10.6	0.5
9.4–21.2	11.9–26.9	5.3–12.0	17.8–40.1	11.5–26.0	10.6–23.9	1
21.2–42.3	26.9–53.7	12.0–24.0	40.1–80.1	26.0–51.9	23.9–47.7	0.5
+42.3	+53.7	+24.0	+80.1	+51.9	+47.7	0

4 Discussion

The main impression is that Spanish cities have decided to open their data in a very heterogeneous way. There are many gaps in both form and content because they have not followed a common strategy.

On the one hand, there are cities with transparent websites that have not opened their data (e.g., Murcia or Ciudad Real). Other cities that have a specific website but have content that is limited, irrelevant, unclear or does not respond to what is considered open data (e.g., Tarrasa and Ciudad Real only have jpg or pdf files respectively). On the other hand, cities like Pisa, Madrid and Valencia, among others, are as advanced as the North American ones (e.g., San Francisco, CA).

A vast majority of the analyzed municipal websites have direct links to any specific fields related to Open Government, but only 36.5% of Spanish cities (23/63) and 36.3% of Italian cities (40/110) have an official Open Data website.

Several autonomous governments, such as Aragón or Castilla y León in Spain and Veneto or Trentino-Alto Adige in Italy, have grouped their regional Open Data portals instead of dividing them into categories (city or province).

With regard to format types, 33 different types have been found. Ten of them represent 83% of all published datasets. The three most used formats by the 11 selected cities are CSV (24.2%), XML (11.7%) and JSON (11.4%). The formats used are mainly focused on promoting their interoperability.

5 Conclusion

This study reveals a lack of an in-depth analysis of the Open Data benefits for an Open Government strategy. The two major uses of Open Data portals are not properly represented in the majority of cities evaluated, namely:

- Citizens' empowerment and transparency. The main issue is the lack of a visualization and organization standard. None of the examples includes an easy module where citizens can ask for relevant information.
- Data business models. No analysis of the data value is evaluated in any example before deciding which data will be published.

Each administration level (national, regional or local) has begun to develop Open Government strategies with various scopes and methods. This is an ineffective approach due to their distribution of responsibilities and to some objections in the dissemination of certain information that could be understood as compromising. All this has led to a heterogeneous state of the art in content and form. Below are summarized some opportunities for improvement and also recommendations to achieve the principles described in the previous code of good governance:

- A common strategy among administrations: In addition to the regulatory framework, it would be advisable to standardize Open Government strategies and automatically share data among them.
- Municipal Strategic Plan for Open Government: The real needs of citizens should be prioritized during the boot process for transparency, openness and participation initiatives.
- Data Qualification: Due to the lack of commitment to data quality, data should be preselected o that it can be opened without becoming a useless mess. This is needed in order to standardize the format, structure and scope of Open Data initiatives and to share common principles: open, standardized, interoperable, linkable, machine-readable and non-proprietary formats.
- Encourage Citizen Participation: while progress towards municipal-management transparency has been shown, citizen participation must be promoted through advertising campaigns, grants, competitions, fairs and/or associations that use municipal resources in order to encourage innovation and entrepreneurship.
- Open Data Indicators: it is advisable to keep track through performance metrics that monitor the commitment of the stakeholders and to identify potential gaps and opportunities of improvement in Open Government policies.
- Open Data Dashboard: It is recommended to show the most relevant data through a dashboard. It should be free, accessible, online, in real time (when possible) and linked to the transparency portal.

Finally, since Spain and Italy are the European leading countries within the Open Data Maturity initiatives (European Data Portal 2015), the methodology used in this analysis aims to be applicable and valid in other contexts and may be useful to analyze Open Data initiatives in European cities.

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References

AgiD. (2015). *Agenda Digitale Italiana.* Accessed at: http://www.agid.gov.it [16-07-2017].

Berners-Lee, T., & O'Reilly, T. (2009). A conversation with Tim Berners-Lee. In *Web 2.0 Summit 09*.

Calderon, C., & Lorenzo, S. (2010). *Open government. Gobierno Abierto*. Algón Editores.

Dawes, S., Vidiasova L., & Parkhimovichc, O. (2016, January). Planning and designing open government data programs: An ecosystem approach. *Government Information Quarterly, 33*(1), 15–27.

EU Open Data Portal. Accessed at: https://open-data.europa.eu/ [15-12-2016].

European Data Portal. (2015). *Open data maturity in Europe. Insights into the European state of play*. European Union.

European Data Portal. Accessed at: http://www.europeandataportal.eu/ [10-12-2016].

Garau, C., Balletto, G., & Mundula, L. (2017). A critical reflection on smart governance in Italy: Definition and challenges for a sustainable urban regeneration. In *Smart and sustainable planning for cities and regions* (pp. 235–250). Berlin: Springer International Publishing.
García, M. (2015). *New businesses around open data, smart cities and fiware*. European Public Sector Information Platform. Topic Report 2015/04.
Giffinger, R., & Fertner, C. (2007). *City-ranking of European medium-sized cities* (pp. 1–12). Vienna UT: Centre of Regional Science.
Global right to information rating. Centre for Law and Democracy. Accessed at: http://www.rti-rating.org/ [16-06-2016].
Gurin, J. (2014). *How open data is transforming city life*. New York: FORBES.
Janssen, K. (2011). The influence of the PSI directive on open government data: An overview of recent developments. *Government Information Quarterly, 28*(4), 446–456.
Jetzek, T., Avital, M., & Bjorn-Andersen, N. (2012). The value of open government data: A strategic analysis framework. In *SIG eGovernment Pre-ICIS Workshop 2012*.
Misuraca, G., et al. (2010). *Environmental digital Europe 2030: Scenarios design on future ICT for governance and policy modelling*. Seville: Joint Research Centre Institute for prospective technological advancements.
Municipal Transparency Index ITA. Accessed at: http://transparencia.org.es/ [02-07-2016].
OGDP. (2007). *Open government data principles: 8 principles of open government data*. Accessed at: http://www.opengovdata.org/home/8principles [15-04-2016].
Open data initiatives map. CTIC Foundation. Accessed at: http://www.fundacionctic.org/. [18-04-2016].
Rojas, L. A. R., Lovelle, J. M. C., Bermúdez, G. M. T., Montenegro, C. E., de Ory, E. G., & Crespo, R. A. G. (2017). Metamodel to support decision-making from open government data. *Journal of Ambient Intelligence and Humanized Computing,* 1–11.
Spanish Government Transparency Portal. Accessed at: http://transparencia.gob.es/ [22-01-2017].
Stephenson, P. J., Bowles-Newark, N., Regan, E., Stanwell-Smith, D., Diagana, M., Höft, R., et al. (2016). *Unblocking the flow of biodiversity data for decision-making in Africa. Biological Conservation*, *213*(2017), 335–340.
The open data handbook. Accessed at: http://opendatahandbook.org/ [25-04-2016].
U.S. General Services Administration. Accessed at: https://www.data.gov/ [03-03-2016].
Each official Open Government website of the assessed Spanish and Italian cities was visited during February and May 2016.

Spatial Footprints of Context-Aware Digital Services. Eventual Self-regulated Alignments of Dating Apps with the Urban Shape

Iñigo Lorente-Riverola and Javier Ruiz-Sánchez

Abstract Since the 'smartphone' outbreak in 2007, the unprecedented growth of context-aware services—so called 'hyperlocal' or Location-Based Services (LBS)—on top of the preexisting urban systems are transforming the way that citizens communicate. As a consequence, new self-regulated cellular digital networks are emerging. Their collective use is transforming the mobility patterns and uses of the urban public and private spaces without subsuming or replacing them. The characteristics and implications for the planning of this new "digitally integrated urban space" (Ratti and Claudel in The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life. Yale University Press, 2016) have to be addressed. This paper focuses on the behavioral/eventual changes at the hybrid digital and physical space. The goal is to analyze how the shape and structure of a LBS changes given an external disruption and how does it adapt to new scenarios, proving both the existence and resiliency of the digital urban space. The method applies Python scripting and GIS techniques to represent live and anonymized data from popular dating services during the Madrid Gay Pride week, including the days before the Parade to establish comparisons between the usual and the occasional scenarios. This comparison enables us to extract conclusions about how the spatial shape of the services can change; which physical limits are dissolved by the digital network's topology; and how stabile the network behaves comparing the usual mobility patterns of its users with the occasional ones.

Keywords Context-aware services · Urban complexity · Geographic information systems (GIS) · Mapping informalities · Storytelling with data

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1 Introduction: Towards Hyperlocal Urban Systems

"Network science stands for a shift from an exclusively spatial perspective on urban data to a topological perspective, focusing on relationships and interactions between people, places, and institutions at any scale." (Ratti and Offenhuber 2014) "Mobile computing has ignited the idea that the physical and logical context of users can influence the behavior of services they call for […]" (Jones 2008). Location Based Services (LBS) are nowadays among the most popular applications in the digital markets. Their use of the GPS sensors in smartphones, and their persisting connection to the "cloud as a service APIs[1]" enable users to have access to a wide selection of services that tend to concentrate in urban areas. The context-awareness leverages the potential of the located data in a physical area to establish a direct peer-to-peer connection between users for many possible purposes that depend on the used application's scope.

From a digital systems perspective, it is important to highlight the idea of context as "any information that can be used to characterize the situation of entities […] that are considered relevant to the interaction between a user and an application, including the user and the application themselves" (Abowd et al. 1999). According to this definition, almost every single element of an urban physical system could take part in a digital context-aware service insofar as its context is located. The form, structure, and outcomes of implementing this kind of ubiquitous services on top of the preexistent urban communicative systems—pushing forward the paradigm of the "smart city"—are yet to be depicted.

"Data driven feedback loops turn the city into a reflexive test-bed and workshop for connected habitation in enmeshed digital and physical space, with a common platform of ubiquitous computing. […] Almost every contemporary action and interaction creates data" (Ratti and Claudel 2016). On the one hand, the latter mentioned "smart" technologies are reorienting the digital economy: from a product-oriented to a digital service one. The huge ecosystem of digital applications[2] with access to located but decentralized data drives this new digital-service economy. For that reason, it is not unusual today to have access to a public car parked anywhere on the streets (Car2Go, eMov…). Neither is it unusual to have access to a cab or private driver at a non-traffic-heavy crossing (Uber, Cabify, MyTaxy…). Nor to rent a flat for vacation or to find nearby flatmates anywhere of

[1]API: Application Programming Interface. "In general terms, it is a set of clearly defined methods of communication between various software components." In web-application programming, they define the procedures of a client to query the server's data.

[2]"Since the debut of Service Oriented Architecture in the year 2000, services computing has transitioned from an enterprise interoperation technology to shape the Web API economy […] According to ProgrammableWeb.com API enjoyed a compounded annual growth rate of 100% from 2005 to 2011, in terms of the total number of APIs registered". Up to this writing, 17,267 Web API's have been registered.

the city (AirBnB, Badi…). Nor even to flirt with somebody in the user's surroundings. Ultimately, the only function of LBS, context-aware, or hyperlocal services is to establish a direct channel between a provider and a consumer to satisfy almost any kind of need "here and now."

On the other hand, and because of the undetermined location for clients, goods, and suppliers, and the geographically limited results for a query—given the user-side API restrictions—the possible interactions of a user in a place/time are traceable. Consequently, an app's—and allegedly random—network of users over any city can be extracted, mapped and analyzed.

Having in mind that urban planning consists of drafting and implementing communicative models that produce at the time same time "possible, probable and legitimate connections" (Riverola 2015) between the urban system's components, the network planning will play a crucial role in defining the possible futures of the already implemented "digitally integrated urban space" (Ratti and Claudel 2016). At this particular stage of digital-physical hybridization, land use and other regulatory categorizations are progressively becoming obsolete because of their rigidity —housing versus 'home sharing', parking versus 'car sharing', proximity commerce versus short-time delivery… and, for this case, meeting versus dating—, the actual use of space is becoming more flexible and complex because of the networks that we don't see and must be taken into account for the future of smart and sustainable urban planning.

Therefore, the focus of this research is to depict some spatial and relational patterns of the most popular context-aware dating services and how they respond to disruptive scenarios to both digital and physical systems. The goal is to verify if a digital service can adapt to changing physical scenarios while it preserves its robustness. What is the urban shape of a dating service and how can it be represented? How responsive to public events is an LBS? Does it generate stable and recurrent connections? Moreover, does it increment the possible, probable and legitimate connections that make an urban system to be complex? Answering to those questions would help the decision makers to face the uncertainty that LBSs introduce providing innovative tools to operate.

2 Method: Storytelling with (Big) Data

Our method is developed to analyze the way a context-aware service operates into a city when given an external disruption. This enables us to compare how the digital system behaves both in normal and exceptional conditions to extract some conclusions about how the urban physical and digital spaces interact with each other concerning the use of public and private spaces and the citizens' mobility patterns. To do that, we have chosen Madrid's Gay Pride Parade taking place throughout the city center. This event can be considered disruptive to the typical use of the urban physical spaces for the following reasons:

- Most of the principal traffic-heavy streets are closed to vehicles to provide big spaces to accommodate large events. For instance, the *Prado-Recoletos* remains closed to traffic during the Parade, *Gran Vía* and *Alcalá* Streets among others inside *Chueca* have major traffic restrictions.
- The bars, pubs and some other facilities of *Chueca* neighborhood have extended opening times to improve their supply. They are also allowed to put their bars on the streets.
- Most of the squares inside *Chueca*, as well as *Plaza de España*, and *Plaza del Callao* have temporary scenarios to accommodate concerts and announcements.

Altogether, those transformations turn the Central District's landscape into a communicative environment that enhances the possibilities for people to interact with each other.

For this case, dating services have been chosen as the type of LBS that resembles the most the urban function of seeing, being seen and communicating with each other. Our selection of the most popular apps among the gay community show between 50 and 200 of the closest profiles to a single user depending on his location.[3] The profiles are shown within a time window of 10–30 min. Every user can chat with anyone on the results unless a user has blocked the other.

To represent the data with graphs and maps (Fig. 1) the most efficient way, we have used a PostGIS server architecture and Python scripting on top of third-party libraries—Pandas, Numpy, Requests, SqlAlchemy, Matplotlib, and FFMPEG.

The spatial database has also been populated with the most recent cadastral information to measure and differentiate the public and private spaces of Madrid's central neighborhoods—*Universidad (Malasaña), Palacio, Embajadores (Lavapies), Cortes (Barrio de Las Letras), Justicia (Chueca)* and *Sol*. The boundaries of the public streets have been calculated using a 'geoalgorithm' to count the number of users per street section depending on its typology.

3 Results: Storytelling with Data

3.1 The Datasets

The datasets show, on the left-hand side of Fig. 2, the physical fabric of Madrid. It consists of a dense and complex network of streets and squares articulating the central neighborhoods of the city. The Prado-Recoletos Avenue encloses the Central District on the east, *Alberto Aguilera* is the northern limit, *Palacio Real*, and *Princesa* are the western limits, and *Ronda de Toledo* constitutes its southern boundary. The district is crossed from east to west by *Gran Vía*. This main avenue

[3]The locations' precision varies up to 25 m to guarantee the user's privacy.

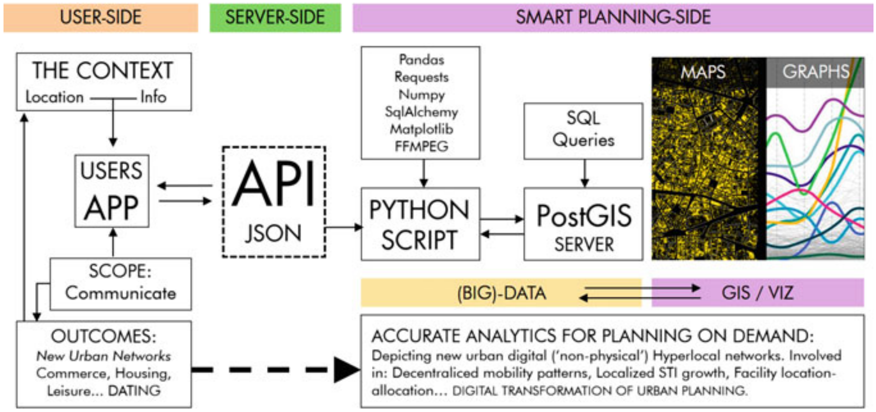


Fig. 1 Schematic methodology

Fig. 2 Madrid City Center: public and private spaces

Fig. 3 Estimated locations

and *Fuencarral* St. *Alberto Aguilera* and *Prado-Recoletos* are the limits of the *Chueca* neighborhood—shaded in white.

On the right, the digital landscape of the dating apps (Fig. 3) emerges from the data. A big dataset composed of more than 2,000,000 rows where the dots represent the geographic locations of more than 19,000 different users along a time span of six days—from June 29 to July 4. The apparent randomness of the digital locations tends to blur the shape and spatial structure of the urban fabric. Nonetheless, some highlighted avenues seem due to the density of profiles in a particular place and time, especially, the *Prado-Recoletos*, *Gran Vía,* and *Fuencarral* Streets.

The distribution of various users per neighborhood (Table 1) shows that Chueca and Malasaña are the most digitally populated neighborhoods. They gather a higher number of users than the rest of the district despite the homogeneity of the data. Nonetheless, the density of users in *Chueca* is significantly greater than the district's average. Another fact that highlights the randomness of the dataset is that 52% of the connections were made inside private spaces, whereas the remaining 48% took place in public urban spaces. That shows the integration of both public and private urban spaces in the digital networks, dissolving the limits between them.

A deeper insight into the dataset's connection times (see Fig. 4) shows a significant increase of users as the parade drew closer—the afternoon of 2 July 2016. This fact highlights the role of the main event as a disruption for both the urban

Table 1 Counts of unique users per neighborhood

Formal name	Popular name	User count	User density (users/ha)	%
Justicia	*Chueca*	8432	113.9	23.4
Universidad	*Malasaña*	7468	78.5	20.8
Sol	*Sol*	5981	134.3	16.6
Cortes	*Barrio de las Letras*	4835	81.86	13.4
Palacio	*Palacio Real/Opera*	4780	32.7	13.3
Embajadores	*Lavapies*	4476	43.6	12.4
	Total	35,972	–	100.0

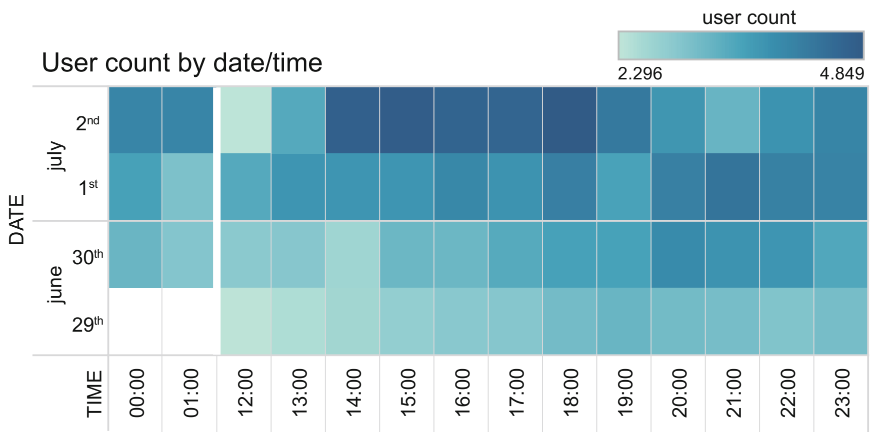


Fig. 4 User count by date/time

physical and digital platforms[4] produced by the attraction of users from both foreign countries and other districts of Madrid (Fig. 5).

3.2 *Use of Public Urban Spaces*

The spatial properties of the places where the digital connections took place are crucial to understanding the social behavior of the 'digital neighbors'. Depending on their toponyms, some conclusions can be grasped regarding which kind of places tend to present a more intense 'digital occupation'.

Figure 6 shows that the spatial network that articulates Madrid's central district is largely composed of residential streets (55.3%) and squares (10.2%), while the

[4]Adapted from the digital platform definition: A platform is a complex system that allows the implementation of various services under a common environment, giving the users access to them.

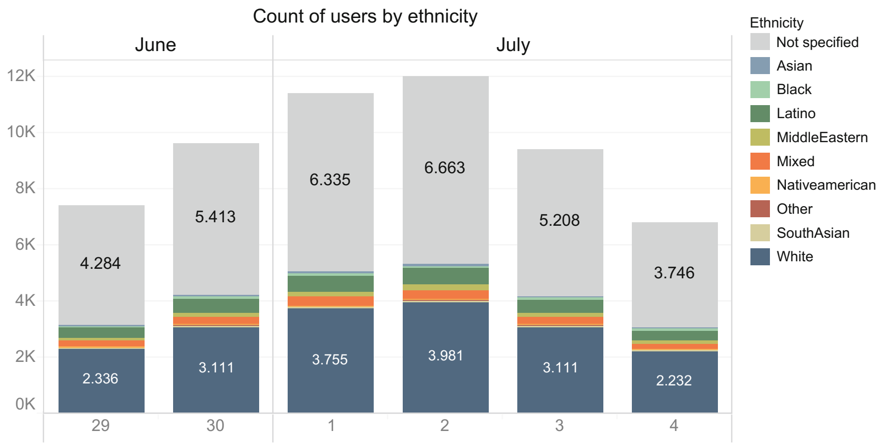
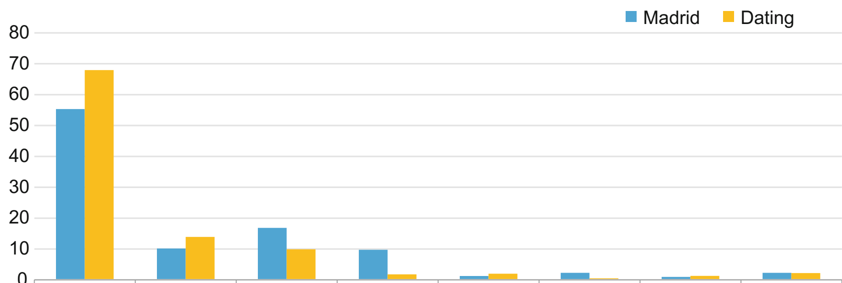


Fig. 5 Counts of users



	CALLE	PLAZA	PASEO	OTRO	RONDA	AVENIDA	CUESTA	GLORIETA
Madrid	55.33329185	10.17832605	16.82788088	9.740003837	1.236234913	2.288128709	0.965072846	2.30645047
Dating	67.93957594	13.91690359	9.899101711	1.802180162	2.003578797	0.498098324	1.305299372	2.213821473

Fig. 6 Percentage of users by public-space typology compared to Madrid's central-district composition

rest of spaces are avenues (19.1%[5]). In contrast, the connections to the dating services were proportionally greater in residential areas, rather than in traffic-heavy streets. This fact means that the usage of this family of digital services relates to the quotidian user's spaces where the user can remain.

For the case of the access to the service at public spaces, those with more capacity to gather various people—spaces to communicate, to see and to be seen—turn out to be 'digitally integrated' in a digital network that enables their users to increase their social connections. On the contrary, the urban or metropolitan-scaled spaces are less likely to be integrated into this kind of network.

[5]The mark stands for "*paseo*"—promenade—and "*avenida*"—avenue.

The private spaces of the city center show a high degree of connection to the digital network. In a significant amount of cases, the user is integrating its quotidian space inside the virtual network.

Up to this point, we have exposed the possibilities that digital services present regarding the incorporation of urban spaces into them. Regardless whether they are public or private, there is a clear relationship between the spaces where a person remains and their incorporation into the dating-oriented services. This normal behavior of the digital system will be further verified in the following points where the impact of the parade will be presented.

3.3 The Parade

The parade is the most popular event of the Gay Pride Week in Madrid. The day when it takes place—2 July, all the public spaces in *Chueca* and its surroundings become into an open scenario where an extraordinary amount of people can gather around.

To compare the behavior of the digital system over the urban spaces and times, we have produced an animated map representing the spatial footprints of the users connected to the social network during the Parade Day. The maps represent the positions using animated dots (Fig. 7[6]), the user density at the public spaces of the city center (Appendix 1) and also the overall density in hex bins (Appendix 2).

The data shows that during the parade and other Gay Week related events, the *Prado-Recoletos* and other important urban spaces significantly increased their user count per square meter. At the same time, there was no substantial decrease in the occupation of other spaces. This fact reflects the stability of context-aware services apart from the eventual urban-shape alignments that could be produced by a major urban-scaled event.

The total count of various users per street (Fig. 8) reinforces this last finding. While some of the most popular public spaces in the city center had significant inflows, the rest of the physical infrastructure—even inside *Chueca* neighborhood —maintained their public space's usage over the whole time span of the dataset.

3.4 Mobility Trends

The results presented before show the dual behavior of an apparently random and constantly changing digital network that enmeshes the spaces where people tend to remain. To conclude this section, the mobility patterns of the users have been summarized verifying this hypothesis. The origin and destination matrixes extracted

[6]Animated map available on YouTube. Link: https://youtu.be/NJlVgcwh_6U

Fig. 7 Key frames of the dataset's animated map

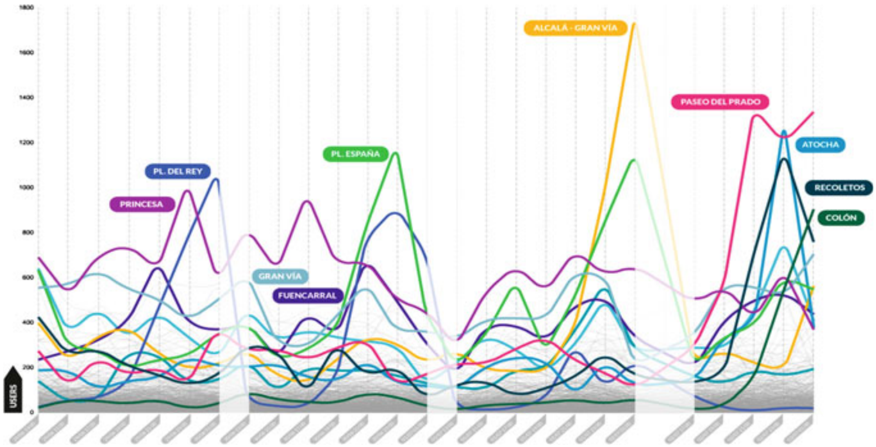


Fig. 8 Count of various users per street by time. The highlighted lines represent the most relevant public scenarios of Madrid's Gay Week. Gray lines represent the rest of the Central District's street network

from the disaggregated data reveal highly stable mobility patterns. The overall graph (Fig. 9) shows that most of the users made their connections to the digital service inside the same neighborhood during the days. As a consequence, all the neighborhoods inside the central district—*Palacio, Embajadores, Justicia, Cortes, Universidad* and *Sol*—maintain a stable basis of users.

Comparing Parade day with the rest (Appendix 3 and 4), the flow diagrams reflect the centrality of *Chueca* and *Malasaña* and *Palacio* as the neighborhoods with more intense and stable activity on the digital network. The first two neighborhoods show a significant decay in their outflows at the first spatial footprint (second column of the diagrams). The foundation of recurrent users, combined with an important inflow of visitors at the same time, increase the 'digital centrality' of the neighborhoods. Whereas, for *Palacio*, its outbound displacements present the

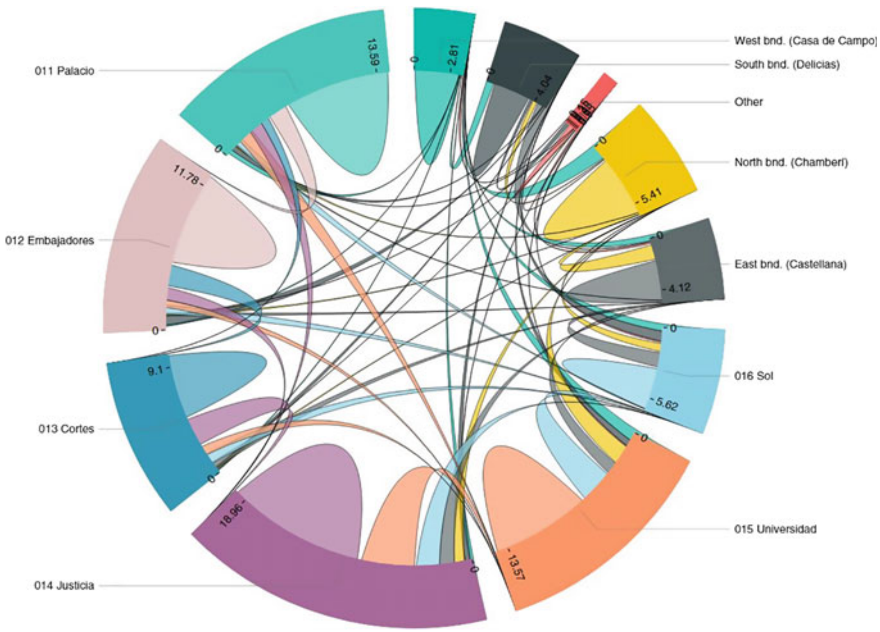


Fig. 9 Chord graph of the percentage of trips between Madrid's Central-District neighborhoods and their adjacent ones

neighborhood as a commuting area to reach the rest of the system. As long as the footprints of the users go further, the neighborhoods with greater commuting infrastructures are more central in the dating network.

In general, these mobility patterns remained stable over the week, proving the stability of the allegedly random digital service over the urban system. Furthermore, the only significant difference between the Parade day and the rest of the dataset is the visitor inflow at the eastern boundary of the district—*rado-Recoletos-Castellana* axis—where the alignment of the digital and the physical infrastructures of the city took place.

In other words, the digital network is reflecting people's behavior, proving our method as a useful tool to understand how the city behaves.

4 Discussion: Understanding 'The Context'

The presented data supports and verifies the main hypothesis argued in this research. The city is a social and spatial communicative system whose evolution, among other facts, depends upon the technological innovation in the way people can communicate. The implementation of new spatial digital networks is producing a disruptive change in the way people interact at the very inside of the urban

Fig. 10 Spatial cellular networks over the physical city. *Plaza del Callao (Madrid). 30 June 2016*

systems. A new generation of connections that neglect the traditional structures of the city—public/private, intimate/exposed, farther/closer, central/peripheral… Nonetheless, this apparently random (big) data-driven boundary dissolution is highly dependent on the social and spatial context for every single user of the digital service and its user-side API limits.

On the one hand, the data presents a significant number of profiles settled in their preferred quotidian spaces, their residential areas, and their nearest public meeting places. The dating networks are producing self-regulated communicative environments that permeate the physical boundaries of the urban space (Fig. 10). These systems seemed to operate with relative autonomy from the supposedly disruptive-event physical plane. This leads us to conclude that the context-aware services can modify the communicative system where their users live.

On the other hand, the same data shows the strong capability of the urban system itself to interact with the normal function of a context-aware service. The big events can produce eventual alignments between the urban and digital shape of both networks, proving that every public event in the contemporary city produces data, and that that data can generate new connections between users that ten years ago would have been unthinkable.

Rather than seeing this enmeshment of physical and digital systems as a threat to planning, this reality presents a new opportunity to promote more efficient and closer connections between citizens, at the same time that it can be used as a tool to understand how the cities behave. The emerging uncertainties that current cellular development is producing have to be faced from a complex point of view, embracing the idea that a service could probably have many different temporary locations and understanding how the city regulates their communicative environments.

5 Conclusion: Beyond Digital Services

Among the cellular organicists from 1960's, Constant Nieuwenhuys drafted the utopia "New Babylon" (Fig. 11). Driven by the idea of superimposing the global urban system on a non-hierarchical infrastructure, the aim of the project was to transcend the communicative constraints of the existing cities. This utopia is in many aspects similar to the presented cellular reality of this work.

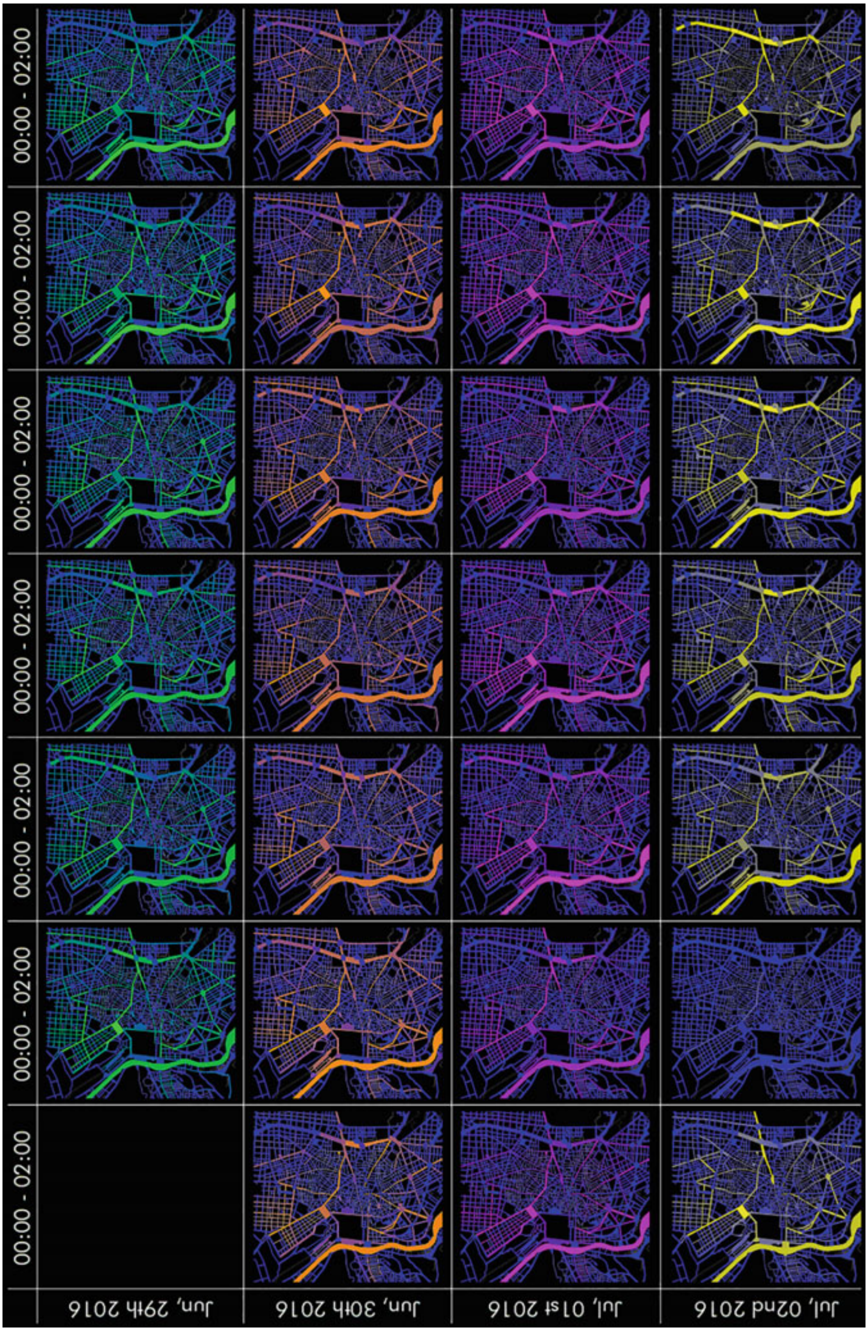
However, some of the consequences of this kind of implementation, far from being utopic—higher risks of contracting STIs (Beymer et al. 2014), increments to the price of housing at AirBnB-crowded areas (Duatis et al. 2016), regulatory problems for the cab sector versus Uber among others (Doménech Pascual 2015)—are today among the biggest challenges to planning.

The method presented in this paper provides a proper tool to increase the decision makers' knowledge about the spatial and structural conditions of dating LBSs in relation to the 'urban platform'. It also raises the question of how the use of the space regulation needs to adapt to this complex reality of digitally integrated urban spaces and the newly emerging spatial economy of the mutable uses of both public and private spaces. The case study can be considered as a proof of concept of how the dating services respond to external disruptions and show resilience, maintaining their normal function apart from a nearby event taking place. This knowledge can be used by planners to design new ways to provide better proximity services by leveraging the capabilities of LBSs. At the same time, the frequent users' location update on this kind of services turns out to be useful to infer the pedestrian activity and mobility patterns whatever the conveyance is. The method is also scalable to other cities and events to globally generate smarter and more efficient planning models.

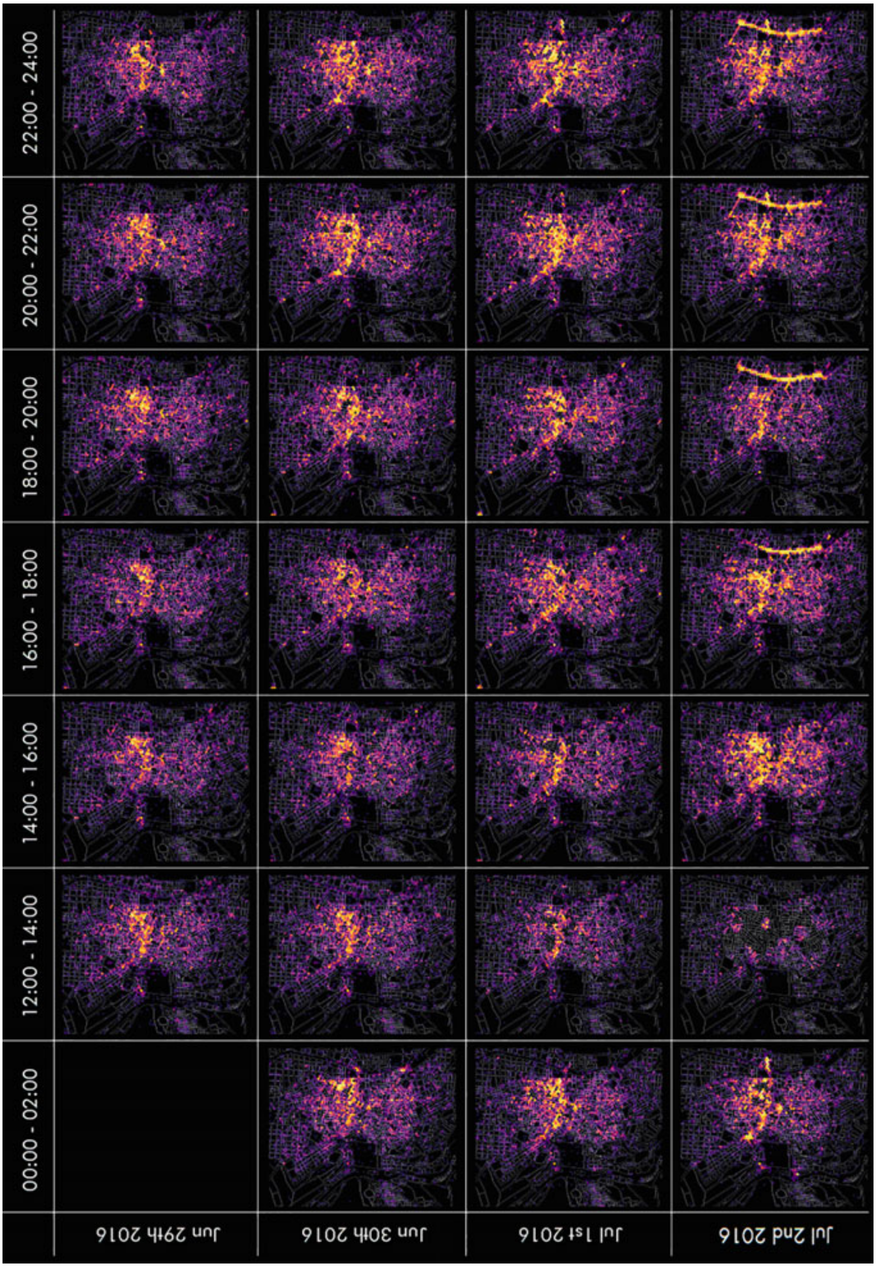
The further steps are integrating more context-aware services and different types of digital applications, spaces, uses, events in the same methodological framework, insofar as it seems to be useful and scalable to depict the digital-physical networks of today for use by the smart physical and digital planners of tomorrow.

Fig. 11 Nieuwenhuys, C. 1959–1974. New Babylon Map

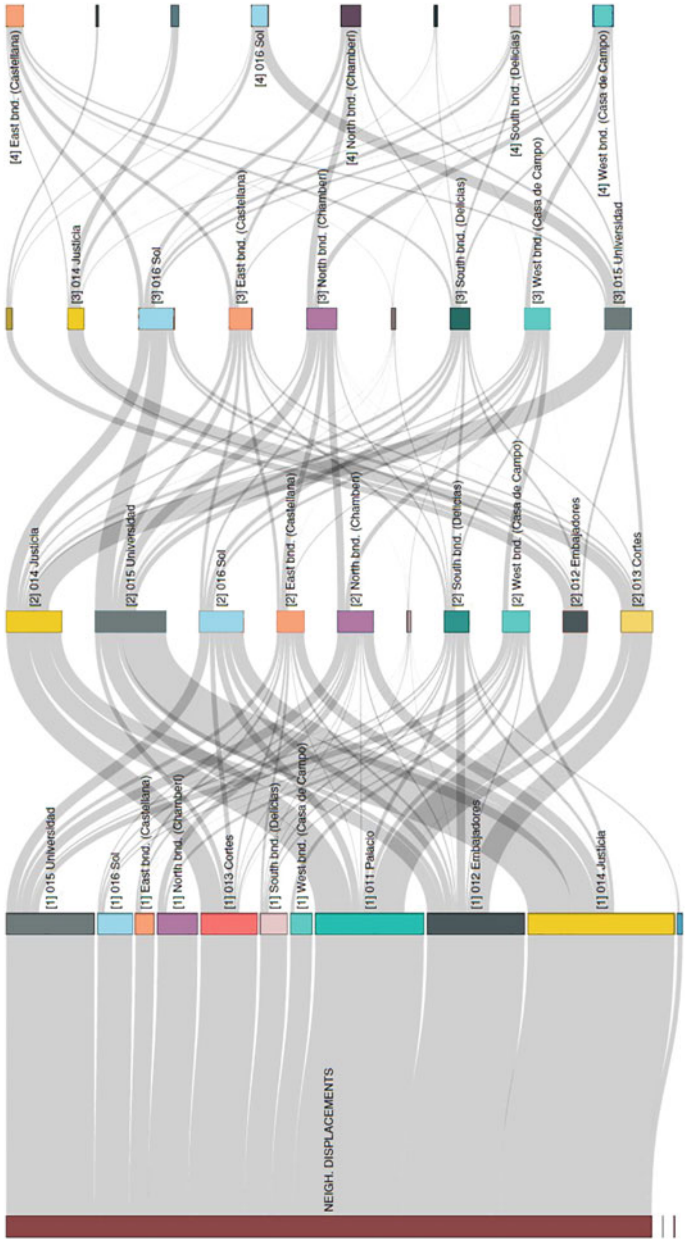
Appendix 1: User Density (Users/HA) Aggregated by Public-Space Entity



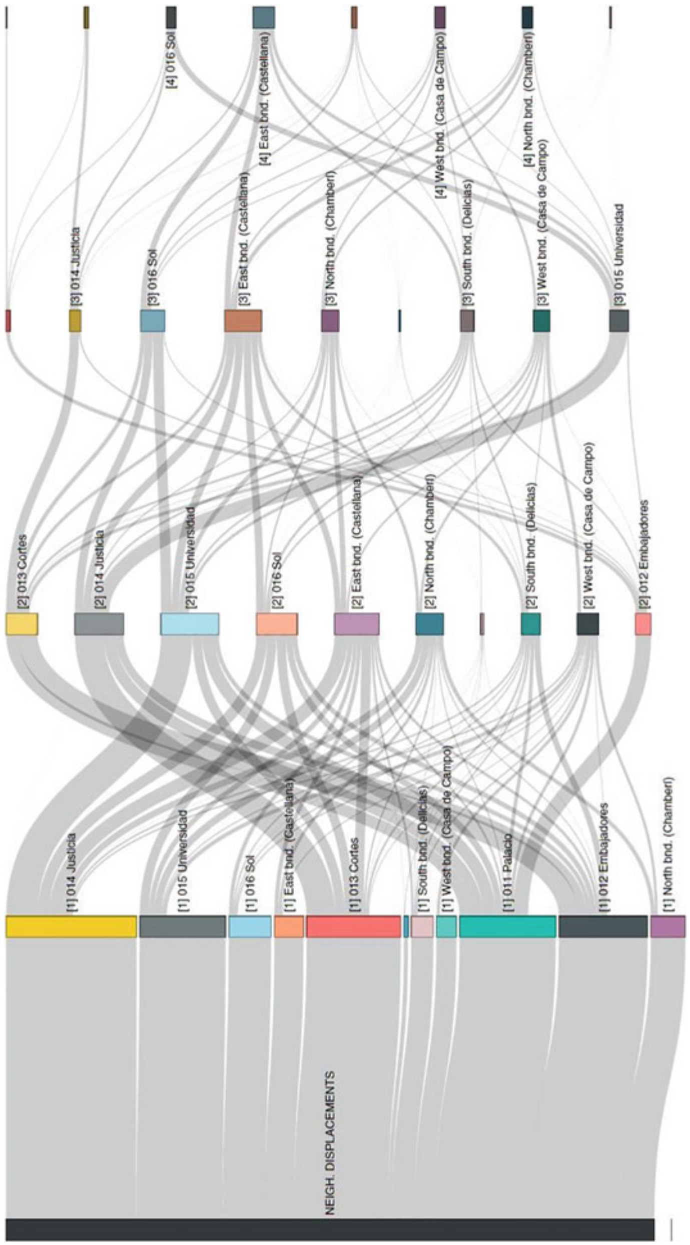
Appendix 2: User Count Aggregated by Hex Bins



Appendix 3: Sankey Flow Diagram of Mobility Between Madrid's Central District Neighborhoods and Their Adjacent Ones on 30 June 2016



Appendix 4: Sankey Flow Diagram of Mobility Between Madrid's Central District Neighborhoods and Their Adjacent Ones on 2 July 2016



References

Abowd, G. D., Dey, A. K., Brown, P. J., Davies, N., Smith, M., & Steggles, P. (1999). *Towards a better understanding of context and context-awareness* (pp. 304–307). Berlin Heidelberg: Springer.

Beymer, M., Weiss, R., Bolan, R., Rudy, E., Bourque, L., Rodriguez, J., et al. (2014). Sex on demand: Geosocial networking phone apps and risk of sexually transmitted infections among a cross-sectional sample of men who have sex with men in Los Angeles county. In *Sexually Transmitted Infections*. https://doi.org/10.1136/sextrans-2013-051494. (Published Online First: 12 June 2014).

Doménech Pascual, P. (2015). La regulación de la economía colaborativa. El caso de Uber contra el taxi. In *Ceflegal. Revista práctica de Derecho* (Vol. 175–176, pp. 61–104).

Duatis, J., Buhigas, M., & Cruz, H. (2016). *Impacte del lloguer vacacional en el mercat de lloguer residencial de Barcelona—Pla Estratègic de Turisme Barcelona 2020*. Ajuntament de Barcelona.

Jones, K. (2008). Building a context-aware service architecture. *IBM developerWorks.*

Ratti, C., & Claudel, M. (2016). *The City of Tomorrow: Sensors, Networks, Hackers, and the Future of Urban Life*. Yale University Press.

Ratti, C., & Offenhuber, D. (2014). Introduction. In *Decoding the City. Birkhuser Verlag GmbH* (pp. 6–16).

Riverola, I. L. (2015). Conexidad y evolución: Aproximación topológica a la idea de resiliencia. El caso del Sobrarbe (Huesca). *Territorios en formación, 9,* 77–95.

Analyzing Cities with the Global Human Settlement Layer: A Methodology to Compare Urban Growth Using Remote Sensing Data

Michele Melchiorri and Alice Siragusa

Abstract Data is a key resource to analyze and compare cities and to track urbanization processes and changes in cities. Nowadays, innovative procedures for acquiring and processing remote imagery provide analysts and policy makers with globally consistent multitemporal data on human settlements, which promise unprecedented advances in urban analysis. The Global Human Settlement Layer (GHSL) has been developed by the European Commission Joint Research Centre. It contains fine-scale global and multitemporal geospatial data on populations and built-up areas. The GHSL opens the possibility to study all cities in a globally consistent and comparative way. This study proposes a new methodology to work on the GHSL at city level and to monitor the process of urban expansion, both in terms of spatial footprint and population dynamics. The methodology introduces seven indicators: area [in km^2], population [inhabitants], built-up [square kilometers], built-up to area ratio, population density [inhabitants per square kilometer], and built-up and area per capita [in square meters]. The changes across reference points in the years 1975–1990 to 2000–2015 are used to monitor and benchmark urban growth and expansion. This research paper illustrates the methodological procedure for data preparation, and it explains the GHSL-derived indicators for monitoring urban analysis. The second part of the research applies the methodology to the Chinese cities of Beijing and Guangzhou to analyze, by a comparative perspective, the two cases. The paper contains data analysis capturing the dynamics of growth of urban areas, population, and built-up surfaces between 1975 and 2015. Guangzhou and Beijing are representative examples of rapid urbanization: Beijing grew faster than Guangzhou in the period 1990–2015 in terms of population, while built-up growth over the same years has been faster in Guangzhou. The comparison of the two cities elicits interesting phenomena such as the different speeds of population and built-up growth in the period 1990–2015.

Keywords Urbanization · Remote sensing data · Megacities · GHSL

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1 Introduction

Data for policy making and analysis are among the key priorities for the future of sustainable urban development as it emerges from the data revolution being promoted at the level of the United Nations. Territorial analysis is among the sectors in which technological innovations has enabled remarkable advances in the way in which analyses are carried out (Geertman et al. 2013). The more systematic use of evidences and data is needed by institutions to improve policy making and by scientists to open new scenarios for modelling and to understand the processes that significantly shape the territory. Contemporary technology enables the production of fine-scale data on human settlements that is useful within several thematic domains, including emergency response, transport, ICT-related information, and energy, among others.

The European Commission Joint Research Centre has developed, between 2010 and 2016, the Global Human Settlements Layer (GHSL), which contains fine-scale data on populations and built-up areas for the entire globe for the epochs 1975–1990 to 2000–2015 (Pesaresi et al. 2016).

The GHSL is part of the key dataset of the Group on Earth Observation (GEO) Human Planet Initiative, and it is also supported by the Directorate-General for Regional and Urban Policy of the European Commission.

The JRC GHSL project team released in October 2016 the Atlas of the Human Planet 2016 (Pesaresi et al. 2016), which contains novel analytics of the GHSL data and showcases the trends in global urbanization since 1975. The atlas analyses the patterns of growth of human settlements around the globe in terms of population dynamics and increases of built-up areas, maintaining the analysis at the continental or national level. The GHSL also offers the possibility to analyze individual human settlements in a globally consistent and comparative way, disaggregating the statistics. Preliminary feasibility tests on the use of GHSL for city analysis were applied to rank cities by total population, built/up area and built/up per capita (Melchiorri and Siragusa 2016). On the basis of that research stream, this paper further explores the potential use the GHSL to implement multi-temporal analysis of urban growth. The scope of the paper is twofold: on the one hand, to elaborate a set of indicators to be used together with GHSL baseline data for urban analysis; on the other hand, to test these indicators in two case-study cities, Guangzhou and Beijing (China). Guangzhou is the biggest urban center[1] in the world per population and area, and fourth per built-up (Melchiorri and Siragusa 2016), while Beijing is the world greatest urban cluster with a population exceeding 100 million (Pesaresi et al. 2016).

[1]A *city center* is an agglomeration with a density greater than 1500 people per km^2 and more than 50,000 total inhabitants, while an *urban cluster* is a cluster of cells with more than 300 people per km^2 and at least 5000 inhabitants and (Dijkstra and Poelman, "A harmonised definition of cities and rural areas: the new degree of urbanisation").

This research proposes statistical data in tables and maps to describe the process of expansion in these two cities during the period 1975–2015.

The study feeds the stream of research in urban analysis with big-data and remote sensing. In 2011, Taubenböck et al. (2012) provided a comparative analysis of megacities growth between 1975 and 2010 on the basis of Landsat images.

The relevance of this new effort stands on two guiding research questions that attain methodological and content-related matters. On the one hand, it is relevant to elaborate on the potential of the GHSL and therefore to identify which are the suitable indicators that can be monitored with its baseline data; on the other, having provided a portfolio of seven indicators, it is consequential to apply them to test case studies.

In the paper, we provide evidence to show that, in the 40 years between 1975 and 2015, the cities of Beijing and Guangzhou have undergone a swift and stark expansion, both in terms of population and built-up areas. According to the GHSL datasets, the two cities, while both witnessing expansion, have shown different growth paths in terms of built-up to area ratio and built-up per capita.

The paper is framed as a contribution to stimulate the debate providing scientific input to the world policy debate about indicators sustainable urbanization monitoring.

2 Methodology

The paper addresses the opportunity provided by the GHSL to bring the analysis of population and built-up areas (and related indexes) from a national-continental level to a city one, addressing urban analysis. Through the set of tested indicators and the use of the GHSL data, it is potentially possible to analyze, in a comparative and consistent way, over 13,000 urban centers around the world, namely, the settlements that exceed a population of 50,000. The GHSL contains three thematic sets of information: the first layer accounts built-up areas of human settlements, the second contains the population information based on population grids and the third the settlement model that classifies urban and rural settlements. The set of definitions and methodological concepts used in the GHSL production are contained in the technical report "Operating procedure for the production of the Global Human Settlement Layer from Landsat data of the epochs 1975, 1990, 2000, and 2014" (Pesaresi et al. 2016). The GHSL-baseline data is obtained from the processing of large masses of data collected from three main sources: Earth Observation satellite sensors (Landsat satellite imagery), national statistical surveys collected in the CIESIN's Population grids and crowd sources such as voluntary geographic information (VGI). The main GHSL product is the built-up layer with reports the values of built-up areas of each pixel (approximately 38 $\times$ 38 m). A built-up area is typically expressed with continuous values representing the proportion of building-footprint area within the total size of the cell. This paper takes the baseline data of the GHSL built-up and population layers to extract the statistics of the two selected Chinese cities: Beijing and Guangzhou. These two cities were selected as representative samples of the urbanization process that has been taking place in China.

This paper analyses the two cities on the basis of three plain data estimating the population in the human settlements, the area of built-up areas (in hectares), the area of the settlements (in hectares), and four additional indicators derived as ratios from the three plain data above: population density (inhabitants per km^2), built-up per capita (m^2 per inhabitant), area per capita and built-up to area ratio (as a percentage).

(a) Population—estimates the total number of inhabitants modelled by the GHSL in the urban center. The population is assigned to each pixel downscaling the CIESIN population grids at 10 km of resolution (CIESIN 2016) according to the built-up presence detected from the GHSL;
(b) Built-up areas—estimates the total surface covered by built-up structures as classified by the definition in Pesaresi et al. (2013);
(c) Area of the human settlement—estimates the physical extension of the urban center;
(d) Population density—estimates the number of modelled inhabitants over the total built-up surfaces; it is calculated as a ratio of population over the area of the settlement;
(e) Built-up per capita—estimates the amount of built-up of constructions theoretically available per person modelled in the settlement; it is obtained as the ratio between the total built-up and the population of the settlement;
(f) Area per capita—estimates the surface of city area available per each inhabitant; it is calculated as the ratio of urban area over population;
(g) Built-up to area ratio—is a percentage and describes the degree of the settlements' area that is covered by buildings.

These seven indicators can describe both the physical structure of human settlements (area, built-up and built-up to area ratio), as well as provide information about principles of sustainable urban planning such as population density that are considered key indicators by UN-Habitat and OECD (UN-Habitat 2015; OECD 2012).

The comparative analysis has been carried out with GIS technology and through spreadsheet computation and analytics.

The choice of the two case-study cities is due to the swift process of expansion that human settlements in China are experiencing. In China, between 1975 and 2015, 65 cities doubled their populations and around 100 had populations that increased 1.5 times. In 2015, the urban population in China exceeds 1.22 billion, with a 20% increase since 1990: overall, 88% of the Chinese population lives in urban areas (Pesaresi et al. 2016). With about 17% of the global population living in Chinese cities, it is of great interest to develop a methodology and a case analysis to understand how this tremendous growth has taken place and which physical characteristics it has assumed.

3 Results

This section presents tables, charts and maps to portray the process of urban growth that occurred in Beijing and Guangzhou between 1975 and 2015. It is important to recall that the Chinese context has significantly evolved within this timeframe. The GHSL gathers data about the status of human settlements in China since 1975, an epoch in which significantly different planning policies had been applied in China. Between the 1980s and early 1990s, China had undergone a process of economic opening. Indeed, these 40 years coincide with the period of unprecedented growth of the Chinese economy—including an average GDP growth of some 10% a year, construction of modern infrastructures and development and modernization of its society.

Since Beijing and Guangzhou are two considerably different cities, they are separately analyzed in dedicated sections, and then a comparison of the contrasting trends for the seven indicators is provided.

3.1 Beijing

Beijing, the capital city of the People's Republic of China, is located in the north-eastern part of the country. In 1975, the area of Beijing was slightly less than 1000 ha and its population above 2.8 million. Over the past 40 years, its area has tripled from 1000 to 3000 ha, and its population has increased by seven-fold, up to nearly 20 million. Figure 1 and following show the process of expansion of Beijing. Two distinct urban centers in 1975 fill the area enclosed by the blue line (the perimeter of Beijing in 2015). In the period 1975–1990 the city developed broadly towards south-west (i.e. Liangxiang), and around poles in the northern part (i.e. Channgping and Shunyi). Between 2000 and 2015, the population tripled—equivalent to more than 9 million people. In spatial terms, the city has saturated the south and north edges (Figs. 2, 3 and 4). The built-up area also tripled, while the total area increased at a faster rate than the built-up, by an average of 6% per year between 1975 and 1990. The growth of population in Beijing has been faster than the built-up expansion. It follows that built-up per capita has declined: between 2000 and 2015, it shrunk by one-third, and in 2015 (at 111 m^2 per capita), it is half that of 1990 (229 m^2). The built-up to area ratio, after increasing from 76 to 83% between 1975 and 1990, declined to 81% in 2000, returning to around the 1975 level in 2015 (see Chart 1). Area per capita has constantly decreased since 1975; todays' area per capita of 151 m^2 per inhabitant is less than one-third that of 1975 (Table 1).

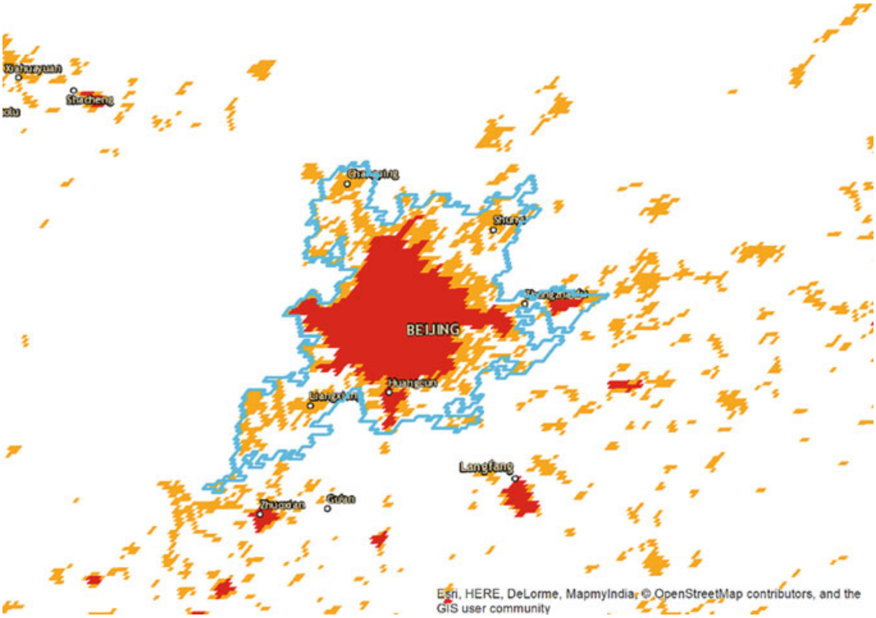


Fig. 1 Beijing 1975: 96 ha area, 2.8 million population (2015 perimeter of the urban center in blue)

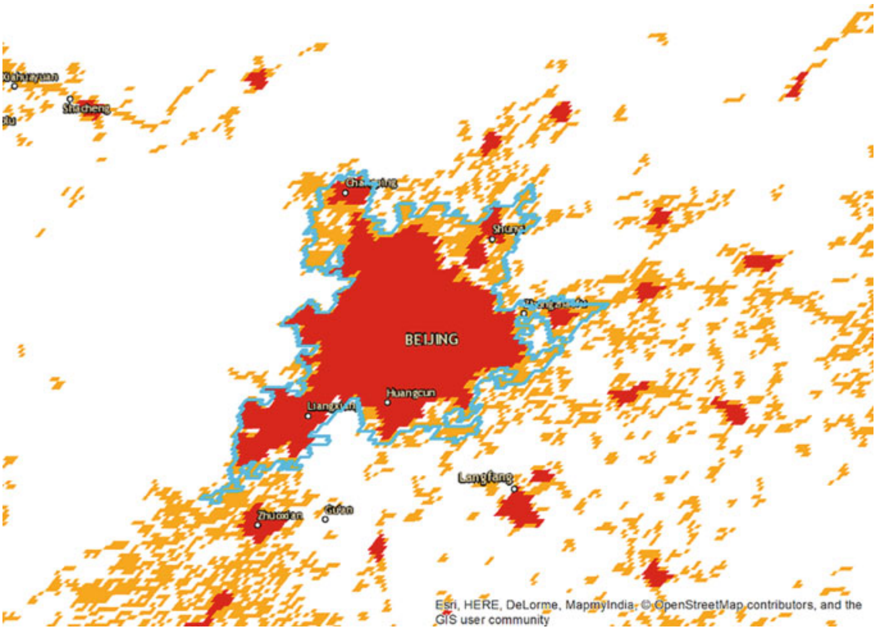


Fig. 2 Beijing 1990: 1900 ha (+918 ha area doubled); 6.9 million people (+ 4.07, 2.4 times 1975 one)

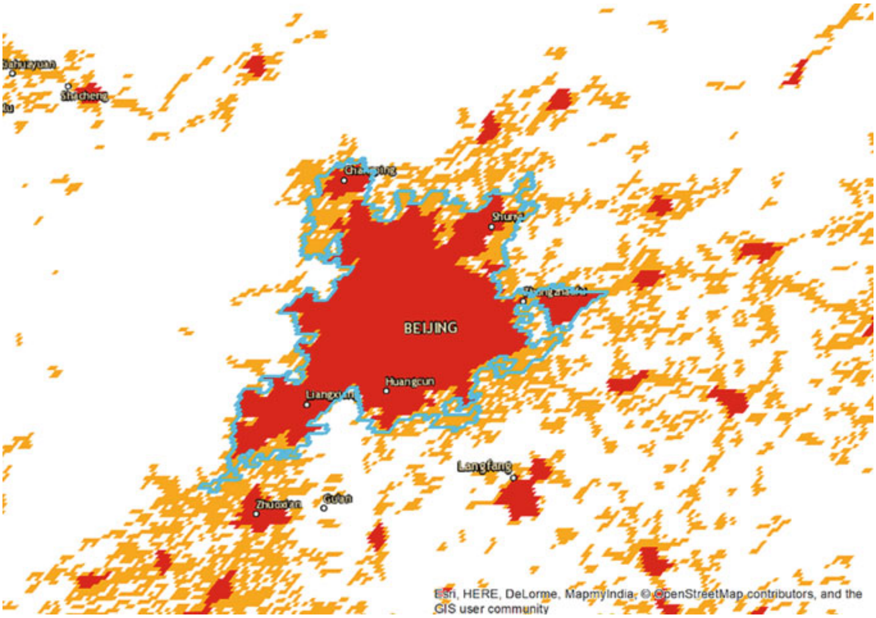


Fig. 3 Beijing 2000: 2100 ha (+268 ha, +14%); 10.8 million people (+56%)

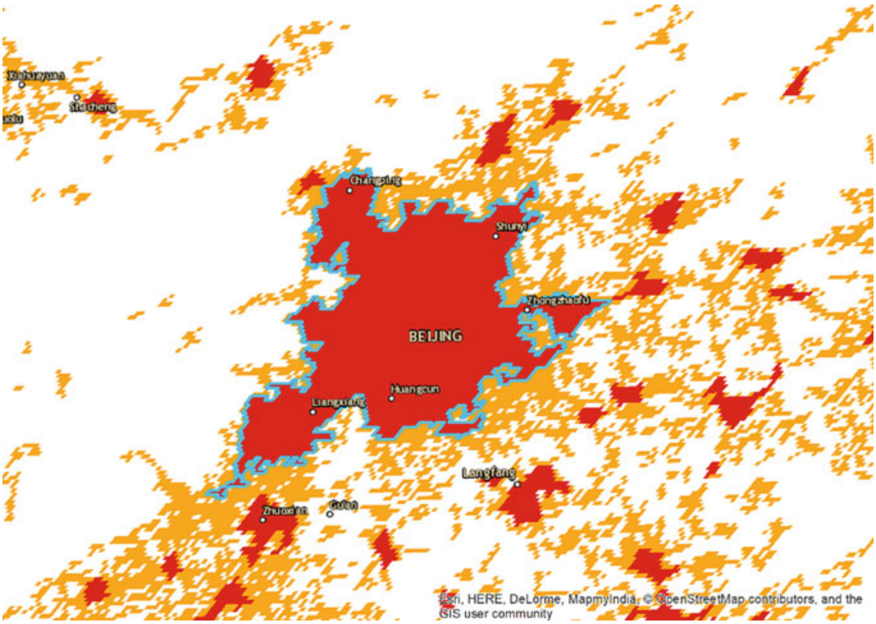


Fig. 4 3000 ha area (+815 ha, +37.4%); 19.9 million people (+9.1, 1.8 times increase)

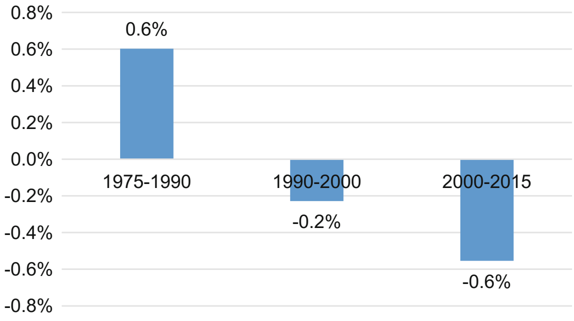


Chart 1 Changes in built-up to area period

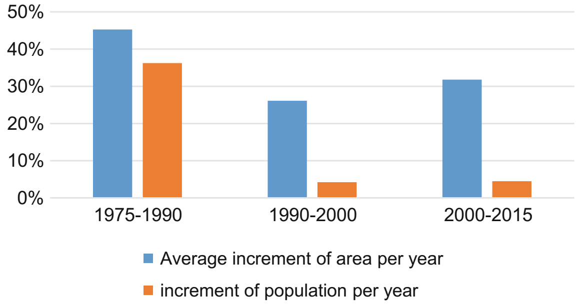
Table 1 Beijing Indicators 1975–1990 to 2000–2015

Beijing				
	1975	1990	2000	2015
Area (ha)	995	1915	2180	2995
Population	2,834,000	6,904,000	10,804,000	19,902,000
Built-up (ha)	755	1580	17,600	2200
BU/Area ratio (%)	75.7	82.6	80.7	74.0
Population density (inhab/ha)	2845.5	3607.4	4951.7	6640.6
Built-up per capita (m^2)	266.2	228.9	163.0	111.4
Area per capita (m^2)	351.4	277.2	202.0	150.6

3.2 Guangzhou

Located in south China on the estuary of the Pearl River, Guangzhou's urban expansion has been remarkable. According to the GHSL database, the area increased by 15 times in 40 years, from 540 to more than 8200 ha: Guangzhou is currently the largest city in the world, followed by Jakarta. The increase occurred

Chart 2 Comparison of yearly growth rate of area and population



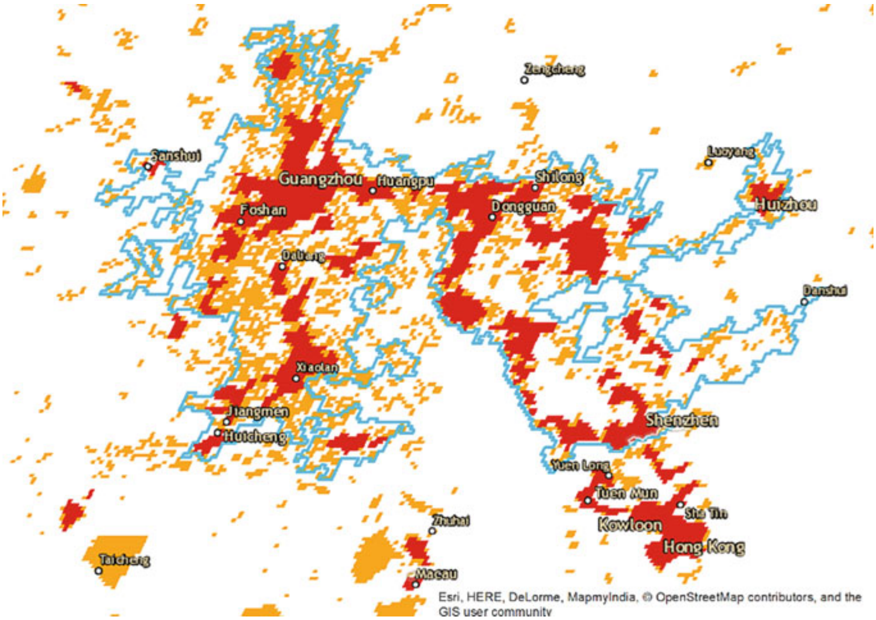


Fig. 5 Guangzhou 1975: 540 ha area, 3 million people

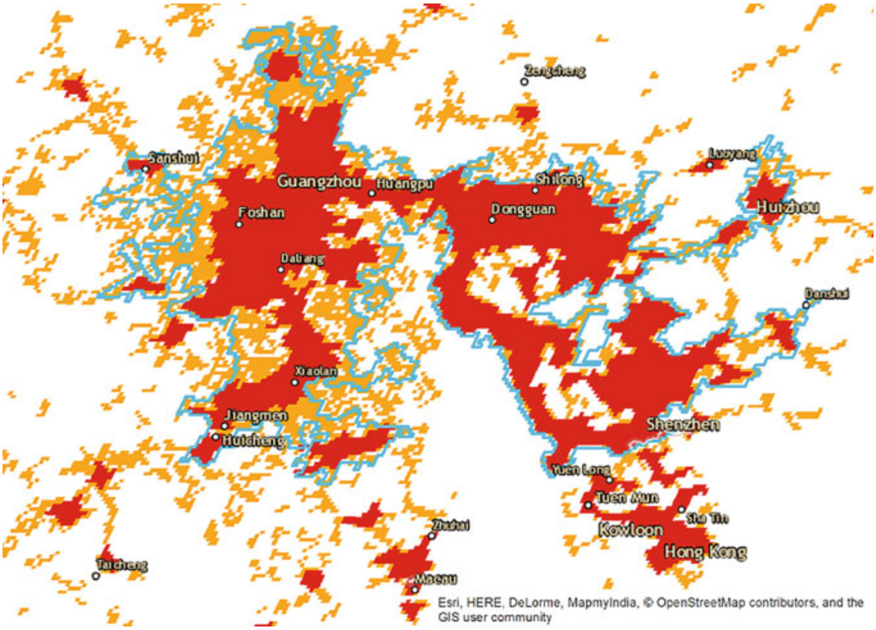


Fig. 6 Guangzhou 1990: 4.200 ha area (+3667 ha), 19 million people (+16 million)

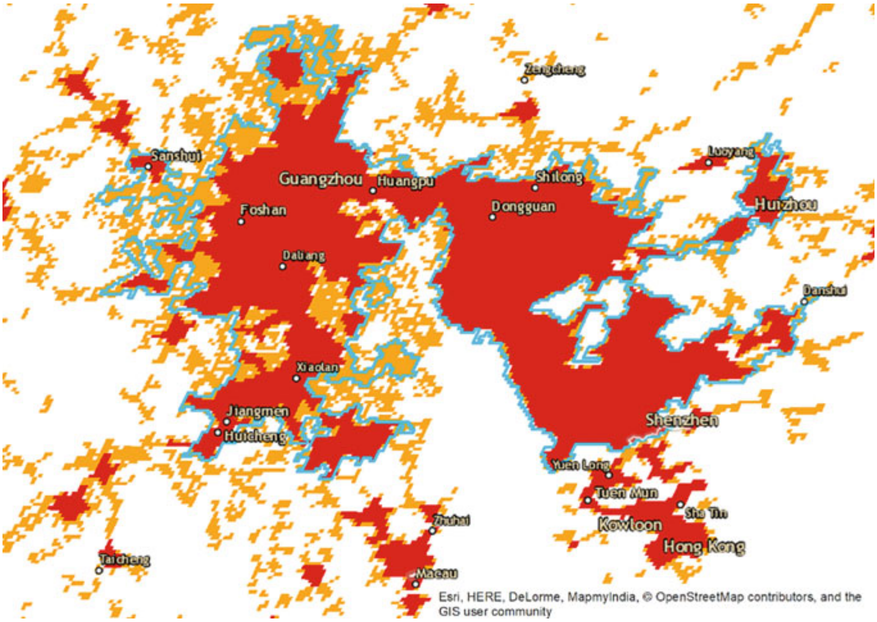


Fig. 7 Guangzhou 2000: 5.600 ha area (+1.410 ha, +33.5%), 27 million people (+8.1 million, +42%)

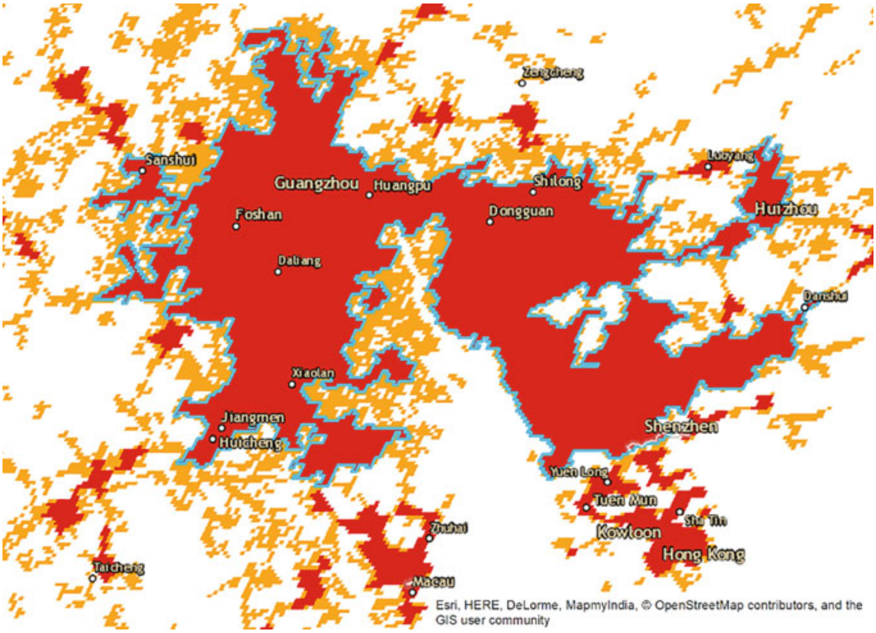


Fig. 8 Guangzhou 2015: 8.100 ha area (+2575 ha, +45.8%), 46 million people (+18.5 million, +42%)

on average by 45% a year between 1975 and 1990; it slowed to 3.4% a year between 1990 and 2000; and it increased again rapidly between 2000 and 2015 (by more than 3.1% a year). In only 15 years, between 1990 and 2015, the area almost doubled. Built-up area in Guangzhou covers today nearly 45% of the total city area. The growth of built-up area has been very fast: in the last 25 years, the surface has doubled, to 3666 ha. Today, Guangzhou's population exceeds 46 million. Figures 5, 6, 7 and 8 show how the surface of Guangzhou urban center in 2015 is the result of the junction of more than 30 urban centers. Two main pattern of growth are observed. In the first period (1975–1990) centers like Guangzhou, Foshan, Huangpu, Dongguan and Shenzhen expands and connect. After 1990 these settlement expand to saturate the shape of the center. First in the eastern part (around Shenzen, between 1990 and 2015), and then in the north and western part (2000 to 2015). Average population growth per year has been faster in the last 15 years (4.5% a year) than between 1990 and 2000 (4.2%) (Chart 2 depicts and compares population to growth of average built-up). The size of the population increment is enormous: between 2000 and 2015, Guangzhou population increased by more than 18.5 million over an expanded settlement area of more than 8100 ha (compared to the area in the year 2000). This impressive growth, also generated by the melding of ten urban centers (Guangzhou, Dongguan, Sanshui, Foshan, Jiangmen, Huichung, Huangpu, Shilong, Shanzen, and Huizou), had impacted the population density of Guangzhou, which exceeds 5600 inhabitants per hectare in 2015. However, the increment of built-up area in Guangzhou has been greater than the increase of population both between 1975 and 1990 and between 1990 and 2000, resulting in a growth of built-up per capita between 1975 and 2000 and, only in the last 15 years, a decrease. Built-up per capita increased from 41 m^2 per capita in 1975, to 74 in 1990 and 86 in 2000; it decreased to less than 80 in 2015. It is also important to point out that Guangzhou expanded its area at a faster rate than its population growth (Table 2).

Table 2 Guangzhou Indicators epochs 1975–1990 to 2000–2015

Guangzhou				
	1975	1990	2000	2015
Area (ha)	540	4200	5600	8200
Population	3,011,000	19,373,000	27,515,000	46,038,000
Built-up	120	1435	2390	3660
BU/Area ratio (%)	22.8	34.1	42.6	44.8
Population density (inhab/ha)	5576.4	4605.1	4898.6	5619.9
Built-up per capita (m^2)	40.9	74.1	87.0	79.6
Area per capita (m^2)	179.3	217.2	204.1	177.9

4 Discussion

This last section of the analysis focuses on the comparison between the plain data and the indicator trend in the two cities.

Between 1975 and 2015 the seven chosen indicators follow three different dynamics in the case study cities:

(a) Area, population, built-up and population density increase both in Beijing and Guangzhou;
(b) Built-up to area ratio increases in Guangzhou and decreases in Beijing;
(c) Area per capita and built-up per capita decrease both in Beijing and in Guangzhou.

Within the dynamic of growth (Case a), the rates of growth of built-up and areas are faster in Guangzhou than in Beijing. Population density (Chart 3) instead grows faster in Beijing up to an average of 3.7% a year between 1990 and 2000 and by 34% between 2000 and 2015—equivalent to over 1600 additional inhabitants per hectare in 15 years.

The divergence of built-up to area ratio (b) (Chart 4): in Beijing, it has decreased since 1990; in Guangzhou, it increases; it doubled in 40 years, moving from 22% in 1975 to 45% in 2015.

Chart 3 Changes in population density 1975–2015

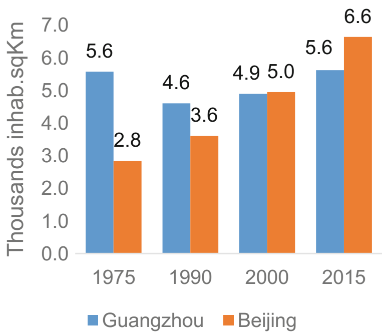
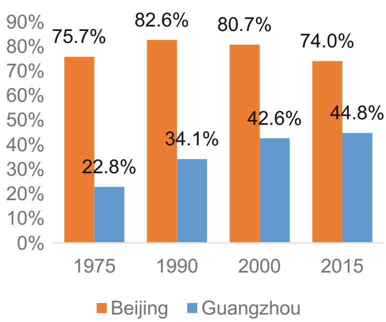


Chart 4 Changes in built-up to area ratio 1975–2015



The common dynamic of decline in built-up per capita (Chart 5) is limited to the period 2000–2015. While the trend of decrease in built-up per capita in Beijing is consolidated, as it occurs since 1975, in Guangzhou there has been a continuous increase up to 2000 (by around 50%); then it starts to decline. However, the absolute value is rather different: in Beijing, built-up per capita in 1990 was more than triple that of Guangzhou. Disparities in built-up per capita in the two cities have reconciled over time.

The process of growth that the two cities encountered is extensive but has taken different forms. Beijing has mainly developed from a single center (that of Beijing) and has expanded around a the core (the original one detected since 1975—Fig. 9).

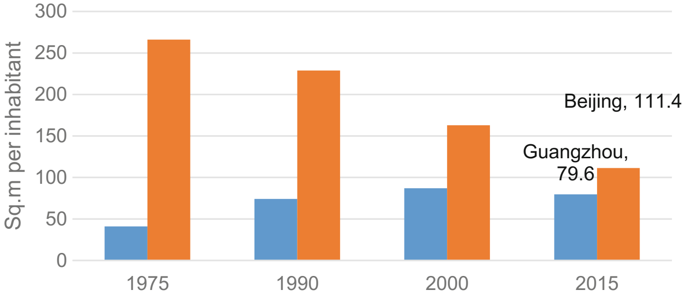


Chart 5 Changes in built-up per capita 1975–2015

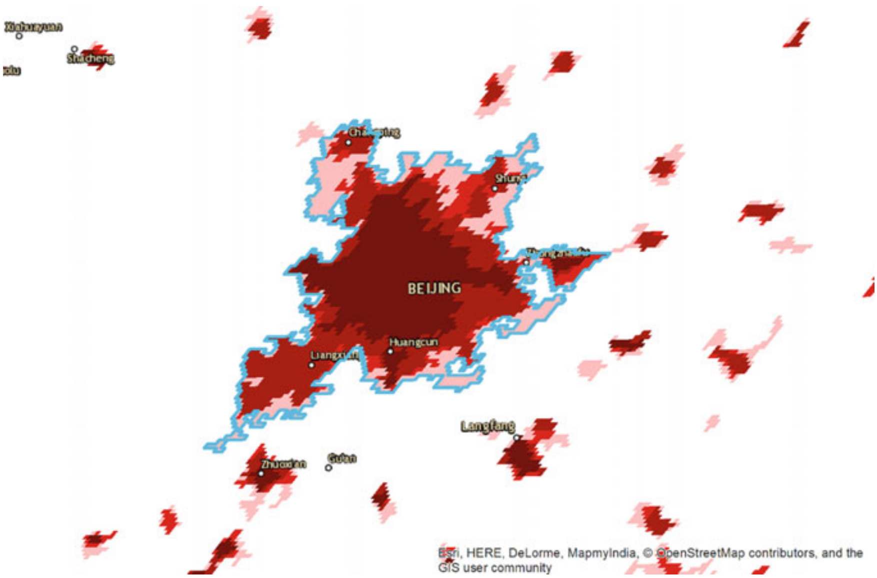


Fig. 9 Multitemporal expansion of Beijing

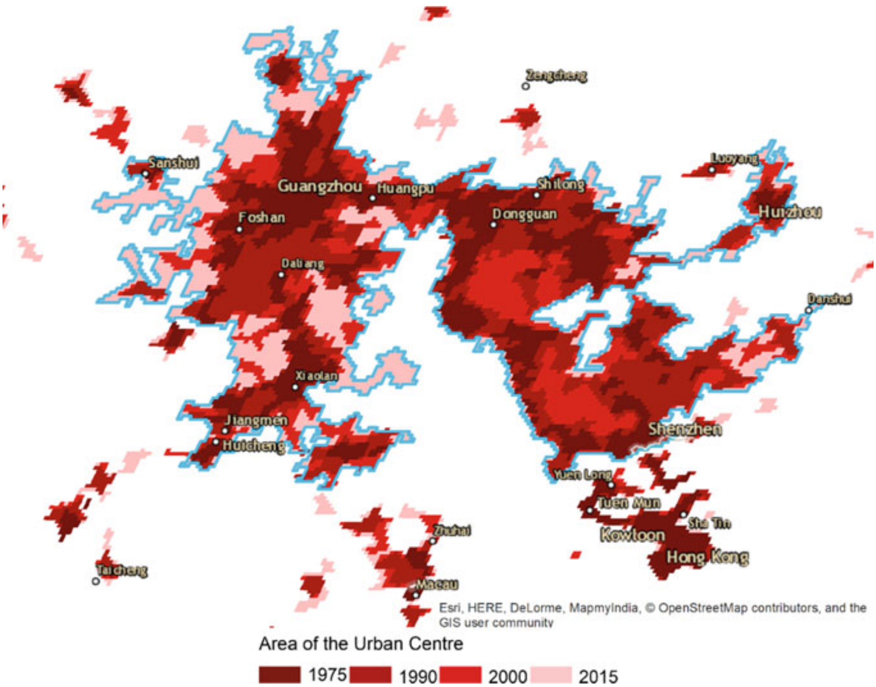


Fig. 10 Multitemporal expansion of Guangzhou

The development of Guangzhou has the trait of extensive conurbation (Schneider and Woodcock 2008). The 30 centers progressively expand and connect one another. A process of extension and gap filling has occurred only in most recent epochs (Fig. 10).

5 Conclusion

This paper proposed a methodology to analyze in a comparative way cities around the globe thanks to the opportunity provided by the Global Human Settlements Layer datasets. The GHSL is one of the most complete and up-to-date big-data layers for territorial analysis and has global coverage. Therefore, the effort to showcase its potential and the research to identify suitable indicators for urban analysis—including some of the Sustainable Development Goals targets—is relevant for launching a global evidence-based and consistent comparative study of the process of growth of cities around the world.

This paper also showcased the rapid and paramount process of urban expansion that the cities of Guangzhou and Beijing experienced between 1975 and 2015.

It is impressive to track that, just in the last 15 years, Guangzhou added more than 18.5 million inhabitants (less than 10 million in Beijing) which exceeded the total population of Chile in 2015.

References

Center for International Earth Science Information Network—CIESIN—Columbia University. (2016). *Gridded population of the world, version 4 (GPWv4): Population density*. Palisades, NY: NASA Socioeconomic Data and Applications Center (SEDAC). http://dx.doi.org/10.7927/H4NP22DQ.

Geertman, S., Toppen, F., & Stillwell, J. (2013). *Planning support systems for sustainable urban development*. Heidelberg: Springer.

Habitat, U. N. (2015). *International Guidelines on Urban and Territorial Planning: Towards a Compendium of Inspiring Practices*. Nairobi: UN HABITAT.

Matsumoto, T., Sanchez-Serra, D., & Ostry, A. (2012). *Compact City Policies: A Comparative Assessment*. OECD.

Melchiorri, M., & Siragusa, A. (2016). City analysis using the GHSL, an example of city ranking. In M. Pesaresi, M. Melchiorri, A. Siragusa, T. Kemper (Eds.), *Atlas of the Human Planet 2016. Mapping Human Presence on Earth with the Global Human Settlement Layer*. EUR 28116 EN. https://doi.org/10.2788/889483.

Pesaresi, M., Ehrlich, D., Ferri, S., Florczyk, A., Freire, S., Halkia, M., et al. (2016). *Operating procedure for the production of the Global Human Settlement Layer from Landsat data of the epochs 1975, 1990, 2000, and 2014*. JRC Technical Report.

Pesaresi M., Melchiorri M., Siragusa A., & Kemper T. (2016). *Atlas of the Human Planet 2016. Mapping Human Presence on Earth with the Global Human Settlement Layer*. EUR 28116 EN. https://doi.org/10.2788/889483.

Schneider, A., & Woodcock, C. E. (2008). Compact, dispersed, fragmented, extensive? A comparison of urban growth in twenty-five global cities using remotely sensed data, pattern metrics and census information. *Urban Studies, 45*(3), 659–692.

Taubenböck, H., Esch, T., Felbier, A., Wiesner, M., Roth, A., & Dech, S. (2012). Monitoring urbanization in mega cities from space. *Remote Sensing of Environment, 117,* 162–176.

Datasets

Pesaresi, M., & Freire, S. (2016). *GHS settlement grid following the REGIO model 2014 in application to GHSL Landsat and CIESIN GPW v4-multitemporal (1975-1990-2000-2015)*. European Commission, Joint Research Centre (JRC) [Dataset] PID. http://data.europa.eu/89h/jrc-ghsl-ghs_smod_pop_globe_r2016a.

Social Acceptance of Energy Retrofit in Social Housing: Beyond the Technological Viewpoint

Jessica Balest and Daniele Vettorato

Abstract Optimized energy systems are achieved by an increase in energy efficiency in parallel with energy savings. SINFONIA is an FP7 European-funded project that aims to implement smart initiatives for optimized energy systems through deep-energy retrofit of social housing buildings in middle-size European cities (i.e., Bolzano, Italy). From a technical viewpoint, the project's main challenge is facing retrofit interventions in inhabited flats; from a social one, the challenge is engaging tenants in the project to achieve an effective decrease in energy consumption through a change in energy use, behaviors, and practices. The bridge between technical and social viewpoints is created thanks to an engagement process of tenants that has the support of some tools, such as the smart-energy meter. The involvement of tenants in engagement activities and smart-energy meter interaction must necessarily account for their characteristics as social actors. A thorough description and analysis of tenants' characteristics is therefore one of the most important starting points in such a research project. The aim of our work is to support experts in the design of smart-energy meters providing them with a methodology for the description and analysis of tenants' characteristics and social contexts. We perform a cluster analysis on the socio-demographic data of tenants involved in the Bolzano SINFONIA case study, identifying three relevant clusters according to family characteristics. Our future research will focus on the design of smart-energy meters and the development of participatory and learning activities addressed to SINFONIA tenants in order to ensure energy savings.

Keywords Smart-energy meter · Energy retrofit · Social housing
Cluster analysis · Tenants' profile

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Green Energy and Technology, https://doi.org/10.1007/978-3-319-75774-2_12

1 Introduction

With the aim of meeting the worldwide goal of keeping global temperature rise below 2 °Cs (Unfccc 2015; COP22 2016), several European projects address issues related to climate change. In this context, technological innovation can contribute to increased energy savings (European Community 2009), efficiency (European Union 2012), production from renewable sources (European Community 2009), and the sustainability of energy systems (Rösch et al. 2017).

However, not only does building a new technology framework require a change in people's energy behavior, but most importantly it also requires a social change (Moriarty and Honnery 2012). While government policies may impact individuals' decisions, encouraging them to act in certain ways to reduce their energy consumption and environmental footprint, the final choice is left to the people themselves (Moriarty and Honnery 2012). Energy retrofit by itself is not sufficient to achieve energy saving goals; likewise, technologies alone are not decisive elements in addressing energy use.

It is the people who actually live in the retrofitted buildings and use the energy and all new related technologies (Rösch et al. 2017; Haas et al. 1998). Therefore, the people have either a direct impact on energy consumptions (i.e., by operating windows, blinds and thermostats, and by switching on or off mechanical ventilation), or an indirect one related to variable occupancy schedules and usage patterns. A household's daily life follows its own rhythm and rituals, whereas people are not always aware of how and why these rituals are performed or which ones are easily changeable (Shove 2003). Learning and participative activities can collect information for answering a few key questions, particularly:

- Are people interested in changing their behaviors to reduce energy consumption?
- Do people know how new technologies can help to increase energy savings in their flats?
- Are people interested in the effective use of new technologies in their flats?

Learning and participative activities can increase the knowledge, awareness, and commitment of inhabitants (Haas et al. 1998) toward a correct use of technologies for energy-systems management and to enhance opportunities to save energy and resources. These activities focus also on the context tenants live in since families influence individual energy use, habits, and practices (D'Oca et al. 2014; Whitmarsh et al. 2011; Chirot 1994).

SINFONIA[1] (an FP7-funded project) investigates the interaction between both technological and social changes through energy retrofit and learning and participatory activities with the main aim of saving energy in middle-size European cities. SINFONIA's energy retrofit is based on interventions such as thermal insulation, mechanical ventilation, renewable energy plants (i.e., solar and geothermal), and

[1]http://sinfonia-smartcities.eu/.

data-monitoring systems. Retrofit interventions are made easier by the generally low percentage of ownership in the social housing flats, which permits intervention on a higher number of units. The central issue of interventions' success is however still the tenant component.

Reflecting awareness of the importance of social change in energy use to achieve energy-saving goals, SINFONIA underlines the need to promote and organize learning and participatory activities to promote a change in energy-use behaviors. These activities consist of meetings for collecting research data, increasing people's knowledge on energy technologies and their correct use, and, on the other hand, increasing researchers' awareness of the importance of changing energy use, habits, and practices. Among the tools developed by the project is the smart-energy meter which shows real energy consumptions and makes suggestions to tenants how to increase savings (D'Oca et al. 2014; Geelen et al. 2013; Hargreaves et al. 2010). In order for the smart meter to be effective, one must consider its real public, i.e., the users.

In this paper, we consider the case study of the Municipality of Bolzano including 12 social-housing buildings to be retrofitted, with a total of 795 tenants involved. Our sociodemographic analysis of the 795 tenants (grouped into 385 families) defines the smart-energy meter users. Our future research will analyze their preferences through a literature review and data collection. These elements will be taken into account for the design of the smart-energy meter.

2 Case Study

In this research, we use case-study methodology to examine in-depth and interpret the Bolzano case (Johansson 2003). In fact, the SINFONIA project bases its activities on Bolzano's social-housing buildings and residents' characteristics. For this paper, we collect tenants' sociodemographic data. When data collectors circulate among social-housing building owners, they act according to the National Privacy Law regarding the use of tenants' personal data. In the Italian context, the relevant law is the Legislative Decree Number 196 of 30 June 2003. Each European country has its own law for guaranteeing individuals their rights for the privacy of their personal data, involving methodological ethics of research that underlines the need for anonymization of data (Moore 2012) and results (Mietola et al. 2017). Research ethics are more important in confidential sectors (medicine) and topics (i.e., disabilities) (Mietola et al. 2017), but it is an important issue throughout the wider social sciences.

Once the data collection has been made, we divide analysis into two steps. In this paper, we describe tenants according to the neighborhood, gender, age, citizenship, and language, while in the second step of this research we describe tenants according to their family characteristics. Sociodemographic data are predictors of energy uses (Frederiks et al. 2015):

- Description of individuals is based on sociodemographic variables which can influence energy behaviors: gender and age detail various needs and uses; citizenship expresses cultural differences on energy viewpoints, practices, and habits; and language. The language and bilingualism are culturally relevant in the Autonomous Province of Bolzano.
- Families are contexts in which tenants act energetically. A family's features include its household size and stage of the family life cycle (Fischer 2008). The higher is household size, the higher is energy consumption. However, the largest sized families minimize *pro capita* energy due to the sharing of energy services. The size, ages, and genders of components affect the stage of each family life cycle and the levels and patterns of household energy consumption (Frederiks et al. 2015).

Individual and family's characteristics are predictors of energy behaviors. We investigate them through **cluster analysis**.

3 Procedure

The procedural steps are:

1. To cluster the tenants in groups according to their characteristics using a cluster analysis.
2. To elaborate participatory and communication strategies customized for each social cluster identified by the cluster analysis.

4 Cluster Analysis

Cluster analysis is a multivariate method used to create natural groups of individuals (or clusters) according to their characteristics (Hardle and Simar 2015). Cluster analysis is the chosen method because the number and the characteristics of the groups of individuals were not known a priori in SINFONIA projects. We need analytical tool explaining families' features according to the case-study data. Accordingly, we group clusters using hierarchical algorithms.[2] The ***hierarchical algorithms*** with ***agglomerative procedure*** calculates the amount of pairwise differences between individuals. In practice, this algorithms agglomerates clusters starting from the separation of an each individual in its own cluster. Gradually, the

[2]Without knowing the right number of clusters a priori, we apply some indices to confirm it, i.e., Hopkins statistics, indices included in NbClust command elaborated in R language (Charrad et al. 2014), and the silhouette cluster plot.

two closest individuals are combined to form clusters that have the greatest interior homogeneities and the largest distances between them (***complete-linkage method***).

Beyond retrofit interventions, tenants are central actors in an effective reduction in energy consumption. Indeed, we investigate tenants' characteristics in the Bolzano case study. Bolzano is a middle-sized city in the Alps in Northeast Italy with 106,441 inhabitants over an area of 52.29 km^2 (in 2016). Bolzano has a high population density, especially if we compare it with regional ones: 2036 inhabitants per km^2 for the Municipality of Bolzano versus 68.21 km^2 for the entire province.

The SINFONIA project focuses on the social-housing residential sector, owned by the Municipality of Bolzano and IPES (Social-Housing Institute of the Autonomous Province of Bolzano). The SINFONIA project comprises 12 social-housing buildings which are distributed in the western part of Bolzano (Fig. 1) and includes 385 flats with 795 tenants.

Even if the Autonomous Province of Bolzano recognizes bilingualism (Italian and German), the 795 tenants have mainly Italian citizenship and Italian as mother

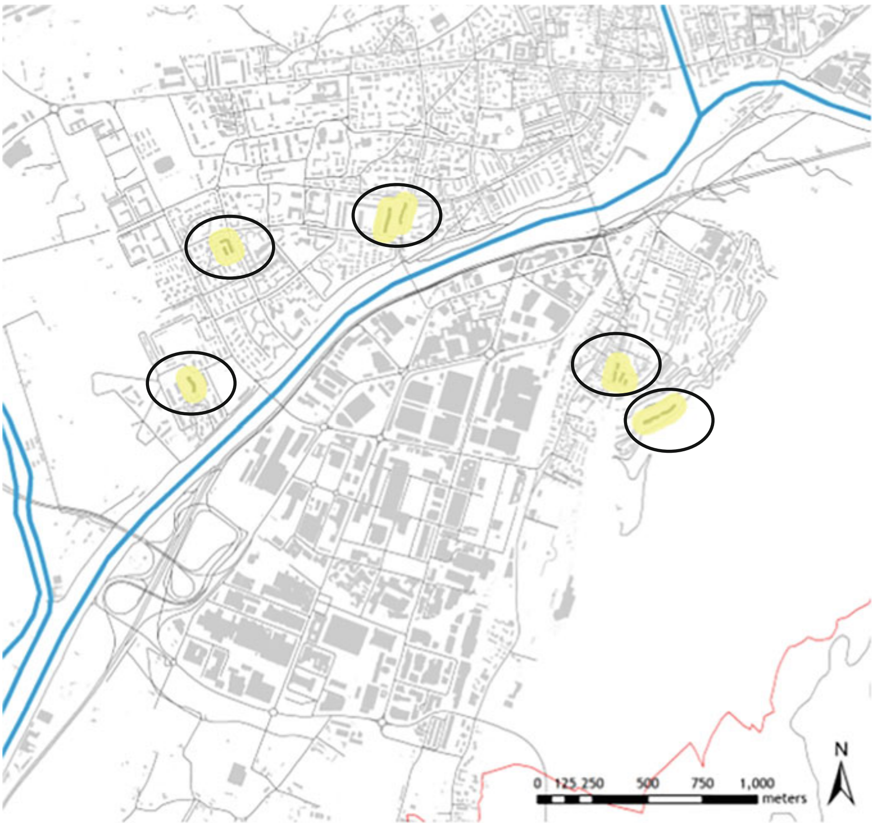

Fig. 1 Western part of Bolzano including the 12 social housing buildings of the SINFONIA project

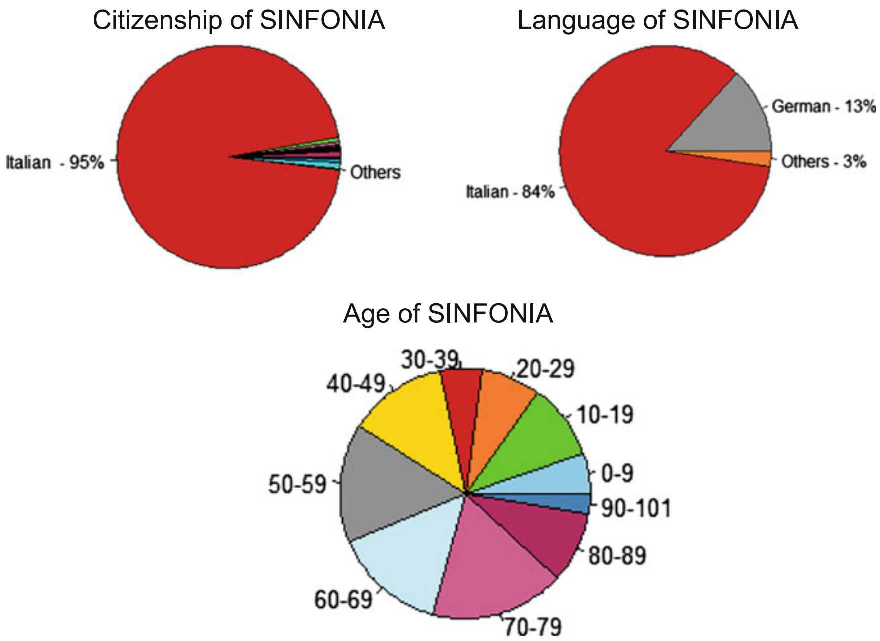

Fig. 2 Citizenship, language, and age of SINFONIA tenants in Bolzano

tongue (Fig. 2). They are equally divided in gender, and the majority of them are 40–80-years old. Further, we can cluster individuals based on their social context and, in particular, family environment.

Here, we investigate family environment based on some sociodemographic data (number of family members, their ages, and their interrelationships), recognizing three relevant clusters:

- The first cluster (CLUSTER 1) includes 350 tenants who are 60–101 years old and live in one or two component families (Figs. 3, 4 and 5), primarily composed of the main tenant or the wife and husband. The first cluster includes "aged people".
- The second cluster (CLUSTER 2) is both the less numerous with 144 tenants and the most well-grouped in this analysis (Fig. 7). They are the "children" 0–23-years old. The heart of this cluster is composed of adolescents (13–19-years old).
- Finally, the third cluster (CLUSTER 3) is labelled "young parents" and includes adults 23–59-years old with two, three, or four members. The structure of these families includes the main tenant, wife or husband, and one or more children, totaling 301 tenants.

These three clusters are the target groups for the smart-energy meter and they are shown in the cluster dendrogram (Fig. 3), which shows three well-grouped clusters

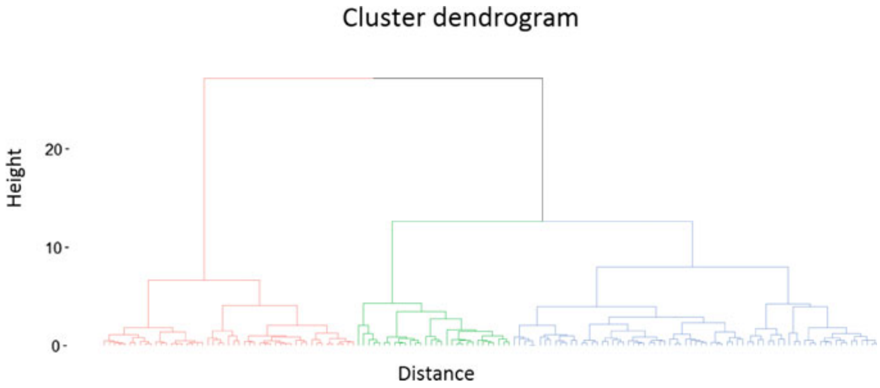

Fig. 3 Cluster dendrogram indicating the three clusters of individuals

Fig. 4 Age of individuals who are included in the three clusters. The underlined horizontal line is the median of cluster age, while the box includes the majority of individuals. However, some individuals are a bit outside of one outlier (the circle)

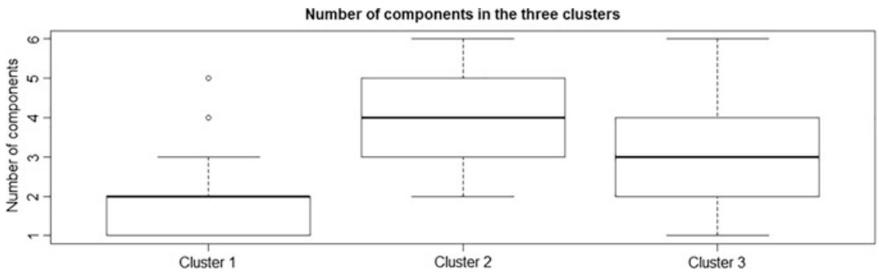

Fig. 5 Number of family's components. The underlined horizontal line is the median of the number of components per each cluster. Here, the outliers (circles) are two. The other horizontal lines indicate quartiles

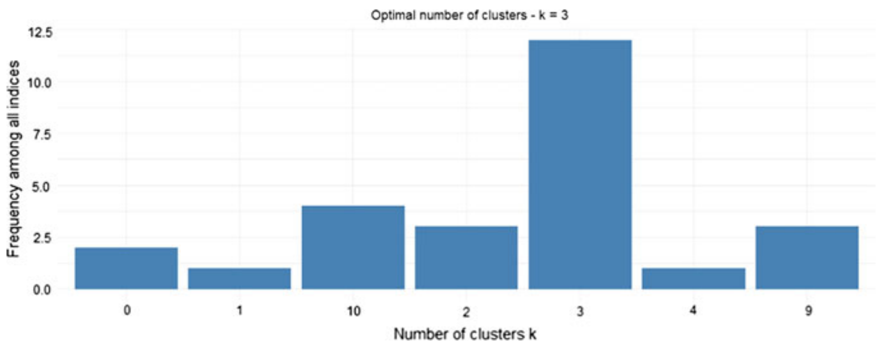

Fig. 6 Optimal number of clusters according to the NbClust R package

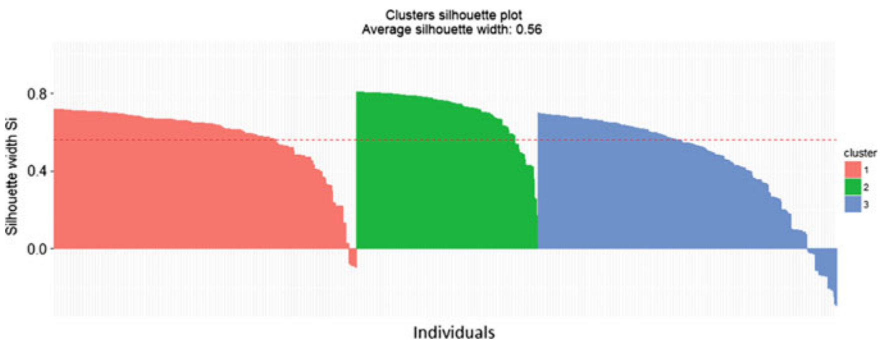

Fig. 7 Cluster silhouette plot. On the x axis are the individuals. On the y axis, there is the closeness to the value one, which means the individuals are well-fitted in the cluster. In this case, the average silhouette is also quite close to one

according to vertical lines whose height indicates the size. The three groups cluster all 795 individuals who are located at the bottom of dendrogram. The positioning represents the distance between individuals, while the height shows the distance between clusters: the greater the height, the greater is the homogeneity within the cluster and the unevenness between clusters.

The natural number of clusters is three and several indices confirm it. First, the Hopkins statistics is close to 0 (0.2837314), confirming the relevance of the three clusters. Second, we use the 30 indices of NbCluster seeking the best number of clusters between 0 and ten. Among all 30 indices, two propose zero as the best number of clusters, one indices proposes one, three propose two, 12 propose three, one proposes four, three propose nine, and four propose ten (Fig. 6). Therefore, 30 indices still confirm three important clusters. Finally, we use silhouette plot showing three well-grouped clusters with significant values of width closed to one (Fig. 7).

5 Strategies for the Social Clusters

Social change in families and neighborhoods reflects energy behavior changes. Several families live in the SINFONIA neighborhoods, and their characteristics are investigated for designing an engagement process and smart-energy meter to increase opportunities for social and energy-behavior changes. A smart-energy meter is a tool that combines communication strategies and graphical real-time and historical feedback based on the monitoring system (Fischer 2008). An effective smart-energy meter is designed based on the tenants' features identified in the case study.

The CLUSTER 1 of families includes 350 tenants who are 60–101-years old and live in one- or two- member families, mainly composed of the main tenant and wife or husband. These families should consume less energy thanks to the low number of components (Frederiks et al. 2015). However, they include the majority of tenants in the SINFONIA case study, so we design the smart-energy meter for them, as well for the other two clusters of families. Aged people should readily watch the smart-energy meter and easily understand its contents. The colors and dimensions of the contents and characters are carefully chosen. Further, concepts included in smart-energy meters are very simple, especially those concepts that are currently fashionable ("the new public concepts", such as CO_2 emissions). The group with children has different needs and preferences.

The less numerous cluster (CLUSTER 2) includes 144 tenants aged 0–23-years old with a large core of 13–19 years old. This group of people is more easily reachable (e.g., through schools), and it can easily influence the other family's members (Zografakis et al. 2008) to affect energy-behavior change. For example, they can influence their parents. The third cluster (CLUSTER 3) is composed of 301 "young parents" aged 23–59 years old in families with 2–4 members. Surely, this typology of family has different household energy patterns based on the stage of the family life cycle (Frederiks et al. 2015), which can include childcare and/or the parents' absence from home. The design of engagement activities of tenants and smart-energy meters consider all these aspects.

The three clusters include all 795 tenants who live in the flats that will be energy retrofitted. Even if the majority of tenants are 40–80-years old, we will cater the smart-energy meter design to the heart of the three clusters. In particular, the second cluster with "children" who live in the most numerous families (3, 4, and 5 components) is central. The heart of this cluster is 13–19-year olds. In addition, the "aged-people" cluster contains the majority of people, and its heart includes 69–81-year olds who live in one- or two-member families. We will mainly address learning activities and smart-energy meter design to the heart of the "aged-people" group (first cluster) and "children" group (second one) that will probably influence the other component groups and engage the "young parents" (third one).

The preferences of these people and the capability of engagement tools to change their energy behaviors will be more deeply investigated in the literature and further research.

6 Conclusion

Mere energy retrofit actions do not necessarily lead to a decrease in energy consumption. To achieve that, well-informed energy use, habits, and practices are of central importance. We believe that learning and participatory activities involving the actual users increase energy savings beyond the results produced by retrofit activities. Therefore, SINFONIA focuses on the investigation of family characteristics and environmental contexts. Individual characteristics are in turn clustered into individual and contextual ones. Context in this case refers to the family. In our analysis, we distinguish three groups of individuals based on the number of family members, their ages, and their interrelationships. This analysis supports the design of a smart-energy meter that, integrated with other activities, aims to change energy behavior and increase energy savings.

Our analysis concludes that, even though all ages matter in our case study, "aged people" and "children" count the most in designing the smart-energy meter. In fact, "children" can more quickly improve and influence the energy behaviors of numerous group of people. In addressing the design of the smart-energy meter, preferences in the "children" age class 0–23 are very heterogeneous. This leads us to consider instead the heart of the cluster, represented by the age class 13–19, living in families of three–five members.

Our current analysis aims to clarify the importance of addressing project activities to real individuals and groups. However, this is only the starting point for a deeper analysis that includes also other important characteristics such as tenants' knowledge of energy issues, their preferences on visualization aspects, and the wider context they live in (i.e., neighborhoods, peer-to-peer groups). Further research will focus on these aspects. The methodology can be used in other European cities, and the strategies used for the social clusters of this research can be replicated.

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References

Charrad, M., Ghazzali, N., Boiteau, V., & Niknafs, A. (2014). NbClust: An R package for determining the relevant number of clusters in a data set. *Journal of Statistical Software, 61*(6), 1–36.

Chirot, D. (1994). *How Societies Change* (pp. 184). Pine Forge Press.

COP22. (2016, November). Informal Consultation on the First Session of the Conference of the Parties Serving as the Meeting of the Parties to the Paris Agreement (CMA 1) and on Item 4 of the Agenda of COP22.

D'Oca, S., Corgnati, S. P., & Buso, T. (2014). Smart meters and energy savings in Italy: Determining the effectiveness of persuasive communication in dwellings. *Energy Research & Social Science, 3,* 131–142.

European Community. (2009). Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC. *Official Journal of the European Union*, 60.

European Union. (2012). Directive 2012/27/EU of the European Parliament and of the Council on Energy Efficiency, amending Directive 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC. *Official Journal of the European Union*, 56.

Fischer, C. (2008). Feedback on household electricity consumption: A tool for saving energy? *Energy Efficiency, 1*(1), 79–104.

Frederiks, E., Stenner, K., & Hobman, E. (2015). The socio-demographic and psychological predictors of residential energy consumption: A comprehensive review. *Energies, 8*(1), 573–609.

Geelen, D., Reinders, A., & Keyson, D. (2013). Empowering the end-user in smart grids: Recommendations for the design of products and services. *Energy Policy, 61,* 151–161.

Haas, R., Auer, H., & Biermayr, P. (1998). The impact of consumer behavior on residential energy demand for space heating. *Energy and Buildings, 27*(2), 195–205.

Hardle, W. K., & Simar, L. (2015). *Applied Multivariate Statistical Analysis* (p. 800). Berlin, Heidelberg: Springer.

Hargreaves, T., Nye, M., & Burgess, J. (2010). Making energy visible: A qualitative field study of how householders interact with feedback from smart energy monitors. *Energy Policy, 38*(10), 6111–6119.

Johansson, R. (2003). Case study methodology. In *International Conference Methodologies in housing research*. Stockholm: Royal Institute of Technology and International Association of People-Environment Studies.

Mietola, R., Miettinen, S., & Vehmas, S. (2017). Presenting and representing others: Towards an ethics of engagement. *International Journal of Social Research Methodology, 20*(3), 299–309.

Moore, N. (2012). The politics and ethics of naming: Questioning anonymisation in (archival) research. *International Journal of Social Research Methodology, 15*(4), 331–340.

Moriarty, P., & Honnery, D. (2012). Preparing for a low-energy future. *Futures, 44*(10), 883–892.

Rösch, C., Bräutigam, K., Kopfmüller, J., Stelzer, V., & Lichtner, P. (2017). Indicator system for the sustainability assessment of the German energy system and its transition. *Energy, Sustainability and Society, 7*, 13.

Shove, E. (2003). *Comfort, cleanliness and convenience: the social organization of normality* (p. 240). Berg Publishers.

Unfccc. (2015). Paris Agreement (22nd April 2016).

Whitmarsh, L., O'Neill, S., & Lorenzoni, I. (2011). *Engaging the public with climate change: Behaviour change and communication* (p. 288). Routledge.

Zografakis, N., Menegaki, A. N., & Tsagarakis, K. P. (2008). Effective education for energy efficiency. *Energy Policy, 36*(8), 3226–3232.

A Goal-Oriented Framework for Analyzing and Modeling City Dashboards in Smart Cities

Katiuscia Mannaro, Gavina Baralla and Chiara Garau

Abstract For several years, many cities around the world are moving through a number of initiatives to implement the so-called "city dashboards", as an opportunity for a new quality of urban life in terms of knowing and governing cities. The main contribution of this paper is to examine how city dashboards are performing on various metrics and comparing them in order to understand what they do. Starting from this perspective, to the best of our knowledge and by examining dashboard examples, there are many differences in the products that go by the name "city dashboards". Moreover there are several methodological and technical issues that are not dealt with and yet solved in terms of data, indicators and benchmarking. The design of a city dashboard needs a clear vision of the direction that public administrations intend to undertake, alongside an ability to build scenarios and analyze the results of experiments in the context of the changing urban variables. Given the gap in academic literature concerning this subject, we developed a goal-oriented framework for examining the characteristics of various city dashboards and developing a taxonomy. Our framework enables a more systematic process for developing an effective city dashboard and provides useful insights to decision makers. The results suggest that some features emerge and our findings highlight specific clusters.

Keywords City dashboard · Urban governance · Taxonomy · Smart cities, goal/question/metric

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1 Introduction

For several years, many cities around the world are moving through a number of initiatives to implement so-called “city dashboards”, as an opportunity for a new quality of urban life in terms of knowing and governing cities. As the term “city dashboard” gains wider and wider adoption, there is still confusion about what a city dashboard is.

Basically, the city dashboards’ implementation has faced both the innovative technological processes and societal perspectives, it has to be used in response to users’ needs, residents’ well-being and city sustainability. Therefore, the same concept of city dashboard has assumed different definitions, not only on the basis of the displayed and offered services, but also in response to social challenges that the cities of the future will be required to confront. Generally speaking, a city dashboard is a big data platform designed, on the one hand, to allow city’s users to get up-to-date information about a city and, on the other hand, to give access to a wide range of datasets about the city to help decision makers. This tool consists of several modules, each of which contains a number of applications that display various data about the city (e.g., real-time data, such as temperature, humidity, air quality, number of car-rental locations, traffic cameras, static data, indicators etc.) (Kitchin et al. 2015).

The proliferation in recent years of various styles of dashboards has led us to attempt to clarify understanding about this tool. Even if city dashboards are defined and shaped in relation to the needs of the urban context and of the local public administrator’s goals, the design of a city dashboard requires a clear vision of the direction that public administrations intend to undertake, as well as an ability to build scenarios and analyze the results of experiments in the context of changing urban variables.

This paper aims to clarify the features of the city dashboards in the context of the smart-cities paradigm, due to the gap in the academic literature concerning this subject. We developed a taxonomy for analyzing the characteristics of various different city dashboards by using an approach based on a goal-oriented framework.

Starting from these statements, the paper is organized as follows. Section 1 provides an introduction and the motivations for the paper. Section 2 discusses the relevant literature on city dashboards and presents some types of city dashboards and their roles. Section 3 analyzes their salient features and describes the framework in order to support the elicitation of dashboard requirements. Section 4 presents the research results. Finally, Sect. 5 states conclusions and suggest future research.

2 State of the Art

Many governments are considering to implement city dashboards for their cities and to use this technology to improve the performances of urban services and, consequently, of smart-city governance. According to Meijer and Bolívar

(2016: 392), we accept the following definition of smart-city governance: “smart city governance is about crafting new forms of human collaboration through the use of ICTs to obtain better outcomes and more open governance processes”. Recently, smart-city governance has been related to the city-dashboard tool. This emerging topic has been attracting increasing attention from scholars, public administrators and politicians (Kitchin et al. 2015, 2017; Osella et al. 2016). In this context, city-dashboard implementation has become very popular as a means to present big data in effective way and to communicate important information in a clearly and efficiently way. Suakanto et al. (2013: 1) assume that a smart-city dashboard can help to predict and accommodate the daily citizens’ needs thanks to data monitoring. Dameri (2016: 71–72) defines a smart-city dashboard as a big data platform enabled to “measure the smartness of a city, both to evaluate the reached goals and support further decisions, investments and initiatives”. Kitchin and McArdle (2016: 2) state that “city dashboards use visual analytics—dynamic and/or interactive graphics (e.g., gauges, traffic lights, meters, arrows, bar charts, graphs), maps, 3D models and augmented landscapes—to display information about the performance, structure, pattern and trends of cities”. Usurelu and Pop (2017: 94) consider the city dashboard as a tool “primarily concerned with processing large amounts of heterogeneous data from sensors, cameras, social streams, user generated content and data produced by city authorities, and displaying it in an easy to consume form”. According to Fegraus et al. (2012), a city dashboard, a web-based decision support tool, is a key cyber infrastructure component designed to satisfy the smart-city objectives and urban ecosystem services. However, government logic is moving from using city dashboards for monitoring and disciplining city users to controlling and influencing their actions, behaviors, effects and opinions (Kitchin et al. 2017).

In particular, browsing online, we found many examples of city dashboards, such as screen-based displays that show the most important performance indicators, city users’ behavioral analysis, multi-charts used for data analysis with a series of interactive tools that graph historical data, real-time traffic information, real-time public transportation schedules, and so on. Tables 2 and 3 in Sect. 3 summarize a bird’s-eye view of the twenty-five most representative online city dashboards that we selected.

The aforementioned smart city-dashboards offer various user friendly interfaces and data. We noted that there are many different ideas of what a dashboard is, and, because they are not based on an international standard, they lack diverse viewpoints (temporal, spatial, and so on) for various types of users (Zdraveski et al. 2017: 36) and depend on policies, indicators and benchmark selections, their communication and visualization, their deployment and their intended use (Kitchin et al. 2015).

This amplifies the key characteristics of an ideal city dashboard. In addition, today’s cities are extremely complex systems in which the materiality of the places interacts with the immateriality of the information in accordance with the smart-city paradigm (Caragliu et al. 2011; Angelidou 2015; Ahvenniemi et al. 2017; Carta 2017).

For this reason, we feel the need to understand how cities are being analyzed and monitored through city dashboards in order to frame them within a more all-encompassing vision.

3 Method

In order to structure our analysis, we followed the well-known paradigm called Goal Question Metric (GQM) Approach, proposed by Basili (1993) for defining the software measurements. The GQM approach identifies three steps. As suggested by its name, the GQM Approach provides a method for defining Goals, refining them into Questions and then defining the Metrics to collect data. This approach has been applied with good success by researchers in several contexts (Akbar et al. 2014; Basili et al. 2014; Behkamal et al. 2014; Mannaro et al. 2004; Southekal 2017; Yeh and Huang 2014). For this reason, we state that its application is suitable also in this context. GQM defines a top-down approach based on three levels: (i) a conceptual level (Goal); (ii) an Operational level (Question); and (iii) a quantitative level (Metric). The goal can be set through specific methodological steps: to define the object that is the primary target of the study (i.e., it that will be analyzed), the purpose that expresses how the goal will be reached, the issue (with respect to) and the viewpoint (from the viewpoint of). A set of questions is used to reach the specific goal. Finally, a set of metrics is associated with every question in order to answer it in a measurable way: the same metric can be used to answer different questions (Fig. 1).

For the sake of brevity, we present in Table 1 some questions and metrics related to the following goal: analyze and classify the thematic areas represented in the city dashboards from the viewpoint of policy makers in order to understand the city trend in terms of smartness strategy.

The metrics plan describes exactly how the data will be researched.

In order to answer the first question (Q1) of the reported example, we searched online city dashboards, and the searches were made in the following databases: Scopus, ScienceDirect, Web of Science, Google Scholar and Google Search. The search was conducted during the period October 2016 to early 2017. The first

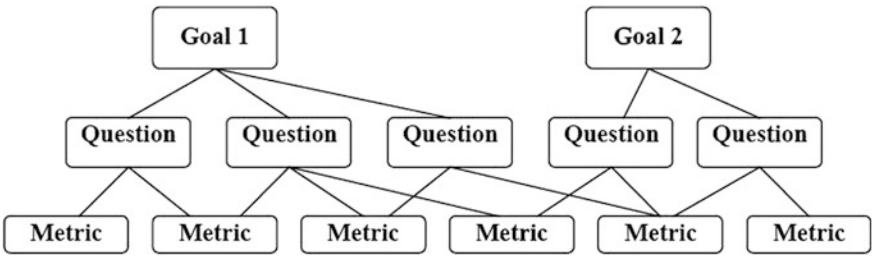

Fig. 1 GQM approach Caldiera and Rombach (1994)

Table 1 GQM approach

Goal	Purpose	Analyze and classify
	Issue	the thematic areas represented in the
	Object	city dashboards
	Viewpoint	from the viewpoint of policy makers in order to understand the city trend in terms of smartness strategy
Question	Q1	Have cities invested in dashboard technology?
Metrics	M1.1 M1.2	n° city dashboards found by search engine: Google, Google images n° city dashboards found in the literature: Scopus, ScienceDirect, Web of Science, Google Scholar and Google Search
Question	Q2	What types of information are shown in city dashboards?
Metrics	M2.1 M2.2	n° information extracted by web scraping n° information manually extracted
Question	Q3	Are the information types gathered under a specific thematic area?
Metrics	M3.1 M3.2 M3.3	n° thematic areas n° information in thematic areas n° information not classifiable
Question	Q4	Can the various types of information collected from the city dashboards be classified in a general taxonomy?
Metrics	M4.1 M4.2 M4.3	n° indicators defined in ISO 37120 n° indicators defined on Global City Indicators Facility—GCIF to use a semantic definition

challenge was to identify an initial set of papers about cities that invested in dashboard technology.

Moreover, our focus in these database searches was to identify keywords and formulate search strings using Boolean operators. We used the following search terms in combination: "city dashboard" OR "urban dashboard", "civic" AND "dashboard", "dashboard" AND "smart city" AND "dashboard" by selecting together the fields article title, abstract and keywords.

The main finding in these articles was that city dashboards and multi-chart displays are quite different. Briefly, Mendonça et al. (2016) describes a smart city-platform, available for police officers, aiming at contributing to improved public safety that employs a web dashboard to support data analysis and statistics. Bui (2015) describes the architecture of some platforms to monitor data related to air pollution, then only in prototype, at a research level. The system proposed by Cagliero et al. (2015) is validated by real non-emergency data acquired in the Turin Smart City environment, and it analyzed an open dataset of non-emergency calls, available only for the government. Nesi et al. (2016) report on research performed in the context of a national smart-city project on mobility and transport integrated with services. The project is grounded on an ontology and tools for smart-city data aggregation and service production. Finally, a large part of the relevant papers found in the literature describes dashboards' prototypes and their architecture; such as IT platforms to handle and manipulate data in order to extract useful information.

Our research aims to analyze the type of data displayed and made accessible by city administrators in the city dashboards, so as to better understand the thematic areas selected for improving urban governance. We identified Google Search as main search engine for accessing online city dashboards worldwide. We selected a representative sample of dashboards: the most-used search criterion was that every dashboard had at least five thematic areas to analyze.

Totally, we identified 25 online city dashboards. In Table 2, we report the list of 20 city dashboards specific for each single city or region with some additional elements (country, area and inhabitants). In contrast, in Table 3 reports on the remaining five dashboards, each of which aggregates a set of dashboards related to various cities.

In order to answer to the question Q2 of our GQM—"What information are shown in city dashboards?"—we studied the selected online city dashboards, one by one, and we collected information to understand the knowledge gathered for each given city.

In relation to Table 3, we decided to consider these dashboards as a single entity, and we report below some remarks.

CityDashboard (reference [21] in Table 2) aggregates simple spatial data for cities around the UK and displays the data on a single dashboard. It links eight different dashboards related to each specific city (London, Brighton, Birmingham, Cardiff, Edinburgh, Glasgow, Leeds and Manchester). In this case, given the small number of dashboards, we analyzed them one by one, and we found that these city dashboards show the same types of information. Moreover, some cities listed in [21], such as London (reference [6] in Table 2) and Birmingham (reference [7] in Table 2), have also additional dashboards with additional types of information, or in the case of Glasgow (reference [8] in Table 2) with similar data but with an interface totally customizable by citizens.

OECDBetterLifeIndex[1] (reference [23] in Table 2) is a dashboard that compares 38 countries around the world—members of the Organisation for Economic Cooperation and Development, or OECD.[2] The main goal is to promote policies that will improve the economic and social well-being of people around the world (OECD 2017). This interactive tool gives eleven topics reflecting what the OECD has identified as essential to well-being in terms of material living conditions (e.g., housing, income, jobs) and quality of life (e.g., community, education, environment, governance, health, life satisfaction, safety and work-life balance).

FabCityDashboard (reference [22] in Table 2) is a platform to monitor city resilience and aggregates 16 cities. It is based on well-being indexes developed by OECD (2017) at country and regional levels. It has been developed under the Fab City project which proposes a new model for locally productive and globally connected self-sufficient cities.[3]

[1] https://www.oecdregionalwellbeing.org/assets/downloads/Regional-Well-Being-User-Guide.pdf.

[2] http://www.oecd.org/.

[3] http://fab.city/.

Table 2 City dashboards' list from [1–20]

City/region	Country	Area (km^2)[a]	Inhabitants	Link	Ref.
New Castle	UK	113.44	279,100	http://uoweb1.ncl.ac.uk/raw_downloader/	[1]
Newark	USA	61.60	502,029	http://data.ci.newark.nj.us/group	[2]
Jersey	USA	54.7	262,146	http://data.jerseycitynj.gov/group	[3]
Western Pennsylvania	USA	data not found	around 4,000,000	http://www.wprdc.org/ https://dat14a.wprdc.org/group	[4]
New York	USA	1,214	8,550, 405	http://data.beta.nyc/group	[5]
London	UK	1,572.15	8,787,892	https://data.london.gov.uk/	[6]
Birmingham	UK	267.77	1,111,300	https://www.birmingham.gov.uk/	[7]
Glasgow	UK	175.5	595,080	http://dashboard.glasgow.gov.uk/	[8]
Gold Coast	Australia	1,402	527,660	http://dashboard.cityofgoldcoast.com.au/	[9]
Bellevue	USA	87.8	121,347	https://data.bellevuewa.gov/	[10]
Surrey	UK	1,662.50	1,132,390	http://dashboard.surrey.ca/	[11]
Venice	Italy	415.9	261,728	http://dashboard.cityknowledge.net/#/venice	[12]
Firenze	Italy	102.32	382,346	http://dashboard.km4city.org/view/?iddasboard=MzA=&nome_dashboard=Firenze2	[13]
Dublin	Ireland	114.99	527,612	http://www.dublindashboard.ie	[14]
Portland	USA	376	583,776	https://www.portlandoregon.gov/cbo/article/523301	[15]
Edmonton	Canada	684.37	877,926	https://data.edmonton.ca/	[16]
Madrid	Spain	604.3	3,141,991	http://ceiboard.dit.upm.es/dashboard/	[17]
Lerwick	UK	12.78	6,830	http://www.lerwick-harbour.co.uk/dashboard	[18]
Sydney	Australia	12,368.7	4,921,000	http://citydashboard.be.unsw.edu.au/	[19]
Salt Lake City	USA	285.9	192,672	https://dotnet.slcgov.com/PublicServices/Sustainability/	[20]

[a]All data come from Wikipedia

Table 3 City dashboards' list from [21] to [25]

Region/project	Link	Reference
UK	http://citydashboard.org/choose.php	[21]
FABCityProject	http://dashboard.fab.city/	[22]
OECDProject	http://www.oecdbetterlifeindex.org/	[23]
USA	https://www.civicdashboards.com/	[24]
America Latina	http://www.urbandashboard.org	[25]

CivicDashboard (reference [24] in Table 2) is a platform which includes information for 3143 counties and more than 30,000 municipalities in the USA. Such information is contained in a specific dashboard for each city, and they are based on ISO 37120 indicators. Using the platform, a user can easily compare information regarding different cities included in the project from a smart-city point of view. We analyzed this collection of dashboards as a single city dashboard because of their similar contents and structure. Moreover, given the high number of involved cities we decided to analyze, only 30 cases were randomly selected to ensure that all cities had the same data structure.

UrbanDashboard (reference [25] in Table 2) contains information about 37 cities from Latin America and Caribbean, and it proposes a single dashboard for each of them. It uses more than 150 quantitative indicators to follow economic and population growth and to compare the involved cities.

On the basis of our GQM, we measured the question Q2 using the metric M2.1 and M2.2. We extracted data from online city dashboards by using both a web-scraper tool called Import.io and methods of manual extraction in all cases in which the automatic data extraction (e.g., inside images) was impossible.

Import.io is a web-based platform for extracting data from websites. By entering a URL as input, Import.io tries to extract data from the online resource in an automatic way. It also allows user to train the tool in order to catch the right field to download the collected data in various formats. In our case, we used CSV format.

To answer to the third question Q3—"Are the information gathered under a specific thematic area?"—we gathered the raw data and built a table for each of the 25 dashboards, following the same structure. For the sake of brevity, we report in Table 4 only one representative example. We chose the case of Dublin city (reference [14] in Table 2). Table 4 contains the following fields: Thematic Areas,

Table 4 Structure of the table for the city dashboard of Dublin

Thematic areas	Datasets	Comments	Type of data
Health and crime	Number of people waiting on trolleys in Dublin hospital, number of theft and related offenses, number of public order and social code offenses	Can be split into two different areas?	Real time data + Indicators
Transport	Current drive time M50 north 24 min, current parking spaces in Dublin 2782, etc.		
Environmental indicators	Sound level at Irishtown Stadium is 55.85 db, weather, current air quality, etc.		
Industry, employment and labour market	Unemployed, employed, etc.		
Housing indicators	Average cost newly-built house, average cost of pre-owned house, average monthly residential rent, etc.		

Dataset related to each thematic area, potential Comments (for example, not all datasets are linked to a specific theme, so we used this field to put some considerations useful for our analysis), Type of data displayed (e.g., real time, static data, indicators, data analysis, other).

In this phase, we faced some issues. Firstly, in some dashboards we found datasets without descriptions or details, and sometimes they had not been inserted into a specific thematic area. Or, we did not find any dataset within the declared thematic area. In other cases, a thematic area was too generic to be classified, or the datasets were inconsistent with the thematic area under which they had been published (i.e., in the Newark dashboard, reference [2] in Table 2, the dataset “Certificate of Occupancies” was under “Public Safety” area). In all these cases, we considered the data only if the correlated thematic area was present or we assigned a new thematic area in a subjective way when it was possible, otherwise we rejected the information. For the mentioned reasons, we did intensive work in order to fill the table.

Secondly, we found different types of dashboards, not only on the basis of the choice of the thematic areas, but also in terms of data representation. For example, we found that some city dashboards have a list of open datasets linked only to a specific theme, or sometimes the same dataset is duplicated in different thematic areas. Moreover, some of these datasets are linked to a specific monothematic dashboard showing the time trends: this type of dashboard resembles a balanced scorecard used in business activities. This latter tool evaluates not only current scenarios but also the future targets of the companies.

Step by step, following our GQM, we identified the main question of our research in Q4—“Can the various types of information collected from the city dashboards be classified in a general taxonomy?”.

Taxonomy refers to the study of classification and allows better understanding of the domain of interest. In our case, the domain refers to the city dashboards in a smart-city context.

After having collected the data from dashboards, the next step was to answer to Q4.

We summarized in a single table the information found in terms of thematic areas and their datasets. Unfortunately, each city uses subjective words to identify a thematic area, and sometimes there are not consistent with the thematic areas and their datasets and vice versa. For this reason, we classified and aligned the different terminology. Similarly to Pani et al. (2015), we defined a general dashboards’ taxonomy using an iterative method combining two approaches: bottom-up (BU) and top-down (TD). Namely, following the BU approach, we collected data from the online city dashboards; then using the TD approach, it was possible to classify this information in accordance with a national or international standard.

By using the TD approach, we defined a reference taxonomy, and we mapped the rules. In accordance with the smart-city indicators such as ISO 37120 (2014) and Global City Indicators Facility (GCIF) (2013), we set the themes defined in the mentioned standards as a reference for the thematic areas and the indicators as a reference for dataset or information.

Simultaneously, we followed the BU approach to detect data from online dashboards and to classify them by using the previous reference taxonomy.

For each thematic area identified in our taxonomy, we verified for all 25 tables of the selected dashboards whether there was the same knowledge in terms of datasets or information. We considered not only the indicators but also the semantic concept in order to give a semantic definition to the thematic areas. We used Tipalo—a tool implemented by Nuzzolese et al. (2013)—which identifies the most appropriate types for an entity in DBpedia. Tipalo—a free online available tool—enables one to type a label of a Wikipedia entity and returns a RDF graph containing the semantic definition. Briefly, this tool uses a minimal graphical interface with a single input. In Fig. 2 we show how Tipalo works: if we type the label “Economy”, Tipalo returns its semantic definition: “An economy is an area of the production, distribution, or trade, and consumption of goods and services by different agents in a given geographical location”. We used this tool to inspect the definitions for each thematic area. However, a single label may not represent completely a specific thematic area. For this reason, we searched more than one definition for some thematic areas by typing relevant labels. A typical example is shown in Table 6 in which the “Safety and Emergency response” thematic area is associated with four different semantic definitions by using four different labels.

The themes identified by ISO 37120 are seventeen in number; then we added three themes coming from GCIF in order to cover some information found in the selected dashboards.

We listed the selected themes in Table 5, and we used them as a reference to define the categories of the taxonomy.

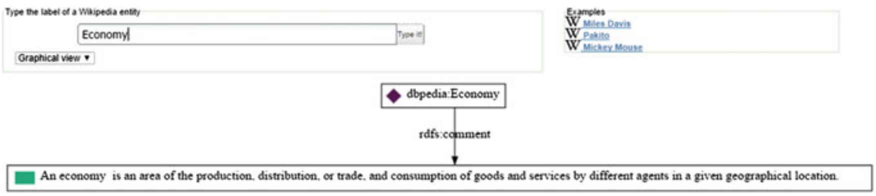

Fig. 2 A screenshot of Tipalo

Table 5 List of themes proposed in ISO 37120 and GCIF

ISO 37120		GCIF
Economy	Health	Housing
Education	Recreation	People
Energy	Safety	Civic engagement
Environment	Solid Waste	
Finance	Telecommunication and innovation	
Fire and emergency response	Transportation	
Governance	Urban planning	
	Wastewater	
	Water and sanitation	

We matched the themes identified in Table 5 with the theme gathered for each selected city dashboard by analyzing the data extracted from each city dashboard. The most frequently found thematic areas found in the selected dashboards were: Environment, Transportation, Finance, and Safety. Instead, Shelter, Telecommunication and innovation, Governance are the thematic areas less frequently found. Moreover, we did not find any matching for some thematic areas (listed in Table 5) in the analyzed city dashboards.

In this phase, we decided to keep pending the unclassified information.

Finally, we conducted a test phase before refining the classification in order to cover all thematic areas. We used *UrbanDashboard* (Reference [25] in Table 2) as our dashboard test object due to the large number of represented data and the proposed topic.

We matched the majority of themes identified in the previous step and listed them in Table 5. We found that the following topics were not present:

1. Citizen engagement and social-media participation;
2. Transparency;
3. Tourism;
4. Weather;
5. News;
6. Social services;
7. Cultural diversity.

Among these seven topics, some of these were the previously pending unclassified topics. In order to cover this gap and incorporate the new topics, we refined the first classification.

We describe below how we added the new thematic areas and how we redefined the previous ones (shown in Table 5).

1. *Citizen Engagement and social media participation.*
2. *Transparency.*
   According to ISO 37101 (2016), we referred to "*Governance, empowerment and engagement,*" and we added in the thematic area Governance of Table 5 the following themes: (i) *Citizen engagement and social participation* and (ii) *Transparency*. We redefined the new thematic area in our taxonomy as "Governance and engagement", and finally we inserted Civic Engagement (listed in Table 5) within this.
3. *Tourism.*
   We found data related to Tourism only in three dashboards, and we inserted this topic into Recreation thematic area of Table 5.
4. *Weather.*
5. *News.*
   These data are typical of real-time dashboards; we inserted these data in a new area that we named "Other".

6. *e services.*
   We incorporated this topic in Shelter of Table 5.
7. *Cultural diversity.*
   We added this topic to People of Table 5 and renamed the thematic area as "People and cultural diversity".
   In order to simplify the taxonomy and due to the low occurrence of some themes, we combined "*Housing*" and "*Shelter*" of Table 5 into a single field "Housing and social services", at the same way "*Water and sanitation*" and "*Wastewater*" *in* "*Water*", "*Fire and emergency response*" and "*Safety*" in "*Safety and emergency response*", "*Environment*" and "*Solid waste*" in "*Environment*", finally "*Transportation*" and "*Telecommunication and innovation (TI)*" *in* "*Mobility, TI*".
   The newly identified thematic areas have been added to our taxonomy derived from ISO 37101, ISO 37120 and GCIF. In the next section, we show an extract of the taxonomy.

4 Results

The built taxonomy proposes a dashboard's classification of thematic areas into which we suggested the datasets to incorporate. In total, we obtained 15 different categories that represent the classified thematic areas.

In Fig. 3, we show on the abscissa the new thematic areas obtained in our taxonomy and on the ordinate the number of analyzed city dashboards and related to the new classification.

For the sake of brevity, we show without details an extract of our taxonomy (see Table 6). Table 6 presents only two of the 15 thematic areas classified as "*Mobility,*

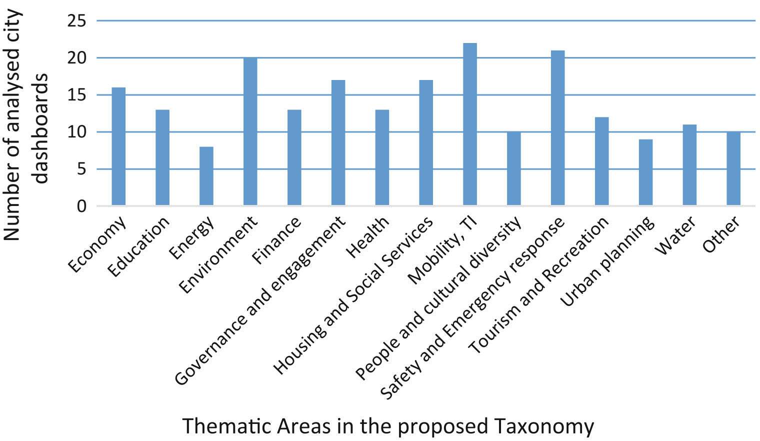

Fig. 3 Number of occurrences of the thematic areas in analyzed online city dashboards

Table 6 An extract of the taxonomy showing "Safety and emergency response" and "Mobility, TI" categories

Final tag	Dashboard theme	Semantic definition	Data
Safety and Emergency response	<Public Safety> <Safety> <Municipal services> <Justice> <Traffic Cameras> <Webcam> <Crime> <Police Bureau> <Livability> <Security> <Community Safety> <Municipal Services—Safety> <Fire & Rescue> <Emergency communication> <Livability> <Vulnerability to natural disasters in the context of climate change> <……..>	http://dbpedia.org/page/Safety http://dbpedia.org/page/Emergency http://dbpedia.org/page/Fire_department http://dbpedia.org/resource/Natural_disaster	Crime prevention overview Police arrest data, Annual crime rate, property crimes per 100,000, Violent crimes per 100,000, Number of new public alerts registrations, Victimization rate, Level of domestic violence, Citizens' perception of police's honesty, Hurricane evacuation zones, Percentage of time unit from closest station is available for response, 311 Call response time, Existence of risk maps, Existence of adequate contingency plans for natural disasters <……..>
Mobility, TI	<Traffic> <Transportation> <Tube Line Status> <Cycle Hire> <In services Rail> <Cruise Ship> <Airplane> <Trains> <real time bus position> <Transport> <Bureau of Transportation> <Mobility> <Infrastructure> <Wi-Fi> <Connectivity> <………>	http://dbpedia.org/page/Transport http://dbpedia.org/page/Wi-Fi http://dbpedia.org/page/Telecommunication https://en.wikipedia.org/wiki/Internet_access	Congestion, Parking spaces, Traffic flow, Average speed, Light rail train, Signalized intersections, Subway station entrances, Number of buses, Train network—ferry network, Bike share, Car share, Electric vehicles, Pedestrian safety, Public transportation (including taxi), Internet connectivity, Wi-Fi, Active devices, Wi-Fi heatmap, Percentage of households with a computer, Number of home computers per 100 inhabitants, Mobile broadband internet subscriptions, Mobile cellular phone subscriptions <…….>

IT" *and* "*Safety and emergency response*" which have the most significant and predominant presence in the analyzed dashboards (Fig. 3).

In our taxonomy for each thematic area, we identified a *Final Tag* (see Table 5). For each category, there are three dimensions: *Dashboard Themes* (some of the corresponding themes come from analyzed dashboards); *Semantic Definition* (it contains the DBpedia semantic definitions obtained by using *Tipalo* tool); and *Data* (data related to the category in terms of dataset, indicators or information coming from analyzed dashboards).

During the classification, we identified the four emerging clusters reported below.

Cluster 1. This cluster contains dashboards with data regarding the city administration and typically shared by government with their community. This kind of dashboard is based on data analysis over time or the use of indicators.
Cluster 2. This cluster contains dashboards that present information of public interest, such as transportation, weather, hospital, parking, warnings, etc. These dashboard show real-time data and interactive maps.
Cluster 3. Dashboards in this cluster are described in the literature in terms of technical architecture. These may process a lot of different information coming from the city and implement data integration, analysis and decision making.
Cluster 4. This cluster contains platforms that make comparisons between different cities; this is possible because data and information are expressed in the same format, and they contain the same indicators.

Furthermore, all the above clusters use maps as graphical tools to present the information. The usage of maps has been becoming increasingly widespread by administrations to show the selected information—in fact it is certainly more intuitive and more impactful.

5 Discussions and Conclusions

City dashboards are defined and shaped in relation to the needs of the urban context and of the local public administrator's goals. However, the design of a city dashboard needs a clear vision of the direction that public administrations intend to undertake, as well as an ability to build scenarios and analyze the results of experiments in the context of changing urban variables. This paper clarified the features of the city dashboards in the context of a smart city through an approach based on a goal-oriented framework.

In particular, we structured our analysis by using a GQM approach. Our aim was to analyze and classify online city dashboards in order to understand the city trends and identify the direction that public administrations intend to undertake. To better grasp the city dashboards' domain, we developed a city-dashboard taxonomy that classifies online semi-structured data by using an iterative method combining the bottom-up (BU) and top-down (TD) approaches. We analyzed 25 city dashboards in order to classify them or determine some classification criteria.

Our proposed taxonomy classifies 15 different categories identifying specific thematic areas. It may be useful in designing a new smart-city dashboard because it provides a specific number of typical elements with their semantic definition and gives suggestions about related datasets to insert.

Moreover the results of our analysis identified four different clusters on the basis of the purpose of a dashboard. *Cluster* 1 contains city dashboards useful for public administrators. By using these type of dashboards, they can communicate a specific government policy to the community with a clear political choice (e.g., showing safety data such as number of law enforcement, crime rate, traffic accidents etc., pays particular attention to security policies for the citizens and the city). *Cluster* 2 includes city dashboards useful for city users in which the information is oriented to citizens' services. Generally, these dashboards do not show a political view, but they pay attention to real-time information. *Cluster* 3 contains city dashboards useful as public administration tools with potential and benefits for governance. The analysis of data may help the government to make decisions by improving existing policies or introducing new ones. *Cluster* 4 presents city dashboards useful to assess the smartness of a city. Making comparisons with similar cities may be useful not only to improve but also to inspire other virtuous cities.

In our opinion, our framework is a useful tool to develop an effective smart-city dashboard and may provide insights for the decision makers. Every city can benefit from having a dashboard if it knows what the purpose of a dashboard is. A well-implemented dashboard may help enhance the process for becoming a smart city. At the same time, a city should take into account the above emerging clusters before implementing a dashboard in accordance with its governance policies. The constant change in today's cities and their dynamic development lead to the conclusion that the dashboard's taxonomy and the identified clusters should not be considered as definitive but a starting point to understand the same trends in the cities. We are working to better define the best way to monitor cities in order to optimize urban governance in relation to the local and specific context.

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References

Ahvenniemi, H., Huovila, A., Pinto-Seppä, I., & Airaksinen, M. (2017). What are the differences between sustainable and smart cities? *Cities, 60,* 234–245.

Angelidou, M. (2015). Smart cities: A conjuncture of four forces. *Cities, 47,* 95–106.

Akbar, M., Sukmana, H. T., & Khairani, D. (2014). Models and software measurement using Goal/Question/Metric method and CMS Matrix parameter (Case study discussion forum). In *2014 International Conference on Cyber and IT Service Management (CITSM)* (pp. 34–38). South Tangerang.

Basili, V. R. (1993). *Applying the Goal/Question/Metric paradigm in the experience factory* (pp. 21–44). Software Quality Assurance and Measurement: A Worldwide Perspective.

Basili, V., Heidrich, J., Lindvall, M., Münch, J., Regardie, M., Rombach, D., & Trendowicz, A. (2014). GQM + Strategies: A comprehensive methodology for aligning business strategies with software measurement.

Behkamal, B., Kahani, M., Bagheri, E., & Jeremic, Z. (2014). A metrics-driven approach for quality assessment of linked open data. *Journal of Theoretical and Applied Electronic Commerce Research, 9*(2), 64–79.

Bui, L. (2015, October). Breathing smarter: A critical look at representations of air quality sensing data across platforms and publics. In *2015 IEEE First International Smart Cities* conference *(ISC2)* (pp. 1–5).

Cagliero, L., Cerquitelli, T., Chiusano, S., Garino, P., Nardone, M., Pralio, B., et al. (2015, April). Monitoring the citizens' perception on urban security in smart city environments. In *2015 31st IEEE International Conference on Data Engineering Workshops (ICDEW)* (pp. 112–116).

Caldiera, V. R. B. G., & Rombach, H. D. (1994). The goal question metric approach. *Encyclopedia of Software Engineering, 2*(1994), 528–532.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2011). Smart cities in Europe. *Journal of Urban Technology, 18*(2), 65–72.

Carta, M. (2017). *Augmented city*. A Paradigm Shift. Trento-Barcelona: Listlab (in press).

Dameri, R. P. (2016). *Smart city implementation: Creating economic and public value in innovative urban systems*. Cham, Switzerland: Springer.

Fegraus, E. H., Zaslavsky, I., Whitenack, T., Dempewolf, J., Ahumada, J. A., Lin, K., et al. (2012). Interdisciplinary decision support dashboard: A new framework for a Tanzanian agricultural and ecosystem service monitoring system pilot. *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 5*(6), 1700–1708.

Facility, Global City Indicators. (2013). *Data, boundaries, and competitiveness: The Toronto urban region in global context*. Global City Indicators Facility: University of Toronto.

ISO 37101. (2016). Sustainable development and resilience of communities—management systems—general principles and requirements. Technical Committee: ISO/TC 268 Sustainable cities and communities. ICS: 13.020.20 Environmental economics. Sustainability. Publication date: 2016-07. Available at https://www.iso.org/standard/61885.html.

ISO 37120. (2014). Sustainable development in communities: Indicators for city services and quality of life. Technical Committee: ISO/TC 268. Sustainable cities and communities. ICS: 13.020.20 Environmental economics. Sustainability. Publication date: 2014-05. Available at https://www.iso.org/standard/62436.html.

Kitchin, R., Coletta, C., & McArdle, G. (2017). Urban informatics, governmentality and the logics of urban control. Available at osf.io/preprints/socarxiv/27hz8.

Kitchin, R., Lauriault, T. P., & McArdle, G. (2015). Knowing and governing cities through urban indicators, city benchmarking and real-time dashboards. *Regional Studies, Regional Science, 2*(1), 6–28.

Kitchin, R., & McArdle, G. (2016). *Urban data and city dashboards: Six key issues*. Working paper. Programmable city working paper 21, Maynooth.

Mannaro, K., Melis, M., & Marchesi, M. (2004). Empirical analysis on the satisfaction of IT employees comparing XP practices with other software development methodologies. In *International Conference on Extreme Programming and Agile Processes in Software Engineering* (pp. 166–174). Springer Berlin Heidelberg.

Meijer, A., & Bolívar, M. P. R. (2016). Governing the smart city: A review of the literature on smart urban governance. *International Review of Administrative Sciences, 82*(2), 392–408.

Mendonça, M., Moreira, B., Coelho, J., Cacho, N., Lopes, F., Cavalcante, E., et al. (2016). Improving public safety at fingertips: A smart city experience. In *2016 IEEE International Smart Cities Conference (ISC2)* (pp. 1–6).

Nesi, P., Badii, C., Bellini, P., Cenni, D., Martelli, G., & Paolucci, M. (2016). Km4City smart city API: An integrated support for mobility services. In *2016 IEEE International Conference* on *Smart Computing (SMARTCOMP)* (pp. 1–8).

Nuzzolese, A. G., Gangemi, A., Presutti, V., Draicchio, F., Musetti, A., & Ciancarini, P. (2013). Tìpalo: A tool for automatic typing of dbpedia entities. In *Extended Semantic Web Conference* (pp. 253–257). Springer Berlin Heidelberg.

OECD. (2017). Getting skills right: Skills for Jobs indicators. *OECD Publishing, Paris.*. https://doi.org/10.1787/9789264277878-en.

Osella, M., Ferro, E., & Pautasso, M. E. (2016). Toward a methodological approach to assess public value in smart cities. In *Smarter as the New Urban Agenda* (pp. 129–148). Springer International Publishing.

Pani, F. E., Lunesu, M. I., Concas, G., & Baralla, G. (2015). The web knowledge management: A taxonomy-based approach. In *Knowledge Discovery, Knowledge Engineering and Knowledge Management: 5th International Joint Conference, IC3 K 2013*. Vilamoura, Portugal, September 19–22, 2013.

Southekal, P. (2017). Data for business performance: The goal-question-metric (GQM) model to transform business data into an enterprise asset. Technics Publications; First edition.

Suakanto, S., Supangkat, S. H., & Saragih, R. (2013). Smart city dashboard for integrating various data of sensor networks. In *2013 International Conference on ICT for Smart Society (ICISS)* (pp. 1–5).

Usurelu, C. C., & Pop, F. (2017). My city dashboard: Real-time data processing platform for smart cities. *Journal of Telecommunications and Information Technology, 1,* 89.

Yeh, T. M., & Huang, Y. L. (2014). Factors in determining wind farm location: Integrating GQM, fuzzy DEMATEL, and ANP. *Renewable Energy, 66,* 159–169.

Zdraveski, V., Mishev, K., Trajanov, D., & Kocarev, L. (2017). ISO-standardized smart city platform architecture and dashboard. *IEEE Pervasive Computing, 16*(2), 35–43.

Assessing Preferences for Attributes of City Information Points: Results from a Choice Experiment

Gianluca Grilli, Silvia Tomasi and Adriano Bisello

Abstract A choice experiment has been carried out to assess the preferred attributes of information points (called totems) to be installed in the city of Bolzano. Totems allow the acquisition, exchange and query of data in real time, as well as provide other services such as electricity or water supply. These infrastructures could be useful for both inhabitants and tourists in need of parking spaces, information about events or charging stations for vehicles. To design them in a cost-effective way, it is important to understand potential users' preferences. For this reason, field surveys using stated preferences are important sources of information to tailor these totem effectively. In order to facilitate the interpretation of results for policy making, estimations are carried out in willingness-to-pay space and by means of a random parameters logit model. Results indicate that the preferred attributes are the presence of Wi-Fi "hot spots", charging stations for electric cars and bikes and real-time information about available car parks.

Keywords Totem · Choice experiment · Willingness to pay space
Smart city · SINFONIA project

1 Introduction

Within the context of smart cities, electronic devices and infrastructures are gaining importance because they allow retrieving information easily, contributing at the same time to the diffusion of information technologies. Currently, there is a sort of environmental-technological nexus, where ever more people are confident with

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using internet and mobile devices (see the high-market penetration of smartphones) and, at the same time, intend to “live greener” (Ling 2013; Mobrezi and Khoshtinat 2016). Consumers, preferring organic products to large scale agri-food industry goods, or drinking tap water instead of bottled, are asking urban public authorities and service companies to support local agri-food markets, to install drinking water facilities in public spaces and to promote eco-friendly happenings (Selfa and Qazi 2005; de Rezende and Daniel 2013; Hardesty 2008). Similarly, environmental aspects, such as local air pollution, call for tangible measures aimed at reducing emissions (Romero-Lankao et al. 2014; Martin et al. 2014), for example, by encouraging people to use electric vehicles (EV) in urban commuting instead of traditional cars. In this context, wireless connections, interactive communication tools and innovative devices are essential components to involve citizens in tackling urban challenges and to make use of the huge amount of information, also called “big data”, continuously harvested by sensors and stored in servers (McKinsey and Company 2011). New public infrastructures are expected to increase the quality of life of residents, meeting their needs and satisfying their expectations. In a context of scarcity of public budgets, investments should be done carefully, without following the “smart city” fascination uncritically. In some cases, a merge between innovation and traditional solutions, well designed for the specific context, makes possible the best result. An example of the technological tools that are currently installed in many cities is represented by information points. These infrastructures, informally called totems, enable users to obtain information about local events, parking availability, weather conditions and much more. When planning the introduction of new information technologies, such as these totems, policy makers should be concerned not only with their cost-effectiveness, but also with the features and attributes that people will likely prefer and that offer to the general public innovative solutions (Furuli and Ølnes 2009; Bertot et al. 2008). Within this context, stated-preferences techniques may play an important role in defining the preferred attributes and, if necessary, the cost for the services that people are likely to consider reasonable (Brownstone et al. 2000).

Starting from these premises, the objective of this paper is to present a stated-preference survey carried out in the city of Bolzano (Italy), by means of a choice experiment (CE), to assess the attributes most preferred by the general public. CEs are economic evaluation methods, originating the marketing field, that enable estimating the perceived economic values of each attribute of non-market goods (List et al. 2006; Chau et al. 2010). Traditionally, this technique has been applied to transportation economics, marketing and environmental economics (Hensher et al. 2015). The good to be valued is decomposed into its relevant attributes, each of which is associated with a certain number of levels, and the combination of attributes and levels generates a series of various alternatives that are presented to the respondents iteratively in a series of choice tasks (Adamowicz et al. 1998). Each choice task proposes from two to six–seven alternatives, among which respondents are asked to choose their preferred option. By including among the attributes the cost associated with the alternative, it is possible to estimate the monetary value of each non-monetary attribute in terms of Willingness to Pay

(WTP). In this work, it was decided to estimate utility function in the so called *WTP-space* form (Campbell et al. 2014), in which coefficients do not represent the marginal effect of each attribute but the WTP for the attribute itself. Compared to the traditional specification of the utility in preference space, this choice is convenient for at least two reasons. First of all, it is easier to estimate confidence intervals for the average WTP, because they are embedded in the regression model, while the common approach is to use simulations such as delta method, Krinsky-Robb procedure or bootstrapping (Hole 2007). Secondly, interpretation of the results is much more straightforward and useful for policy making.

The remainder of the paper is organized as follows. The next section describes the methodology, including the study area, data collection and econometric analyses. Then, results and the discussions of the results are presented.

2 Methods

2.1 Study Area

The study has been carried out in the city of Bolzano, which is a city in the northern part of Italy. Bolzano, with approximately 100,000 inhabitants, is the main city of South Tyrol, a mountainous province in the Alps. The city itself, and the surrounding alpine territory, are a well-known holiday destination, appreciated for a high environmental quality and hospitality. Efficient public services (especially transportation) and green, tourist-oriented marketing also contribute to promoting the image of Bolzano, as well as the territory inland and abroad. At the country level, the city often ranks on the top of annual charts comparing the quality of life in various contexts. For historical and cultural reasons, Bolzano is characterized by strong liaisons to neighboring Austria; it is, in fact, bilingual, and both Italian and German are official languages. The economy of the region, and similarly of the city, is based on services and a strong industrial sector, which enables Bolzano to be one of the richest Italian city. At the same time, the municipality is committed to making Bolzano into a smart and technological city, in order to increase the inhabitants' well-being.

2.2 Questionnaire Structure and Data Collection

Data were collected by means of personal, face-to-face interviews, carried out by three recruited interviewers, from July to October 2016. People were engaged in some strategic places of the city and invited to participate to the survey. Interviewers paid attention to sampling strategy and attempted to provide a representative sample of the citizens. In this regard, they surveyed an even number of men and women, and made sure that all age groups were represented in even proportions. Given that the local population belongs to two language groups (i.e., Italian or German speaking), the questionnaire was available in both languages. German speakers are assessed to be roughly 26% of the population of Bolzano, thus around one third of the questionnaires were compiled in German. The questionnaire contained four sections, for a total of 29 questions. The first section contains introductory and “warm-up” questions, with the main objective of presenting the topic and helping respondents to become comfortable with it. The second section includes attitudinal questions to assess the degree of knowledge and the feelings of the respondent regarding technology in general and information points in particular. The third section contains the choice tasks, and lastly, the fourth section contained socio-demographic questions to collect information about the sample. The survey design and pre-test for the present research is described in detail in Bisello and Grilli (2016), while a general overview on expected benefits emerging from smart-city projects, and related assessment tools are treated in Bisello et al. (2017).

The CE exercise was designed according to the guidelines available in the literature (Hoyos 2010; Riera et al. 2012). Relevant attributes and attribute levels included in the choice tasks are summarized in Table 1. Attributes were chosen from a list of candidate services that was discussed with representatives of the municipality of Bolzano. In particular, possible solutions involve the inclusion of

Table 1 Attributes and levels for the experiment

Attribute	Description	Levels
SOS	Emergency call service	Yes (SOS) No (SQ)
WATER	Drinking water	Yes (WATER) No (SQ)
WI-FI	Hotspot for Wi-Fi connection	Yes (WI-FI) No (SQ)
ELECTRICITY	Charging stations	Tablets and smartphones (DEVICES) Electric bicycles (BICYCLE) Electric vehicles (AUTO) No (SQ)
INFO	Information about the city	Weather and environmental conditions (WEATHER) Touristic and cultural (TOURISTS) For residents (RESIDENTS) No (SQ)
MOBILITY	Information about mobility	Availability of charging points for EV (CHARGE) Traffic conditions and public transport (TRAFFIC) Availability of parking spaces (PARKING) No (SQ)
COST	Monthly cost of the option (€)	0.50, 1.00, 1.50, 2.00, 2.50, 3.00, 0.00 (SQ)

	SERVICES	OPTION 1	OPTION 2	OPTION 3
	SOS	NO	YES	NO
	WATER	YES	NO	NO
	WI-FI	YES	NO	NO
	ELECTRICITY	• TABLET or SMARTPHONES	• TABLET or SMARTPHONES • ELECTRIC BICYCLES	NO
	INFO	• WEATHER and ENVIRONM. CONDITIONS	• WEATHER and ENVIRONM. CONDITIONS • TOURISTIC and CULTURAL	NO
	MOBILITY	• FREE PARKING SPACES • FREE CHARGING POINTS	• FREE PARKING SPACES • FREE CHARGING POINTS • TRAFFIC CONDITIONS and PUBLIC TRANSPORTS	NO
	COST	2.00 €	2.50 €	0 €
	BEST OPTION			
	WORST OPTION			

Fig. 1 Example of the choice card included in the questionnaire

SOS points (i.e., emergency-call service), water supply, hotspots for Wi-Fi, some level of information about the city (in particular, information about weather conditions, tourist attractions and services for residents), electricity supply (for charging tablets and smartphones, electric bicycles and electric cars) and information about mobility (parking slots availability, free charging points for EV and traffic information). Finally, the last attribute is the cost associated with each alternative, in the form of a monthly ticket to be paid to access those services. The status-quo (SQ) level describes the present situation, i.e., without information points.

In order to allocate the attributes of the alternatives, a rotation orthogonal design with 36 choice tasks was created, subsequently arranged in three blocks, using the software "R" and, in particular, the function called "rotation.design" in the package "support.CEs" (Aizaki et al. 2015). This orthogonal design was only used in the pre-test, whose main objective was collecting priors, to create an efficient design in a second step (Vecchiato and Tempesta 2015). Each respondent was required to complete 12 choice tasks. Each task, as shown in Fig. 1, was composed by two alternative structures of information points (option 1 and option 2) and the SQ option (option 3, which is the current situation with no information points within the city). The SQ solution is the alternative with no additional cost for respondents (sometimes called the opt-out alternative), which is chosen if the respondent is not interested in having information points within the city. In each choice situation, respondents were asked to indicate their preferred option (best), as well as the least preferred one (worst). This answering format is known as Best-Worst method (Flynn et al. 2007), which makes possible increasing sampling efficiency compared to the conventional pick-one solution, with only a small increase in the cognitive effort for respondents (Goodman et al. 2005; Scarpa et al. 2010). The pre-test revealed some interesting evidence. For example, the number of choice tasks was too large for respondents, thus interviewers notice a drop in the level of attention of the respondents (Bisello and Grilli 2016). For this reason, the questionnaire for the main survey was created with only eight choice tasks. Pilot questionnaires were not included in the final sample because of the difference in task number. By means of estimated priors, the design was modified after the pre-test to increase its statistical efficiency, following a procedure described by Huber and Zwerina (1996). The new, more efficient design was assessed with the D-error criterion, as explained by Rose et al. (2008).

2.3 Econometric Modelling

The CE methodology is embedded in the Random Utility Theory (RUM), stating that individual choices are observable with a certain degree of uncertainty (Manski 1977). According to RUM, the utility that people derive from a certain purchasing option can be modeled as:

$$U_{int} = V_{int} + \varepsilon_{int},$$

where U_{int} is the global utility obtained by individual i, from alternative n in the choice situation t, V_{int} is the observable (deterministic) component of the utility and ε_{int} is a random unobservable disturbance. The analyst is able to evaluate the deterministic component of the utility that, according to Lancaster´s attribute theory (Lancaster 1966), is given by the sum of the utility provided by each attribute of the option:

$$V_{nt} = \beta_t X'_{tn},$$

where X'_t represents the vector of attributes of the option n in the choice situation t and β_t a vector of parameters. This specification of the utility is usually called "*preference space*", in which the estimated coefficients indicate the marginal effect of each attribute in the composition of the observed utility. In order to evaluate V_{nt} with a statistical model, it is necessary to make assumptions about the distribution of ε_{int} (Henser et al. 2005). The most common way to do that is to assume a Generalized Extreme Value distribution type I (McFadden and Zarembka 1974), enabling the computation of choice probabilities through a Multinomial Logit Model (MNL). Under the assumptions of Independently and Identically Distributed (IID) random terms and Independence from Irrelevant Alternatives (IIA), the MNL model generates one point estimate for each parameter. A point estimate indicates that the marginal effect is the same for all respondents, therefore MNL is not capable of capturing preference heterogeneity across respondents. When preferences across respondents matters, a common statistical specification to relax the assumption of preference homogeneity is the mixed-logit model (MXL). MXL assumes a random distribution of the parameters, for which a location and a scale parameter are estimated, thus it is possible to compute individual parameters. In the MXL model, choice probabilities take the form (Train 2003):

$$P_{ni} = \int \frac{e^{\beta_n' X_{ni}}}{\sum_j e^{\beta_n' X_{ni}}} \varphi(\beta|b,\Omega)\, d\beta$$

in which $\frac{e^{\beta_n' X_{ni}}}{\sum_j e^{\beta_n' X_{ni}}}$ is the logit formula and $\varphi(\beta|b,\Omega)$ is the density function of the distribution of the coefficients. A common practice in empirical evaluations is to assume normally distributed parameters and, to a lesser extent, analysists make use of triangular or uniform distributions (Hensher and Greene 2003). A closed form for the above-described integral does not exist, thus distributions are usually derived by means of simulations, taking random draws from the parameters' distribution. Among several algorithms that are available to draw from distribution densities, halton and sobol sequences appear to be the most efficient ones because correlation among draws is very small (Bhat 2003; Train 2000). In this case, we make use of 1000 random sobol draws to approximate the integral. The calculation of willingness to pay (WTP) for each single attribute is given by the negative of the ratio between coefficients, formally:

$$WTP_b = -\frac{\beta_b}{\beta_{cost}}$$

where β_b is the mean value of the distribution of any of the non-monetary attributes of the utility function. In the MXL context, β_b are assumed not to be point estimates but rather distributions, to accommodate taste variability among respondents. However, the coefficient for the cost attribute (β_{cost}) cannot be considered normally distributed because the ratio between two normal distributions would lead to a Cauchy distribution, which has no central moment (Giergiczny et al. 2012). Thus, a constant price attribute is preferred, which implies that respondents are cost sensitive in the same way. This assumption has the same limitation of MNL and is not likely to hold in practice because of individual preferences and budget constraints. For this reason, a new estimation model has been recently developed. The new procedure models the observed component of utility V_{nt} differently from the standard preference space specification:

$$V_{nt} = \beta_{cost} X_{tj,cost} - \beta_{cost}(\beta_b X_{tjn}'),$$

where β_{cost} is the coefficient associated with the cost attribute $X_{tj,cost}$, while β_b and X_{tjn}' are the vectors of coefficients and the vector of non-monetary attributes, respectively. This new approach to model the observed component of utility is called "*willingness-to-pay space*" (Scarpa et al. 2008) because the estimated coefficients represent themselves the WTP for the attribute, rather than the mere marginal effect, thus solving problems connected with ratios between normal distributions. The cost attribute may be, in this case, normally or log-normally distributed (Hensher and Greene 2001); in our case, we assume cost to be normally distributed across respondents. In addition, estimations in WTP-space facilitate the interpretation of the results, which is useful for policy purposes. In this paper, we estimate MNL and MXL models in WTP space, using R statistical software (R Core Team 2013) for the analyses.

3 Results and Discussions

Interviewers were able to collect 221 complete questionnaires that, considering eight choice tasks per respondents answered with the BW method, lead to 3536 observations. The sample was composed of 52% women and 48% men and the median-age class was between 35 and 44 years old. Concerning educational levels, 52.4% of respondents obtained a high school diploma, while roughly 40% had a university degree or higher. Sixty questionnaires (27%) were compiled by German-speaking respondents, almost matching the proportion of German-speaking natives in the local population. From these descriptive statistics, it can be reasonably concluded that the sample is adequately representative of the population of Bolzano.

Table 2 summarizes the results obtained from the statistical analyses of respondents' choice by MNL and MXL. The coefficient for the cost attribute, which is the only one not representing WTP, is negative and statistically significant. This was an expected result because it implies that utility for individuals declines as the cost increases. Conversely, all non-monetary attributes are positive, meaning that each of the alternative solutions may be preferred by potential users. Looking at the MNL model, it can be seen that almost all the attributes are statistically significant, with the exception of I_WEATHER. This result might be explained since most of the people have a smart phone, already reporting weather conditions and forecasts. For this reason, this attribute might be ignored by respondents while choosing alternatives. Similarly, the SQ is non-significant, which means that people might not consider the current situation (i.e., the city without totems) while choosing among alternatives.

Conversely, relevant attributes for individuals are the possibility to call SOS, WATER availability, as well as Wi-Fi connections. In particular, people stated an average WTP for Wi-Fi of about 1.49€ per month, while for SOS and WATER 0.94 and 0.97€ per month, respectively. Concerning electricity-charging points, people are willing to pay for each of the proposed solutions, i.e., for DEVICES (such as smartphones and tablets), electric BIKES and electric CARS. In particular, the estimated averages were a WTP of 1.27€ for DEVICES, 0.94€ for electric BIKES and 1.82€ for charging electric CARS. Among electric facilities, charging stations for bicycles showed the lowest level of WTP. This might be due to the fact

Table 2 Results of the choice models

	MNL			MXL		
Attributes	Estimate	Std. error	Signif.	Estimate	Std. error	Signif.
SOS	0.98	0.24593	***	1.02	0.2315	***
WATER	0.94	0.17552	***	0.94	0.1893	***
WI-FI	1.49	0.20919	***	1.23	0.2558	***
E_DEVICES	1.27	0.24841	***	1.03	0.2517	***
E_BIKES	0.94	0.26922	***	0.92	0.3865	*
E_CARS	1.82	0.34712	***	1.73	0.4248	***
I_WEATHER	0.38	0.30919		0.13	0.2815	
I_TOURISTS	0.95	0.24985	***	0.46	0.3285	
I_RESIDENTS	1.41	0.24156	***	1.07	0.3636	**
M_CHARGE	0.71	0.24982	**	0.66	0.1436	***
M_TRAFFIC	1.51	0.24229	***	1.25	0.2299	***
M_PARKING	1.58	0.23408	***	1.23	0.2778	***
SQ	0.53	0.34851		0.43	0.6942	
COST	−0.415	0.03587	***	−1.0121	0.1390	***
Sd_SOS				1.0558	0.1734	***
Sd_WATER				0.7683	0.1598	***
Sd_WIFI				1.3042	0.2229	***
Sd_E_DEVICES				0.5529	0.2823	
Sd_E_BIKES				0.0672	0.2158	
Sd_E_CARS				0.6209	0.2170	**
Sd_I_WEATHER				0.5395	0.4437	
Sd_I_BIKES				0.4521	0.2209	*
Sd_I_CARS				0.5395	0.1830	***
Sd_M_CHARGE				0.4521	0.7504	
Sd_M_TRAFFIC				0.645	03979	
Sd_M_PARKING				0.00205	0.3026	
Sd_sq				3.83	0.7205	***
Sd_COST						
LL		−2270			−2109	
N Parameters		14			27	
AIC		4542			4246	
BIC		4548			4252	
N Respondents	221					
N observations	3536					

*,**,*** indicate significance levels of 10, 5, 1 and 0.1%, respectively

that, at present, e-bike's autonomy in most of the cases matches the current daily needs of users (differently from common smartphone battery's performance). Thus, it could be irrelevant for many of them to have such an additional feature, outside their home or accommodation place. The answer could be different for charging points located far from an urban area, along touristic paths. On the other hand, a high level of WTP for EV might be reasonable, because their share on the market is growing. Considering this trend, a wide territorial coverage of charging stations is a fundamental requirement for an increase in public acceptance and trust toward EVs (Zubaryeva et al. 2012). Concerning information, as already stated, WEATHER information seems to be irrelevant in individual choices. Conversely, information about tourist attractions and for services to residents (expressed by the coefficients of I_TOURIST and I_RESIDENT) matters for respondents. People stated an average WTP of 0.95€ per month for tourist information and 1.40€ for the possibility to retrieve information for residents in Bolzano. The last structural attribute for the totems that was considered is represented by information about mobility within the city and the region. People showed a WTP level for information about other charging station in the city of about 0.71€ per month (coefficient called M_CHARGE), while a WTP for TRAFFIC and PARKING information of 1.51€ and 1.58€ per month respectively. This result is reasonable if one considers the present situation of the city, in particular concerning parking availability. In fact, parking services are often overcrowded, and it is difficult to find empty spots in a reasonable timespan. In addition, Bolzano is also characterized by a large share of commuters, thus also information about traffic might be relevant, in order to avoid bottlenecks and overcrowded roads.

Moving to the MXL model, we can see that the log-likelihood function is higher than that in the MNL, thus suggesting a better fit for the data, even though these two values are not directly comparable because of the difference in the number of estimated parameters (Cavanaugh 1997). For this reason, AIC and BIC statistics are better statistics to evaluate model fitting. The decision rule is to choose the model with the smaller value of AIC or BIC. In our case, both indicators suggest that MXL has a better explanatory power for the data, meaning that preference heterogeneity matters among respondents. Even in the case of MXL, coefficients for structural attributes of the totems are all positive, even though the level of WTP is on average lower. The lowest difference between the models is for SOS, in which the estimated average WTP in the MXL model is equal to the WTP estimated by MNL. Conversely, the average WTP for having tourist information available (I_TOURISTS) has the largest difference, of about 0.49€ per month. Coefficients with the prefix "Sd_" represent the estimated standard errors of coefficients' distributions. The significance of these parameters indicates that variability of parameters matter, thus a distribution describes better sample preferences compared to point estimates. This result strengthens the hypothesis that preference heterogeneity across respondents is important and should be therefore considered, to reach better estimates. Concerning the present situation, even in the MXL case, the SQ is non-significant. However, the variance of SQ distribution is significant, thus meaning that the tendency of non-attending the SQ is the average behavior, but this situation is variable within the sample.

4 Conclusions

This contribution introduced a field survey based on a CE application, carried out in the city of Bolzano in Italy. The main purpose of this work was to assess the structural attributes to be embedded in an innovative information infrastructure to be installed at strategic points in the city, to supply residents and commuters with technological devices able to provide additional services. Results suggest that attributes such as Wi-Fi connection, information about mobility and charging points for cars are relevant for respondents. For this reason, they should be included in the final layout of the totems to accomplish the stated preferences of potential users. Conversely, including information about weather conditions seems to be irrelevant for respondents, thus it might be not included in the totem if it requires substantial investments.

In general, it can be said that stated-preference surveys, despite a certain degree of uncertainty and limitations, are important tools for understanding preferences of the target population. Such information might be used in the design of public policies for manifold situations, to plan public expenditures effectively, increasing the usefulness of solutions and, in certain contexts, reducing conflicts that might arise.

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References

Adamowicz, W., Boxall, P., Williams, M., & Louviere, J. (1998). Stated preference approaches for measuring passive use values: Choice experiments and contingent valuation. *American Journal of Agricultural Economics, 80*(1), 64–75.

Aizaki, H., Nakatani, T., & Sato, K. (2015). *Stated preference methods using R*. London-New York: Taylor & Francis Group.

Bertot, J., Jaeger, P., & McClure, C. (2008). Citizen-centered e-government services: Benefits, costs, and research needs. In *The Proceedings of the 9th Annual International Digital government research conference*, 137–142.

Bhat, C. R. (2003). Simulation estimation of mixed discrete choice models using randomized and Halton sequences. *Transportation Research Part B: Methodological, 37*(9), 837–855.

Bisello, A., Grilli, G., Balest, J., Stellin, G., & Ciolli, M. (2017). Co-benefits of smart and sustainable energy district projects: An overview on economic assessment methodologies. *Green Energy and Technology*, 127–164. https://doi.org/10.1007/978-3-319-44899-2_9.

Bisello, A., & Grilli, G. (2016). The benefit of an innovative urban information infrastructure: The choice experiment method applied to the "Totems" of EU project Sinfonia. In *AISRE 2016—XXXVII CONFERENZA ITALIANA DI SCIENZE REGIONALI, At Ancona (Italy)*.

Brownstone, D., Bunch, D. S., & Train, K. (2000). Joint mixed logit models of stated and revealed preferences for alternative-fuel vehicles. *Transportation Research Part B: Methodological, 34*(5), 315–338.

Campbell, D., Hensher, D. A., & Scarpa, R. (2014). Bounding WTP distributions to reflect the "actual" consideration set. *Journal of Choice Modelling, 11,* 4–15.

Cavanaugh, J. E. (1997). Unifying the derivations for the Akaike and corrected Akaike information criteria. *Statistics & Probability Letters, 33*(2), 201–208.

Chau, C. K., Tse, M. S., & Chung, K. Y. (2010). A choice experiment to estimate the effect of green experience on preferences and willingness-to-pay for green building attributes. *Building and Environment, 45*(11), 2553–2561.

Flynn, T. N., Louviere, J. J., Peters, T. J., & Coast, J. (2007). Best-worst scaling: What it can do for health care research and how to do it. *Journal of Health Economics, 26*, 171–189. http://doi.org/10.1016/j.jhealeco.2006.04.002.

Furuli, K., & Ølnes, S. (2009). Finding the right services for a citizen portal lessons learned from the norwegian mypage portal. In *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)* (pp. 282–292).

Giergiczny, M., Valasiuk, S., Czajkowski, M., De Salvo, M., & Signorello, G. (2012). Including cost income ratio into utility function as a way of dealing with "exploding" implicit prices in mixed logit models. *Journal of Forest Economics, 18*(4), 370–380.

Goodman, S., Lockshin, L., & Cohen, E. (2005). Best-worst scaling: A simple method to determine drinks and wine style preferences. *In International Wine Marketing Simposium*. Sonoma, pp. 1–16.

Hardesty, S. D. (2008). The growing role of local food markets. *American Journal of Agricultural Economics, 90*(5), 1289–1295.

Hensher, D., & Greene, W. (2001). The mixed logit model: The state of practice and warnings for the Unwary, 2007(8).

Hensher, D. A., & Greene, W. H. (2003). The mixed logit model: The state of practice. *Transportation, 30*(2), 133–176.

Henser, D. A., Rose, J., & Greene, W. (2005). *Applied choice analysis*. Cambridge: Cambridge University Press.

Hensher, D. A., Rose, J. M., & Greene, W. H. (2015). *Applied choice analysis*, Cambridge University Press.

Hole, A. R. (2007). A comparison of approaches to estimating confidence intervals for willingness to pay measures. *Health Economics, 16,* 827–840.

Hoyos, D. (2010). The state of the art of environmental valuation with discrete choice experiments. *Ecological Economics, 69*(8), 1595–1603.

Huber, J., & Zwerina, K. (1996). The importance of utility balance in efficient choice design. *Journal of Marketing Research, 23*(8), 307–317.

Lancaster, K. (1966). A new approach to consumer theory. *Journal of Political Economy, 74*(2), 132–157.

Ling, C. Y. (2013). Consumers' purchase intention of green products: An investigation of the drivers and moderating variable. *Elixir Marketing Mgmt. 5,* 57(A), pp. 14503–14509.

List, J., Sinha, P., & Taylor, M. (2006). Using choice experiments to value non-market goodsand services: Evidence from field experiments. *Advances in Economic Analysis and Policy, 6*(2), 1132–1134.

Manski, C. F. (1977). The structure of random utility models. *Theory and Decision, 8*(3), 229–254.

Martin, C. J., Taylor, P. G., Upham, P., Ghiasi, G., Bale, C. S. E., James, H., et al. (2014). Energy in low carbon cities and social learning: A process for defining priority research questions with UK stakeholders. *Sustainable Cities and Society, 10,* 149–160.

McFadden, D., & Zarembka, P. (1974). Conditional logit analysis of qualitative choice behavior. *Frontiers in Econometrics*, 105–142.

McKinsey & Company. (2011, June). Big data: The next frontier for innovation, competition, and productivity. *McKinsey Global Institute*, 156.

Mobrezi, H., & Khoshtinat, B. (2016). ScienceDirect investigating the factors affecting female consumers' willingness toward green purchase based on the model of planned behavior. *Procedia Economics and Finance, 36,* 441–447.

R Core Team, R. C. (2013). R: A language and environment for statistical computing.

de Rezende, C. D. (2013). Alternative agri-food networks: Convergences and differences in the evolution of the markets. *Agroalimentaria*, 19(37), 17–37.

Riera, P., Signorello, G., Thiene, M., Mahieu, P.-A., Navrud, S., Kaval, P., et al. (2012). Non-market valuation of forest goods and services: Good practice guidelines. *Journal of Forest Economics, 18*(4), 259–270.

Romero-Lankao, P., Gurney, K. R., Seto, K. C., Chester, M., Duren, R. M., Hughes, S., et al. (2014). A critical knowledge pathway to low-carbon, sustainable futures: Integrated understanding of urbanization, urban areas, and carbon. *Earth's Future, 2*(10), 515–532.

Rose, J. M., Bliemer, M. C. J., Hensher, D. A., & Collins, A. T. (2008). Designing efficient stated choice experiments in the presence of reference alternatives. *Transportation Research Part B: Methodological, 42*(4), 395–406.

Scarpa, R., Thiene, M., & Train, K. (2008). Utility in willingness to pay space: A tool to address confounding random scale effects in destination choice to the Alps. *American Journal of Agricultural Economics, 90*(4), 994–1010.

Scarpa, A. R., Notaro, S., Louviere, J., & Raffaelli, R. (2010). Exploring scale effects of best/worst rank orderedchoice data to estimate benefits of tourism in alpine grazing commons. *American Journal of Agricultural Economics,* 1–28.

Selfa, T., & Qazi, J. (2005). Place, taste, or face-to-face? Understanding producer-consumer networks in "local" food systems in Washington State. *Agriculture and Human Values, 22*(4), 451–464.

Train, K. (2000). *Halton sequences for mixed logit*. Working paper. Department of Economics. University of California.

Train, K. (2003). *Discrete choice methods with simulation*. Berkeley: Cambridge University Press.

Vecchiato, D., & Tempesta, T. (2015). Public preferences for electricity contracts including renewable energy: A marketing analysis with choice experiments. *Energy, 88*(June), 168–179.

Zubaryeva, A., Thiel, C., Barbone, E., & Mercier, A. (2012). Assessing factors for the identification of potential lead markets for electrified vehicles in Europe: Expert opinion elicitation. *Technological Forecasting and Social Change, 79*(9), 1622–1637.

Game Over or Jumping to the Next Level? How Playing the Serious Game 'Mobility Safari' Instigates Social Learning for a Smart Mobility Transition in Vienna

Katharina Gugerell, Mario Platzer, Martina Jauschneg, Cristina Ampatzidou and Martin Berger

Abstract Serious games and gaming are increasingly considered as the magic bullet for improved stakeholder involvement and citizen engagement in urban planning and governance. They are also discussed as means to instigate learning and capacity building and to raise the awareness of citizens and stakeholders about various urban topics. These learning processes can unfold in various different formats, such as social or game-based learning. This chapter investigates if playing the serious game prototype 'Mobility Safari' supports such processes. Mobility Safari is a serious-game prototype developed for the City of Vienna. The game is targeting Vienna's ambition to become a smart city. One focal point of this ambition concerns the change towards a more sustainable mobility system. Our analysis illustrates that the serious game indeed evokes learning processes during the gameplay and the debriefing, covering a broad range of learning activities and social interaction. Incomplete rule-sets and un-governed situations trigger discussions in which players confront the game experience with their actual real-world practices. Our analysis suggests that games are indeed suitable means for informing citizens and supporting capacity-building processes in participatory-planning approaches. However, they need a careful design, facilitation and sufficient time for a debriefing so that players can reflect on the game experience. This reflection is crucial to transform the game experience into a deeper learning experience that is meaningful for real-world contexts.

Keywords Serious games · Urban governance · Civic learning
Sustainable mobility · Smart city · Vienna

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1 Introduction

Serious games, digital tools and gamified environments are increasingly utilized in a broad variety of different sectors related to planning, such as health, urban and community planning, mobility, or energy related issues (e.g., Kleinhans et al. 2015; Mohammed and Pruyt 2014; Poplin 2014). The reason is that they can represent complex 'real-world' situations and allow players to engage with these in explorative and experiential ways. In the field of planning, serious games and gamelike approaches were first introduced in the 1960s. More recently, the proliferation of mobile devices (e.g., smart phones), the broad availability of Wi-Fi, modelling and simulation technologies (e.g., GIS, ABM)—but also the emergence of the smart city discussion—have resulted in a new wave of gamified tools, serious games and digital technologies in the field of planning (e.g., Gugerell et al. 2017; Tan 2014). Serious games and gamified environments are considered valuable because they enable the exploration of various pathways, support experimentation with various behaviors and the manipulation of system components (Cumming et al. 2012). The immediate response of the game system to decisions taken is one of the assets for the players. Consequently, playing games instigates various formats of experiential learning, such as knowledge creation, finding common ground, conflict resolution, experimenting with rules or institutions and motivating goal achievement (e.g., Bluemink et al. 2010; Devisch et al. 2016; Guzzetti et al. 1993; Hämäläinen 2011; Poplin 2014).

The game Mobility Safari targets Vienna's ambition to shift towards a more sustainable mobility system and to encourage 'greener' behavior by its citizens. Vienna is growing by 30,000 inhabitants per year, corresponding to a proportional increase in the number of trips. The current modal split shows a distribution of 39% public transport, 7% bicycles, 27% pedestrians and 27% motorized individual traffic (MA23 2016). Hence, CO_2-free modes such as walking and cycling should be strengthened to progressively lower the MIT to 15% by 2050. Also, with new propulsion technologies for non-motorized types of PT and MIT, the entire commercial traffic (source and destination traffic) should run CO_2 free by 2050 (City of Vienna 2016). The city stakeholders are aware that this policy's success is dependent on the citizens' daily mobility behavior and their involvement in mobility projects. Thus, the city administration stresses the importance of: (i) awareness rising among the various actor groups; (ii) informing these actor groups which resources are needed for 'green' and 'shared' mobility projects; (iii) supporting networking and trust-building to set up sharing initiatives and citizen collectives; (iv) informing citizens of existing mobility initiatives and upcoming mobility projects run by the city; and (v) integrating underrepresented groups into these activities. The city's ambition is also characterized by urgency: the mobility and transport sector accounts for approximately 27% of global energy consumption and CO_2 emissions and 33% in the European Union (IPCC 2014). Also, mobility is causing significant urban noise and air pollution and can pose a major constraint on the quality of urban life (Batty et al. 2015; Banister and

Thurstain-Goodwin 2011). Thus, cities are important units for policies and practices addressing sustainability issues and aiming at strong environmental benefits (e.g., Bulkeley and Castan Broto 2013). This is because cities play two important roles: (1) of actors regarding local transport; and (2) of loci and provider of low-carbon innovation and services (Geels 2011a, b; Nevens et al. 2013). Hence, experimentation with alternative social and mobility practices questioning and disrupting existing, and envisioning, novel policies are—along with technological, market, policy and institutional questions—important tiers for urban sustainability transitions. In particular, local action is crucial for major sustainability-related changes. Still, modal choice and mobility practices are a consequence of a mix of values, attitudes and perceptions (e.g., Hunecke et al. 2010; Klinger and Lanzendorf 2016; Lesteven 2014; Thøgersen 2009), and/or economic viability (e.g., Van Exel and Rietveld 2009). Thus, however, sustainability transitions are not only about content or technology, but they rest on process- and practice-related matters and local action. Sustainability transitions are long-term processes of fundamental changes in practices, culture and structure (e.g., Avelino et al. 2016). In this article we raise the questions if: (i) the serious game 'Mobility Safari' can trigger civic learning and experimenting for sustainability (e.g., Lozano 2007, 2014; Gugerell and Zuidema 2017), together with alternative practices that might contribute to such transformations; and (ii) if the learning outcomes correspond with the ambitions stated in Vienna's smart city strategy. To better understand the links between games and learning, we briefly introduce the academic debate on the topic in the following section. In Sect. 3, we explain the game prototype 'Mobility Safari' and our research methodology. Section 4 contains the main findings, and finally in Sect. 5 we come back to our objectives in the conclusion. There we suggest that games can indeed evoke civic learning and can act as the onset of process-oriented sustainability transitions, but in more ambiguous ways than initially expected.

2 Games as Blissful Learning Environments for Sustainability Transitions

Playing is the most basic form of learning, and imaginative and social forms of play are crucial for conceiving and making sense of the external world (Piaget 1962; Huizinga 1999; Papert 1987). Learning through play is currently undergoing a renaissance with the rise of digital tools and the increasing popularity of (digital) games and serious games. In planning, more gameful (rule-based) and playful (free-form) participatory tools and digital models have emerged over the previous 25 years, many of them with the purpose to support participatory processes, decision making and a better understanding of the environment. Especially GIS and simulation technologies have experienced a certain "gamification", implementing gameful elements for improved participatory engagement (e.g., Schauppenlehner et al. 2016). Citizens are often considered as sensors but also as supporters for research and solving complex scientific problems by playing games such as 'Fold-It' (protein folding, Cooper et al. 2010) or 'Quantum Moves' (moving quantum atoms, Center for Community Driven Research). Research argues that serious games have advantages over traditional learning formats. They allow players the discovery and reconstruction of knowledge and skills (Papert 1980, 1987) by active engagement with the game, receiving immediate feedback to actions and decisions taken in the gameplay, and support the understanding of complex systems by representing complex real-world matters in an artificial game environment (Mayer et al. 2005; van Bilsen et al. 2010; Medema et al. 2016; Tan 2014). The game as artifact prepares and guides the discovery and exploration path of the players (Marzano 2007), makes possible the taking of risks and manipulation or exploration of extreme pathways without facing the real consequences of failing or causing damage (Devisch et al. 2015; Juul 2016; Raphael et al. 2010). Games are pleasant and entertaining learning environments because they offer a balanced mix of progressing challenge, foster social interactions, provide feedback loops and rewards, ideally encourage replay and thus divest the player of the feeling of being wrong or having misunderstood (Papert 1980; Gee 2005; Lieberman 2006). Common criticisms against serious games suggest that players might get so immersed in the gameplay that they fail to achieve the initial learning objectives or that 'serious games' are sometimes too serious. Hence, the challenge is to integrate learning into the game without spoiling what is enjoyable and fun (Ke 2016) to keep the players blissfully engaged.

Research suggests that games support the development of improved cognitive and social learning (e.g., Erhel and Jamet 2013; Gee 2005; Granic et al. 2014; Hamari et al. 2016; Prensky 2006; Shaffer et al. 2005). Consequently, as 'serious learning technologies', games are expected to deliver benefits such as teaching problem solving, enhancing spatial sense and visual thinking, reflecting on complex problems, raising awareness, increasing media literacy, educating target audiences on specific topics and skills and building coalitions and networks (Ventura et al. 2013; Erhel and Jamet 2013; Gee 2005; Hamari et al. 2016; Prensky 2006; Crookall 2010). If such learning actions take place in group settings, where players interact with each other (i.e., in negotiating strategies, knowledge sharing, praising each other's achievement), the process is associated with social learning (e.g., Hummel et al. 2011). Multiplayer games, such as 'Mobility Safari', merge individual and social learning. Various different learning concepts (e.g. behaviorism, constructivism) promote different views on the importance of social interaction, but agree on the benefits of group interaction for learning in general (e.g., Doise et al. 1976; Grusec 1992; Piaget 1981). Within gameplay, social interaction helps to unlock joint knowledge, linking to already established practices or tacit knowledge to produce a new one. More recently, learning, exploration and experimentation have also been positively associated with action and actors engaged in sustainability transitions (e.g., Nevens et al. 2013; Frantzeskaki et al. 2014; Wittmayer et al. 2014). Lozano (2007, 2014) proposes an integrated concept that merges various learning approaches (i.e., adaptive, anticipatory, action-based) with the scheme of single-, double- and triple-loop learning (see Fig. 1). Lozano argues that learning

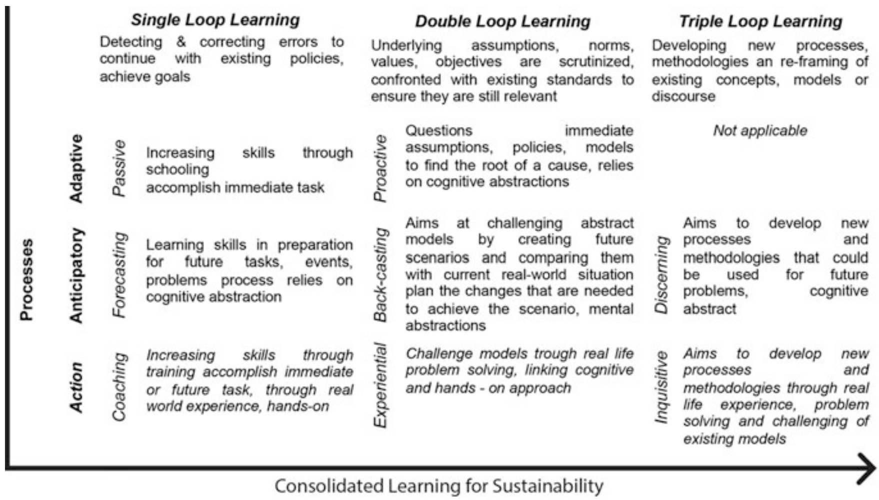

Fig. 1 Consolidated learning processes range from single-loop to more complex forms of learning, such as action-based triple learning. Illustration based on Gugerell and Zuidema (2017), Lozano (2014)

for sustainability requires consolidated learning processes that cover the range from single-loop knowledge learning to complex inquisitive forms of triple-loop learning that scrutinizes conceptual models and develops alternative ones. Especially the more complex learning formats align well with Papert‘s and Piaget’s learning concepts, focusing on actively challenging, questioning and constructing new mental models, concepts and processes to make sense of the game and the real world surrounding it. If, by playing a game, players reflect on their civic practices and actions, conceptualize them within a wider context, and can apply the learning outcomes (e.g., knowledge, skills) outside the game in a real-world context, this learning process becomes associated with civic learning (Gordon and Baldwin-Philippi 2014; Raphael et al. 2010). Thus, consolidated civic-learning processes are crucial to respond sufficiently to complex societal challenges, such as the pursuit of a sustainable mobility system. In our analysis, we ask whether playing ‘Mobility Safari’ unlocks various forms of learning, ranging from single-loop knowledge acquisition to more complex modes of social learning, including of double- and triple-loop learning.

3 Methods and Game Prototype ‘Mobility Safari’

The research follows a mixed method approach, combining: (a) a standardized questionnaire (n = 78); (b) participatory observation during gameplay; and (c) a debriefing at the end of each playing session (n = 16). Before and during the test phase, various methods for recruiting voluntary players were used, including social media (e.g., Facebook, Twitter, LinkedIn) and snowball sampling. The standardized questionnaire is literature based, querying: (a) sociodemographic data; (b) knowledge and attitudes towards environment, mobility, energy and participation; (c) player types and game preferences; (d) gaming experience and strategy; and (e) gaming/learning impact. 'Learning impact' was sampled by the players' self-evaluation of their learning experience. The completed questionnaires were coded with SPSS and analyzed by descriptive statistics (see Table 1). The analysis was complemented by qualitative data on the playing processes, player interaction and decision-making processes in the game, which were collected through participatory observation. Mapping player interaction is crucial to identify learning actions associated with collective and social learning (Medema et al. 2016; Wendel and Konert 2016; Dörner et al. 2016). The debriefing was organized as a focus-group discussion moderated by a facilitator, where the players jointly reflected on the gameplay, strategies and decisions taken and linked the gaming with their real-world experience. Serious gaming literature stresses the importance of debriefing to transform the gaming experience into a deeper learning experience (Lederman 1992; Crookall 2010). The debriefings were recorded, transcribed and coded, and a content analysis was performed (Gläser and Laudel 2010; Mayring 2015). The sample is skewed towards higher levels of education and female participants. Most players are between 19- and 30-years old, which represents the project's focus group of young adults. The sample is balanced regarding gaming abundance: 36% play games rarely to never, 25% occasionally and 39% play games frequently, but with rather modest experience in serious games.

3.1 Serious Game 'Mobility Safari'

'Mobility Safari' is a co-located, serious board game for four to six players (see Fig. 2). The aim of the game is to increase the literacy of citizens about sustainable urban mobility options, experiment with different mobility choices, e.g., how to set up mobility cooperatives, and let players experience the community and environmental impact of their in-game choices. The game narrative is embedded in the local mobility narrative and the city's ambition for a sustainable urban mobility system (City of Vienna 2014, 2016; Mobilität—STEP 2025). The game board represents the city of Vienna and is divided into colored tiles that correspond to the main tiers of the city's policy (purple: innovation and learning; green: active and healthy; yellow: flexible and connected, red: fair and safe). Dicing drives the players to move their playing figure on the game board. Arriving at a tile, the player can decide on implementing a project determined by the color of the tile. Players can prioritize their target tiers and personal goals. The project cards are presented face-up, so the players can deliberate which project suits them most by checking its value and the requirements and resources needed to implement it. These requirements mirror a limited number of institutional, financial and social rules:

Table 1 Survey results on the players' perceived learning outcomes and learning effects

Statements	Relative frequency in %				
	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Single-loop learning/knowledge learning					
I was curious to learn something new from the game	6	8	29	33	24
Through the game, I am inspired to learn more about the mobility transition in my region	10	26	29	28	7
Through the game, I understand more about implementing urban development projects	14	18	37	28	3
I obtain and explore new perspectives on the topic of mobility	6	37	31	22	4
Through the game, I learned something new about the mobility transition in my city	18	30	31	18	3
Social learning/double- and triple-loop learning					
Playing the game demonstrated that by cooperation with others environmental problems can be solved	8	17	31	32	12
The game shows various options for participation and civic involvement	10	20	36	27	7
Playing the game raised my interest and awareness regarding mobility projects	12	21	32	24	11
Through the game, I have a better understanding of possible projects in my city that contribute to the mobility transition	13	19	33	32	3
After playing 'Mobility Safari', I would like to engage more in mobility initiatives	19	28	31	19	3
Social learning/co-located learning by observation					
Through the game, I learned more about other players	7	14	31	34	14
Watching the strategies of other players helped me to understand the game better	7	24	36	22	11
I learned things I didn't know about the mobility transition from other players	23	28	29	14	11
The game offered me a new perspective on the interests and concerns of other players	17	31	34	14	4
Total	72 (100%)				

Fig. 2 Serious game prototype 'Mobility Safari', co-created in the play!UC project by various stakeholders, planners and researchers in Vienna (Austria) and Groningen (Netherlands)

(a) creating networks; (b) obtaining a permit (either by rolling a dice or answering a multiple-choice quiz question); and (c) paying the implementation and realization costs. Each implemented project provides the player's network with a certain number of coins (financial aspect), community points (social aspect) or CO_2-reduction points (environmental aspect). Players have to settle annually, increasing mobility costs at the end of each game round, paying with the coins they collected when implementing projects. At the end of each of the five rounds, an activity card is played: activity cards are single events that introduce external impacts on mobility, such as oil crisis, elections, increasing population or floods. At the end of the game, there are three possible winning conditions: players with the highest number of coins, community or CO_2-reduction points.

4 Consolidated Civic Learning with 'Mobility Safari'

Civic learning for sustainability should ideally cover all three formats of learning: single-, double- and triple-loop learning. The players evaluate 'Mobility Safari' as 'fun-to-play': "It was great fun playing it" (77%), "The game is well constructed" (62%) and "The game is interesting and diverse" (44%). Favorable feedback on the fun-factor and a high willingness to replay the game (73%) illustrate that 'Mobility Safari' works well as a game. Players that are active in community and participatory projects were even slightly more positive about the value of the game and the gameplay. Approximately one third of the players agreed that the game inspired them to learn more about sustainable urban mobility.

Learning actions in the ambit of single-loop learning occurred in the game via the quiz questions. The questions targeted at instruction in the field of sustainable urban mobility, such as providing information on bike-sharing, sustainable service providers, PT, CO_2 emissions and the urban carbon footprint. The wording of the multiple-choice quiz questions included some pieces of additional information. Thus, it was not necessary for players to know the correct answer: they could reconstruct it by using these bits of information. The various answer options facilitated approximating the correct answer. More than half of the players stated that during the gameplay they have learned something 'new' and that they have obtained new knowledge on urban initiatives and new perspectives on mobility: "I've learned about sustainable projects and ideas I had no idea about" (G17). One fourth of the players perceived that they had learned about the environmental and community dimension of mobility choices: "The game shows that every project has a sustainable influence on the environment" and "[What I enjoyed was] setting up a joint venture and not executing projects on my own—and seeing the common benefit from implementing these projects". Even though learning actions occurred and the players actively reconstructed knowledge together by working on the quiz questions, their self-perception of learning remained moderate. That might be due to: (a) the slight overhang of well-educated people who are already well informed; and (b) given the better education, the set of quiz questions was perhaps a bit too easy and not sufficiently challenging for that player group.

The quiz questions linked single-loop learning with more complex forms of learning by triggering social interactions such as knowledge sharing or group discussions. The experience of social learning is twofold and stems both from getting acquainted with other players and their perceptions and from observing other players. Concerning getting to know other players, the game delivered effects above average. More elaborated effects, e.g., learning about other players' perspectives (48%)—"Now I know how you really tick" (G17) or anticipating other players' knowledge (25%) also occurred but on more moderate levels. The quiz questions were an important source of interaction. To approximate or calculate the answer, the groups confronted the quiz questions with their game experience and individual mobility and social practices in everyday life. In the resulting discussions, the players actively engaged in the debate about individual practices, shared their information about mobility options and other real-world experiences. Real-world experiences paired with individual values and norms played an important role in the discussions on the project selection: "No, I don't support electromobility projects. That's not solving any traffic and mobility issues of the city" (G14). The players actively linked the debate with the socio-spatial context of the various districts of Vienna: "No, for *Lobau* (district in Vienna, N/A) a promenade does not fit—so I'll choose another tile and topic." (G12) or "(…) the most important point of the strategy is to choose the right neighborhood for urban development (…) to enjoy the multiplier effects of neighboring projects" (G15). Hence, our work aligns with the prior work of Medema et al. (2016) showing that the gameplay delivers social-learning activities in the ambit of double-loop learning. We also observed that, apart from rules, also values and norms transgress the boundaries, in consequence linking the game and the real world (Juul 2011).

In addition to the content-specific group discussions, indications for institutional learning and capacity building occurred. Players indicated that they appreciated "negotiating and cooperating with other players" and the "process of gathering a team of project members". Contrary to standard game-design theory, we left some situations in the game ungoverned, such as coalition building or who should answer, and how, the quiz questions. We observed various strategies how groups dealt with this matter. In some cases, rules were actively negotiated, but more often norms were subliminally accepted. An example was the creation of a project coalition, where the spectrum of different motives covered altruistic (“Nobody is left behind”, G6), redistributive (“(…) you have almost no implemented projects yet”, G6) or regulatory, normative motives, stressing that “Players who already collected many points were not considered anymore later in the game” (G13). However, less discursive formats for coalition building were also used, such as random selection or ‘first-come first-served’ options. These norms and subliminally accepted game rules were then re-introduced in the debriefing by the facilitator. At this stage, players often were surprised, arguing that “that was a rule” and eventually admitting that they actually just accepted something they did not always fully agree with. Some players complained about the lack of predefined rules to govern such situations. Experimenting with alternative institutions in the game also occurred, and it included resource sharing, gifting resources to other players or reasoning in favor of players who were struggling. Nevertheless, players also used active bribery, corruption or usury as informal game institutions. During the gameplay and in the debriefing, players addressed and discussed such practices, as well as institutional tensions, alternative institutional formats and the changeability of institutional designs. We interpret these activities as modest indications of anticipatory triple-loop learning. However, the discussion on alternative or new institutional formats and practices occurred much less often and in less obvious form than it happen with social and mobility practices and other real-life experiences.

5 Conclusions

In this article we argue that playing the serious game ‘Mobility Safari’ triggers learning activities and processes. The game delivers benefits that are associated with social learning addressed in the academic debate on sustainability transitions, such as evoking group discussions, spatial sensitivity, spatial sense or coalition building (e.g. Nevens et al. 2013; Neef et al. 2017). Hence, the game also works as a supportive tool in the implementation of Vienna’s smart city strategy by raising awareness, informing actors on green mobility, and sharing projects and existing intitatives, as well as supporting networking (City of Vienna 2016).

While the game indicates promising results within the scope of single and partly double-loop learning, it falls short in the more complex ambit of the consolidated learning scheme (see Fig. 1). Hence, the anticipated consolidated learning process to support sustainability transitions remains moderate. Though the gameplay and the debriefing show moderate indications of more complex forms of learning (i.e., action-based triple loop), the players do not actively perceive them as learning processes. In consequence, the learning results, also those stated in the questionnaire, were rather modest. However, the players’ perception that the activity is ‘playing a game’ and less a ‘learning experience’ confirms that the serious game works as a game without players noticing too much that they are learning. Nevertheless, in future research, a stronger focus on institutional learning in the debriefing would be worth exploring. In the testing period, we also learned that the incomplete rule-set created added value to the more complex formats in the scope of double- and triple-loop learning: ambigous, ungoverned situations forced the players into the experience of institutional tensions. These situations motivated them to actively engage and explore various options for how to deal with or solve problems. The game, as the general structure, guides the players through their learning experience. Gaps and ungoverned spaces in the rule set of the game support active engagement and discovery learning (Papert 1980) of players. Hence, regarding gameful learning for sustainability transitions, consolidated civic learning is the ambition. Incomplete and ambigous rule-sets might be a suitable option to trigger active engagement and different modes of learning activites, such as exploring new rules, questioning institutions and discussing, negotiating and deciding on institutional formats. This finding adds to the traditional gaming literature that outlines unambiguous, fixed and binding rule sets as fundamental conditions for games (Salen and Zimmerman 2004; Juul 2011). To deliver a challenging learning experience, we suggest developing customized 'combat levels' (i.e., easy, moderate, hard), not only for entertainment but also for serious games. Player groups might differ significantly; to ensure a challenging experience, the players need the opportunity to select their game level. While this option is quite common in entertainment games, in serious games it is almost entirely missing. With differentiated levels, the players can experience progressive challenges over a longer time period or while playing the game more often. This will keep them interested and motivated and make the gaming experience more fun and enjoyable.

We also learned that the debriefing is the crucial moment to transform the gaming experience into a deeper learning experience by discussing and reflecting, e.g., institutional questions which are not obvious to the players in the gameplay. Thus, the debriefing and its design should be carefully considered and sufficiently addressed in the serious game design (Winn 2009; Hunicke et al. 2004). The debriefing activity is crucial to consciously link the gameplay and game experience to real-world circumstances, practices and local action and to contextualize their meaning. This reflection is the conceptual and procedural bridge that is required to facilitate serious games and gamified environments as sources and tools in participatory processes and collaborative action for the governance of sustainability transitions.

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References

Avelino, F., Grin, J., Pel, B., & Jhagroe, S. (2016). The politics of sustainability transitions. *Journal of Environmental Policy Planning, 18,* 557–567.

Banister, D., & Thurstain-Goodwin, M. (2011). Quantification of the non-transport benefits resulting from rail investment. *Journal of Transport Geography, 19*(2), 212–223.

Batty, P., Palacin, R., & González-Gil, A. (2015). Challenges and opportunities in developing urban modal shift. *Travel Behaviour and Society, 2*(2), 109–123.

van Bilsen, A., Bekebrede, G., & Mayer, I. S. (2010). Understanding complex adaptive systems by playing games. *Informatics in Education, 9*(1), 1–18.

Bluemink, J., Hämäläinen, R., Manninen, T., & Järvelä, S. (2010). Group-level analysis on multiplayer game collaboration: how do the individuals shape the group interaction? *Interactive Learning Environments*, 18 (November 2012), 365–383.

Bulkeley, H., & Castan Broto, V. (2013). Government by experiment? Global cities and the governing of climate change. *Transactions of the Institute of British Geographers, 38*(3), 361–376.

City of Vienna. (2016). *Smart City Wien—Framework Strategy*, Vienna. https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008392.pdf. Accessed 06 August 2017.

City of Vienna. (2014). *STEP 2025 Fachkonzept MOBILITÄT*. https://www.wien.gv.at/stadtentwicklung/studien/pdf/b008390b.pdf. Accessed 06 August 2017.

Cooper, S., Khatib, F., Treuille, A., Barbero, J., Lee, J., Beenen, M., et al. (2010). Predicting protein structures with a multiplayer online game. *Nature*, 466(7307), 756–760.

Crookall, D. (2010). Serious games, debriefing, and simulation/gaming as a discipline. *Simulation & Gaming, 41*(6), 898–920.

Cumming, G. S., Olsson, P., Chapin, F. S., & Holling, C. S. (2012). Resilience, experimentation, and scale mismatches in social-ecological landscapes. *Landscape Ecology,* 28(6), 1139–1150.

Devisch, O., Diephuis, J., Gugerell, K., Berger, M., Jauschneg, M., Constantinescu, T., et al. (2015). Game mechanics for civic participation in digitized cities. In Partanen Jenni (Ed.), *Complexity and digitalization of cities—challenges for urban planning and design*. AESOP: Tampere.

Devisch, O., Poplin, A., & Sofronie, S. (2016). The gamification of civic participation: Two experiments in improving the skills of citizens to reflect collectively on spatial issues. *Journal of Urban Technology, 732,* 1–22.

Doise, W., Mugny, G., & Perret-Clermont, A.-N. (1976). Social interaction and cognitive development: Further evidence. *European Journal of Social Psychology, 6*(2), 245–247.

Dörner, R., Martin-Niedecken, A. L., Kocher, M., Baranowski, T., Kickmeier-Rust, M., Göbel, S., et al. (2016). Contributing disciplines. In R. Dörner, S. Göbel, W. Effelsberg & J. Wiemeyer (Eds.), *Serious games: Foundations, concepts and practise* (pp. 35–82). Chams: Springer International Publishing Switzerland.

Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education, 67,* 156–167.

Frantzeskaki, N., Wittmayer, J., & Loorbach, D. (2014). The role of partnerships in "realising" urban sustainability in Rotterdam's city ports area, the Netherlands. *Journal of Cleaner Production, 65,* 406–417.

Gee, J. P. (2005). Why are videogames good for learning? *Spectrum, 32,* 25–32.

Geels, F. (2011a). Role of cities in technological transitions. In H. Bulkeley, V. Castán Broto, M. Hodson & S. Marvin (Eds.), *Cities and low carbon transitions* (pp. 13–28). London & New York: Routledge Taylor and Francis Group.

Geels, F. (2011b). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions, 1*(1), 24–40.

Gläser, J., & Laudel, G. (2010). *Experteinterviews und qualitative Inhaltsanalyse*. Wiesbaden: VS Verlag für Sozialwissenschaften.

Gordon, E., & Baldwin-Philippi, J. (2014). Playful Civic Learning: Enabling Reflection and Lateral Trust in Game-based Public Participation. *International Journal of Communication, 8,* 759–786.

Granic, I., Lobel, A., & Engels, R. C. (2014). The benefits of playing video games. *American Psychologist, 69*(1), 66–78.

Grusec, J. E. (1992). Social learning theory and developmental psychology: The legacies of robert sears and albert bandura. *Developmental Psychology, 28*(5), 776–786.

Gugerell, K., Höffken, S., & Netsch, S. (Eds.). (2017). Play the city. Stadt und Spiel, *Die PlanerIn*, *38*(2), 1–78.

Gugerell, K., & Zuidema, C. (2017). Gaming for the energy transition. Experimenting and learning in co-designing a serious game prototype. *Journal of Cleaner Production, 169,* 105–116.

Guzzetti, B. J., Snyder, T. E., Glass, G. V., & Gamas, W. S. (1993). Promoting conceptual change in science: A comparative meta-analysis of instructional interventions from reading education and science education. *Reading Research Quarterly, 28*(2), 117–159.

Hämäläinen, R. (2011). Using a game environment to foster collaborative learning: A design-based study. *Technology, Pedagogy and Education*, 20 (March 2015), 61–78.

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. (2016). Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning. *Computers in Human Behavior*, *54*, 170–179.

Huizinga, J. (1999). *Homo ludens: A study of the play-element in culture*. Abingdon: Routledge Chapman & Hall.

Hummel, H. G. K., Van Houcke, J., Nadolski, R. J., Van Der Hiele, T., Kurvers, H., & Löhr, A. (2011). Scripted collaboration in serious gaming for complex learning: Effects of multiple perspectives when acquiring water management skills. *British Journal of Educational Technology, 42*(6), 1029–1041.

Hunecke, M., Haustein, S., Bohler, S., & Grischkat, S. (2010). Attitude-based target groups to reduce the ecological impact of daily mobility behavior. *Environment and Behavior, 42,* 3–43.

Hunicke, R., Leblanc, M., & Zubek, R. (2004). MDA: A formal approach to game design and game research. In *Proceedings of the AAAI-04 Workshop on Challenges in Game AI, 25–29 July, San Jose California*. http://capital.osd.wednet.edu/media/capital/staff/leduc/schedules/MDA.pdf. Accessed 06 August 2017.

IPCC. (2014). *Climate Change 2014—Synthesis Report*. https://www.ipcc.ch/report/ar5/syr/. Accessed 06 August 2017.

Juul, J. (2011). *Half real: Video games between real rules and fictional worlds*. Cambridge, Massachusetts, London: MIT Press.

Juul, J. (2016). *The art of failure: An essay on the pain of playing video games*. Cambridge, Massachusetts, London: MIT Press Ltd.

Ke, F. (2016). Designing and integrating purposeful learning in game play: A systematic review. *Educational Technology Research and Development, 64*(2), 219–244.

Kleinhans, R., Van Ham, M., & Evans-Cowley, J. (2015). Using social media and mobile technologies to foster engagement and Self-organization in participatory urban planning and neighbourhood governance. *Planning Practice & Research*, *30*(3), 237–247

Klinger, T., & Lanzendorf, M. (2016). Moving between mobility cultures: What affects the travel behavior of new residents? *Transportation, 43*(2), 243–271.

Lederman, L. (1992). Debriefing: Toward a systematic assessment of theory and practice. *Simulation & Gaming, 23*(2), 145–160.

Lesteven, G. (2014, April). Behavioural responses to traffic congestion. In *Transport Research Arena (TRA) 5th Conference: Proceedings of Transport Solutions from Research to Deployment* (pp. 14–17). Paris.

Lieberman, D. (2006). *What can we learn from playing interactive games?* (pp. 379–397). Playing video games: Motives, responses, and consequences.

Lozano, R. (2007). Collaboration as a pathway for sustainability. *Sustainable Development, 381* (March), 370–381.

Lozano, R. (2014). Creativity and organizational learning as means to foster sustainability. *Sustainable Development, 22*(3), 205–216.

Marzano, R. J. (2007). *The art and science of teaching: A comprehensive framework for effective instruction*. Alexandria: Association for Supervision and Curriculum Development.

Mayer, I. S., van Bueren, E. M., Bots, P. W. G., van der Voort, H., & Seijdel, R. (2005). Collaborative decisionmaking for sustainable urban renewal projects: A simulation—gaming approach. *Environment and Planning B: Planning and Design, 32*(3), 403–423.

Mayring, P. (2015). *Qualitative Inhaltsanalyse: Grundlagen und Techniken*. Weinheim, Basel: Beltz.

Medema, W., Furber, A., Adamowski, J., Zhou, Q., & Mayer, I. (2016). Exploring the potential impact of serious games on social learning and stakeholder collaborations for transboundary watershed management of the St Lawrence River Basin. . *Water, 8*(5), 1–24.

Mohammed, I., & Pruyt, E. (2014). Speeding up energy transitions: Gaming towards sustainability in the Dutch built environment. *Topics in Safety, Risk, Reliability and Quality*, *24*, 223–237.

Neef, R., Verweij, S., Gugerell, K., & Moen, P. (2017). *Wegwijs in Living Labs in Infrastructuur en Ruimtelijke Planning*. Groningen: Een Theoretische en Empirische Verkenning.

Nevens, F., Frantzeskaki, N., Gorissen, L., & Loorbach, D. (2013). Urban transition labs: Co-creating transformative action for sustainable cities. *Journal of Cleaner Production, 50,* 111–122.

Papert, S. (1987). Constructionism: A new opportunity for elementary science education. *National Science Foundation NSF Award Search: Award # 8751190*, 1–2. http://nsf.gov/awardsearch/showAward?AWD_ID=8751190. Accessed 06 August 2017.

Papert, S. (1980). *Mindstorms. children, computers and powerful ideas*. New York: Basic Books Inc.

Piaget, J. (1962). *Play dreams and imitation in childhood*. New York: Norton & Company.

Piaget, J. (1981). *Meine Theorie der geistigen Entwicklung*. Weinheim Basel: BELTZ.

Poplin, A. (2014). Digital serious game for urban planning: "B3-design your marketplace!". *Environment and Planning B: Planning and Design, 41*(3), 493–511.

Prensky, M. (2006). Don't bother me Mom, I'm learning!: How computer and video games are preparing your kids for twenty-first century success and how you can help! *Minnesota Paragon House*, 27–51.

Raphael, C., Bachen, C., Lynn, K.-M., Baldwin-Philippi, J., & McKee, K. A. (2010). Games for civic learning: A conceptual framework and agenda for research and design. *Games and Culture, 5*(2), 199–235.

Salen, K., & Zimmerman, E. (2004). *Rules of play*. Game Design Fundamentals, Cambridge, Massachusetts, London: MIT Press.

Schauppenlehner, T., Eder, R., Gabriel, S., Salak, B., & Muhar, A. (2016). Enabling pupils to contribute to societal challenges and participatory processes. In *Proceedings of International Journal of E-Planning Research*, *31 March–4 April*. Lisbon Portugal.

Shaffer, D. W., Squire, K. R., Halverson, R., & Gee, J. P. (2005). Video games and the future of learning. *Phi delta kappan, 87*(2), 104–111.

Tan, E. (2014). *Negotiation and Design for the Self-Organizing City*. *Gaming as a method for Urban Desgin* (Ph.d. Thesis). TU Delft. https://admin.stedenintransitie.nl/wp-content/uploads/2015/02/Negotiation-and-Design-for-the-Self-Organizing-City.pdf. Accessed 06 August 2017.

Thøgersen, J. (2009). Promoting public transport as a subscription service: Effects of a free month travel card. *Transport Policy, 16*(6), 335–343.

Van Exel, N. J. A., & Rietveld, P. (2009). Could you also have made this trip by another mode? An investigation of perceived travel possibilities of car and train travellers on the main travel corridors to the city of Amsterdam, The Netherlands. *Transportation Research Part A: Policy and Practice, 43*(4), 374–385.

Ventura, M., Shute, V., & Kim, Y. J. (2013). Assessment and learning of qualitative physics in Newton' s playground. *The Journal of Educational Research, 106,* 423–430.

Wendel, V., & Konert, J. (2016). Multiplayer serious games. In R. Dörner, S. Göbel, W. Effelsberg & J. Wiemeyer (Eds.), *Serious games. foundations, concepts and practise (*pp. 211–242). Chams: Springer International Publishing Switzerland.

Winn, B. M. (2009). The design, play and experience framework. In E. Ferdig Richard (Ed.), *Handbook of research on effective electronic gaming in education* (pp. 1010–1024). Hershey: IGI Global.

Wittmayer, J. M., Schäpke, N., van Steenbergen, F., & Omann, I. (2014). Making sense of sustainability transitions locally: How action research contributes to addressing societal challenges. *Critical Policy Studies, 8*(4), 37–41.

Placemaking, Livability and Public Spaces: Achieving Sustainability Through Eco-liv@ble Design

Marichela Sepe

Abstract The livability of places is determined by many factors which are in turn influenced by a variety of tangible and intangible elements concerning the area in question and its surrounding. At the same time, computer science and new technologies have in recent decades become increasingly useful supports for the improvement of studies and applications in the field of area investigations. Consequently, the theory of placemaking has been updated and new methods and representational tools have been developed in order to make it capable of illustrating more complex urban scenes and help provide urban sustainability. One of these is the original Ecoliv@ble design method which consists of different kind of surveys, observations and questionnaires. The aim of this paper is to present the Ecoliv@ble design method which intended to: identify sustainable urban livability and the factors which make places happy and livable from the users point of view; and identify design interventions to enhance or create livability. The method is supported by a software, still in development, for smart phone or multimedia tablet. The final product will be constituted by interactive mosaics capable to visualize places and factors which contribute to urban livability and happiness. The main users to who Ecoliv@ble design method is devoted include visitors, tourists, technicians and administrators who are interested in more liveable and sustainable places. The description of two emblematic case studies conclude the paper.

Keywords Livability · Healthy city · Sustainability · Urban happiness
Cultural heritage and identity · Material and immaterial flows · Smart territorial linkages

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1 Introduction

Livability and happiness of places—and in particular of public spaces—are determined by many factors which are in turn influenced by a variety of tangible and intangible elements concerning the area in question and its surrounding (Appleyard 1981; Friedmann 2010; Madanipour 2003; Porteous 1977; Gehl 2010; Taylor et al. 1998).

Indeed, the definition of urban livability and happiness are strongly interwoven with social, environmental, economic and philosophical studies, and, in accordance with the rapid transformation of lifestyles, needs and habits, the definition is in continuous change (Carmona et al. 2010; Lynch 1960; Relph 1976). On the other hand, the definition appears to be similar to that used for defining well-being, quality of life, health and, in a certain sense, sustainability. Urban livability and happiness could be defined as a character that gives to the place a positive perception by people who live there and which induces them to spend a long time there and/or to repeat the same experience (Sepe 2017).

Furthermore, as Sauders (2017) asserts, air pollution, social connectedness, mental well-being, road danger, noise and physical activity can impact our health and it is important to implement good practice in urban design in order to introduce these elements into the planning at all scales (Kyttä et al. 2015; Saunders 2017; Wang and Shenjing 2016). As many studies report, "urban planning and design can help to mitigate risk factors and to contribute to better mental health and happiness in the city". Factors such as "green place, active place, pro-social place and safe place (…) can facilitate innovative thinking (…) and promote better mental health and well-being" (McCay 2017). Although theories agree on the benefits that people derive from these factors, it is not easy to assume and demonstrate that these improve livability, happiness and then health (AAVV 2017; Ballas 2013; Burton 2015; Crappsley 2017).

At the same time, computer science and new technologies have in recent decades become increasingly useful supports to improve studies and applications in the field of area investigations (Montgomery 1998, 2013; Burns 2005; Evans et al. 2011; Florida et al. 2013).

Consequently, the theory of placemaking—"the art of making places for people"—in order to encompass emerging urban topics, has been updated and new methods and representational tools in order to be capable of illustrating more complex urban scenes and topics and provide both urban livability and sustainability (Sepe 2013, 2017; Zelinka and Brennan 2001; Zidansek 2007). One of these is the original Ecoliv@ble design method which consists of various kind of surveys, observations and questionnaires.

Starting from these premises, the aim of this paper is to present the Ecoliv@ble design method, carried out in the framework of CNR research projects. The method aims at: identifying sustainable urban livability and the factors that make places happy and livable from the user's point of view; and identifying design interventions to enhance or create livability. A series of case studies has been carried out on squares and pedestrian and semi-pedestrian thoroughfares, urban parks and waterfronts, and cultural districts that are particularly representative of the respective city. Regarding waterfronts, these include: Hankou River in Wuhan, Hafencity in Hamburg, Lungomare Caracciolo in Naples, Bordeaux Waterfront in Bordeaux and The Bund in Shanghai. Examples of cultural districts include: the 798 Art District in Beijing, Nanluoguxiang in Beijing and the Museums Quartier in Vienna. Concerning parks, the case studies include: the Millennium Park in Chicago and the Citygarden in Saint Louis (Missouri). Regarding thoroughfares, the Ramblas in Barcelona and the Graben in Vienna were researched. Finally, the Stadtlounge in St. Gallen, the Place des Vosges in Paris, the Piazza del Campo in Siena and Piazza Trevi in Rome are the squares included in the study.

The results of the pilot case studies enabled the creation of the Charter of Happiness and Livability of public spaces with twenty principles that are integral to the method.

In order to collect elements from the user's points of view, one overlaps these data with others coming from internet databases and visualizes the results in "friendly" multimedia maps; the method is supported by software for smart phones or multimedia tablets, still in development. The main users for who both the method and computer science tool are intended include visitors, tourists, technicians and administrators who are interested in more liveable and sustainable places. The description of two emblematic case studies and a relevant discussion conclude the paper.

2 Method

The Ecoliv@ble design method, as mentioned before, aims to identify urban liveability and happiness and the factors that make places happy and liveable from the user's point of view. The analytical component of the method—which is called Happy Place Mapping—consists of various kinds of surveys, observations and questionnaires. The design component comprises five phases and includes a check for consistency with the 20 principles of the Charter of Happiness. The whole illustration is reported in order to better explain uses and functions of the computer science tool (Sepe 2015).

The first phase of the method consists in the selection and definition of the study area. It is necessary needs to visit the site in question and, through an inspection, decide whether to confirm the delimitation decided beforehand or to modify it.

The second phase is characterized by the observation of the characteristics of the place through three surveys concerning activities, perceptions and elements that contribute to the perception of happiness.

In the first survey, it is necessary to observe the types of people (locals, visitors, professionals) and activities (enjoyment, passing by, work, etc.). These activities are measured from the quantitative point of view, i.e., observing to what extent the activity is present in that place and how that influence liveability. Similarly, the presence of persons is measured from the quantitative point of view, as well.

Then one observes the frequency with which the activity is repeated or implemented and with what pace, i.e., if that activity is carried out at a rapid, slow or moderate pace.

The second survey consists in identification of singular visual, auditory, tactile, olfactory and taste perceptions, as well as mixed perceptions, such as chaos, serenity, disorder, joy, harmony, disorientation and so on, that derive from the sum of one or more perceptions. Then it is necessary to observe their quantities—expressed as light, medium or high—as well as the quality of the perceived impression, expressed as pleasant, uninfluential or annoying.

The third survey of this phase consists of observation of the elements that contribute to the happiness sensation, such as built and natural elements, transportation modes, equipment and services (furniture, wireless, etc.).

Finally, from the intersection of these data, a first result on the degree of happiness is obtained, derived from the surveys conducted in this place.

The third phase consists of a questionnaire completed by the users of the site aimed at identifying factors and elements that make people who live in that place happy or sad.

Questions may include the following and will be modified in accordance with the characteristics of the place:

1. Does this place gives you a feeling of happiness or sadness?
2. What are the elements that make you here happy/sad?
3. What are the facilities that make this place good or bad?
4. What kind of activities do you act in this place? How often?
5. Does the presence of many or few people improve the pleasantness or unpleasantness of the place?
6. What could be done in order to improve this place?
7. What is a happy place that you remember to have visited in this city or elsewhere?
8. Do you think that weather conditions might influence the perception of this place?

The fourth phase is the analysis of the cartography in order to understand the elements that compose the place in terms of the type of urban fabric, the historical and architectural elements, the natural environment (sea, hills, etc.), and other public spaces in the surrounding area.

The fifth phase involves the construction of the map of happiness with the identification of spaces and features that give the people who use that place the perception of happiness.

The map will be the result of all the information collected with the various survey modes, analysis and observation.

In the sixth phase, the check of the degree of happiness and liveability is carried out. This is obtained through the study of the map of analysis with the identification of both intrinsic and extrinsic factors that are capable of determining urban happiness. The aim is obtaining a map of the “waiting areas” where the design hypothesis can be concentrated. The intrinsic factors concern the perceptions, tradition and culture. Extrinsic factors concern the architecture, facility and urban furniture. The areas defined as "waiting areas" concern those areas where there is a minor presence of those factors and which are underused with respect to the place in general. These areas could be represented by physical empty spaces or perceived empty spaces (e.g., an unutilized square, an area destroyed following an environmental disaster, and so on).

The "waiting areas" are marginal with respect to the place or central, due the fact that their position with respect to the area study is not emblematic of its own success. The areas can also be constituted by the whole study place.

The phase seven consists of the check of satisfaction of the 20 principles of urban happiness concerning the charter. The check is carried out through the overlapping between the map of the waiting areas and the charter principles. The product of this phase will be represented by a mosaic of principles to be implemented.

The premise of this charter is that a happy and livable place is a space which can transmit a feeling of happiness and livability to everyone who uses it.

(1) It is important that both the place identity and the intangible characteristics of the site and its surroundings are present in the public space.
(2) It is important to encourage the use of the place by people of various age groups, from children to the elderly, and not to have architectural barriers that might discourage people from frequenting that space.
(3) A public space should allow different types of functions (games, breaks, walking, etc.). It is also desirable to facilitate gymnastic activities with the presence of small equipment or a designated space for them.
(4) The possibility of performing actions that normally are not permitted, such as walking barefoot in the water or in designated public areas, creates a feeling of freedom and joy.
(5) The composite elements of the space should have an appropriate balance between the elements of nature, landscape and equipment.
(6) The presence of water in different shapes (e.g., fountains) promotes the vitality of the place.
(7) The presence of art in its various forms is desirable.
(8) The presence of sculptures, games, or other elements and amenities which that bring a smile to a person's face promotes a state of happiness.
(9) The public space should have natural lighting during the day and artificial at other times. Artificial light in daily hours should be avoided.
(10) An adequate state of cleanliness and maintenance must be retained.
(11) The public space has to provide a sense of security and safety to those who use it.
(12) It is important that noise generated by public transport is either or entirely absent.
(13) The possibility of perceiving naturally occurring smells e.g., wood, grass, the sea, provides a feeling of happiness.

(14) The possibility of having direct contact with natural materials, preferably local, used in the design of the space gives a sense of well-being.
(15) The possibility of doing actions—such as walking, watching, etc.—with a moderate or slow pace promotes the taking of breaks in the space.
(16) The feeling of being able to contribute to the life of that place increases the sense of belonging.
(17) The consideration of the place as symbolic of the neighborhood improves the perception of its identity.
(18) The educational function that a place has, e.g., clearly displayed information about the history of the place, etc., increases its intrinsic value.
(19) The possibility of using the space in different seasons and weather conditions improves its liveability and increases willingness to contribute to its good state of maintenance.
(20) The possibility of using new technology to increase the knowledge of its intangible values and history can offer a more profound experience of the place.

In phase eight the identification of project interventions for the realization of the principles is carried out. The insertion of these project interventions in the waiting areas is carried out together with a check of consistency with spaces and urban furniture and equipment already present. In this way, a map of urban happiness design will be obtained.

Phase nine concerns the check of the design ideas with the users of the place through two types of questionnaires: the questionnaire on site to be administered to the users of places and the research on different kinds of websites concerning the visitor comments about the place in object. A mosaic of the degree of pleasure related to the design ideas is obtained.

The design hypothesis will be verified with demands selected by who those who carried out the study, which will be ad hoc with respect both to the place and the results of the phase eight. Answers to the questionnaires administered on site will be overlapped with those carried out by questionnaires or web forum concerning the booking of tourist services (e.g., booking or Tripadvisor). These questionnaires constitute the participative part of the project, but also the possibility of comprehension of the place in a broad manner. A further possibility, in the case of an ad hoc created tool, will be the realization of blogs or other social network tools to support this and other phases of the project.

Phase ten consists in the transformation of the project interventions in design of the spaces. This will be carried out through two operations: the overlapping of the results of the previous phases and the identification of the use of the traces—urban, cultural, etc.—already present in the place. The final result will be the happy-and-livable-place design map.

The last design phase is the most difficult. The design of the new spaces to be harmonized with the existing ones is an important point, especially when the final objective is constituted by the urban happiness and livable achievement, a concept which is both hardly reachable and in a certain way subjective.

The existing traces to which people connect are not only the urban ones, but also the cultural and natural ones belonging to memories, perceptions and other tangible and intangible factors. A detailed analysis will provide more suitable information in order to make merge the existing characteristics and peculiarities with the project of new parts.

3 Results: The Case Studies of HafenCity and Hankou

The two emblematic case studies that illustrated how the research was conducted concern HafenCity in Hamburg (Germany) and Hankou in Wuhan (China).

The case studies are located in places that are quite different in terms of geographical area but have many points in common. First of all, these are new regeneration areas that have as a focus the creation of new public spaces, the resilience to flood problems and the enhancement of natural and cultural heritage. Furthermore, Hankou riverfront in Wuhan is, although in China, a place which has been designed, as many others parts of Wuhan, with a "Western" appearance, making them comparable with European regeneration areas such as HafenCity in Hamburg.

The case studies will be illustrated following the main phases of the Ecolivable design method.

HafenCity is an area of 155 ha, the subject of an intensive operation of urban regeneration, which started in 1998. This case study concerns the paths through the public spaces of the whole new area. Indeed, HafenCity is noteworthy as an extended process of urban regeneration, which is changing both its identity and use through various kinds of urban projects, including those concerning public spaces. Surveys, observation and questionnaires were carried out over one year and periods of various lengths, both on week days and on weekends, during daytime and afternoon hours.

The first phase entailed the choice and definition of the study area. Three site inspections were carried out in the whole study area and in the surroundings to identify the sites of interest for the experimental goals. The places that were chosen for the experiments concern the HafenCity public spaces, which in their totality give continuity to the area. Namely, the region's boundaries were identified as: Hubenerstrasse on the south and Am Sandtorkai on the north, including Grasbrookhafen, Sandtorhafen on the western part and Am Sandtopark on the east.

In order to illustrate the activities, the place was divided inti six stretches: (1) Grasbrook Playgound, (2) Marco Polo Terraces, (3) Dalmannkai Promenade, (4) Vasco de Gama Place, (5) Magellan Terraces and (6) Überseeboulevard. Grasbrook Playground, Marco Polo Terraces, Vasco de Gama Platz and Magellan Terraces are connected with each other through the Dalmannkai Promenade and Überseeboulevar.

Surveys, which started in Grasbrook and ended in Überseeboulevard, were carried out in daytime and afternoon hours, both on week days and weekends.

Phase three entailed: the questionnaire on site to the users of the places intended to identify the elements that make people happy or sad in living in that place and studying the same information through online research of guest reviews.

With regards to the onsite questionnaire, this was administered to about 100 people in the English language, both local and tourists. Questions are addressed mainly to people while they took breaks on the benches or on the lawn in the various stretches of HafenCity. All the people who were interviewed answered the questions, even though they have had various different timespans to answer.

To the question "does this place give you a feeling of happiness or sadness", the totality of people both locals and tourists answered happiness, even though with various different meanings, depending on which stretch of the area they responded. The term happiness was used mainly for Grasbrook Playground, while for the other spaces the terms which were used included joy, serenity, livability and sustainability, reflecting the agreeable sensations perceived in HafenCity. As regards the second question, "what are the elements that make you happy or sad here", answers referred to various elements. Locals who were interviewed were both people who work in the area (70%) and people who work and live elsewhere (30%). For the locals, the majority (80%) of people referred to the possibility of enjoying the sea, public spaces, bar and restaurants and then the ease of connection with the center of Hamburg. As regards tourists, about 80% answered that the elements concern the new architectures, the ability to stroll among the old sailing ships, the boats which pass by there, bar, and the presence of many places to sit. 20% of both answered in a more generic manner, affirming that this place is well maintained and organized. To the question "what are the facilities that make this place good or bad", 70% of locals answered that is was the playground, the deckchairs and the other seating and the presence of the university with many outdoor public spaces. The majority of tourists (80%) also commented on the small-scale modern sculptures, the sailing ships, and the HafenCity infoPavillion with information concerning the various phases of urban transformation and the model of the whole area. The remaining portion of interviewees, both local and tourists, mentioned the public and private ships for water tours of HafenCity.

As regard the research of reviews through websites, the first data that emerged was the prolific presence of HafenCity on the web, e.g., through the Google search engine, 2,200,000 results have been found. The website that shows the greatest number of reviews is Trip Advisor, with about 600 reviews focused on HafenCity. As regards the people who contributed the comments, these were mainly visitors from Europe and US, aged 25–60 years old. The comments are always positive. Aspects that are cited regard the operation of urban regeneration, which is for them successful, the beauty of buildings, public spaces, the presence of restaurants and the cleanliness of the area. In the comments—all positive—there is mention of aspects of the place connected to the sea, the old sailing ships and the boats for the visiting the area by water.

As regards the traditional analysis (phase four), an important aspect that emerged was that history has played a fundamental role in the waterfront regeneration.

Although only a partial reconversion of the harbor warehouses has been carried out, the regeneration project is restoring the maritime vocation of the historical city and is firmly connected with the city.

Hamburg is one of the major European ports and Germany's main port. Indeed, the town joined the Hanseatic League in the first half of the 13th century, and Hamburg played a key role in the League.

The project is subdivided into eight main areas, including: Am Sandtorkai, Dalmannkai quarter, Grasbrook, Strandkai, Uberseequartier, Elbtorquartier, Am Lohsepark. Brooktorkai and Elbbruken. An elaborate articulation of private and public spaces has been designed, many of them already completed. The building of HafenCity will increase the surface of the original Medieval City Center city by 40%. The new area—155 ha of the medieval city's overall area—is constituted by two thirds land and one third water, and it is expected that 12,000 of the city's residents will have moved to HafenCity over the next ten years, while stimulating the creation of 20,000 new jobs. The regeneration project is coordinated by a private company, the HafenCity Hamburg GmbH, which is owned by the Free Hanseatic City of Hamburg and which manages relations between the public and the private sectors.

The fifth phase concerns the identification of elements that contribute to the happiness of the place. HafenCity is an area which has many elements of interest. This study refers to the public spaces which constitute an important part of this because they enhance its liveability and resiliency to floods.

Due to its nearness to the historical center of Hamburg, but also thanks to the intense level of participation which has been carried out from the beginning of the regeneration project, the area is very known to the inhabitants of the city and to the tourists and so very lively. The presence of public spaces with many possibilities for sitting has resulted in the fact that both professionals who work there and locals coming from other areas of Hamburg frequently use this place at a slow or moderate pace.

The presence of tradition, provided by both the Speicherstadt warehouses and the historical sailing boats and innovation, provided by the new structures, create an atmosphere of both history and the contemporaneity that people who visit the place like. The presence of an InfoPavillion and a maritime museum on the Magellan Terraces inform people about the history of the place and the on-going project of regeneration, offering a further element of participation.

Another aspect of success is the presence of pedestrian and cycle paths also integrated into the design: various different levels, many visual perceptions and urban landscapes in perspective, an articulated design which create variety for those who live in it.

The realization of a playground for children—also used by students for educational trips—is a further aspect of success of the area, together with the presence of the new HafenCity University which creates continuous use of the place. The sea is experienced in its multiple "shapes": as a background of architecture, as a landscape scene to be observed from various points of view and as a place to be lived in and admired, thanks to the possibility to take both public water transport and tourist ships for various kinds of tours. The presence of bars and restaurants offer the possibility of extending a stay in a pleasant way. Serenity, joy, happiness and surprise are the most solicited sensations in that place.

This area in its current state respects the majority of the principles of the charter. The case study shows that this place is emblematic for livability and happiness and does not need further design intervention to improve these characteristics.

The other case study that will be illustrated concerns the new Hankou riverfront of Wuhan, China, carried out in the framework of the FP7-PEOPLE-2011-IRSES Project Planning, Urban Management and Heritage—PUMAH.

The first phase consisted of the selection and definition of the study area. Three inspections of the new waterfront of Wuhan were carried out on various different days and hours in order to delimit the place to monitor. This area has a considerable size in terms of length and extension, but it was decided to consider the entire surface because, although it is characterized by various uses, it comprises a sort of *continuum*. Then, the boundaries that were determined concern the entire area delimited by Yanijang Avenue, Wuhan Changjiang Tunnel and the cross between Yanijang Avenue and Chenjiaji Avenue.

The third phase concerns the questionnaire for users of the place, aimed at understanding the elements that make them happy or sad in living in the area in question.

The questionnaire was administered to approximately 120 people, mainly tourists and passers-by.

To the first question as to a feeling of happiness or sadness in this place, most of people, independent of age and nationality, answered happiness.

As to the second question, what are the elements that make you happy/sad, the answers were varied widely, making difficult the use of these for our purpose. The most frequent answer was related to the Concession buildings behind the waterfront area, the river, the sculptures, the cherry trees and nature in general, and the park in its entirety.

As to the third question, what are the facilities that make this place good or bad, most of people answered benches and tiers.

The fourth phase concerns the analysis of the cartography on an urban scale. Wuhan is a city situated in the middle of China in the southeast of Hubei Province, known for its huge amount of lakes that characterize the territory. Wuhan has been subject to three major flood in the 20th century: 1931, 1954 and 1998 with great destruction in terms of both of the built and natural environment.

The development of the Hankou waterfront started after the last flood, in 1999, both with the aim to create flood control and a high-quality urban design. The waterfront area of analysis is about 4 km^2 and, as mentioned before, is located between Yanijang Avenue, the Yangtze River which flows along this area, Wuhan Changjiang Tunnel and the intersection of Yanijang and Chenjiaji Avenues. Furthermore, the waterfront area has a linear plan comprising both green and built area. The greater singularity of this area is that it borders five concession areas: French, English, German, Russian and Japanese. This singularity gives this place a variety of architectural styles, as well as the various bridges that cross the riverfront.

The fifth phase concerns the identification of the elements that contribute to the happiness of this place. The happiness and livability of Hankou Riverfront are given by the variety of functions that this place offers because it constitutes an effective respite from the nearby road traffic. It is also a place full of history, witnessed by the buildings of the five concessions situated nearby.

Along several stretches of the waterfront, it is possible to enjoy nature—with its perfumes and colors, the water games and the sculptures—sitting down on the benches or on the steps, and enjoying the river view.

The site also offers the possibility of dynamic activities such as using the exercise equipment, kite flying, walking on the sand and letting the children enjoying the playground. Furthermore, the equipment for events such as the amphitheatre provides the possibility to attend artistic performances during festivities. The sculptures are of particular interest involving visitors and attracting them to this place. As the answers to the questionnaire have shown, in the new waterfront of Wuhan, the activities aforementioned are also the most frequently enjoyed and those that offer the greatest feeling of happiness to people. The success of this area rests on its uniqueness for the city of Wuhan, as there exists a right balance between nature and landscape, games and sports activities and the possibility to take a break. Furthermore, the park is built with quality materials and accurate design, despite a preponderance of the use of cement, offering characteristics of beauty as well.

By checking the consistency between the results of various surveys and the charter, also in this case, urban livability and happiness were observed. For this reason the latter phases of design were not necessary.

4 Discussion

To afford intangible aspects of urban and natural places in a scientific way is always a challenge and open to the risks of subjectivity of interpretation. The method that was presented in this paper is an evolution of the original PlaceMaker method (Sepe 2013) which was devoted to the identification of the elements which constitute the place's identity and intervention for its enhancements. The identity of places, although rather elusiveness, is constituted by very tangible elements, such as the architecture of buildings, the urban morphology, etc. In line with this concept, urban happiness can be—if only at the first stage of analysis—considered to be influenced by perceptions. Also in this case, perceptions and intangible aspects are strongly connected to architecture, public spaces and the natural environment.

The experiments which were carried out concern public spaces that are well known and successful, in order to comprehend the reasons, movements and behavior of people, and the physical elements that contribute to urban livability and happiness. This is carried out through various kinds of surveys, among these, the survey realized using ad hoc schedules. These, although used in different cases and in general considered suitable, can be further improved in order to comprehend data concerning movements of people that are hardly predictable before direct observation, different for any place and its parts.

Another focal point is the identification of the intrinsic and extrinsic elements that contribute to the urban livability and happiness. Indeed, those elements are in strong relationships to each other, and consequently the identification of waiting areas is complex. Nevertheless, here is concentrated the parts of interest for the design. Another key aspect is the correct integration between the answers to the questionnaires—both of analysis and design—administered on site and collected from internet websites. The typologies of questions, answers and people who participate in these could be very different, making it difficult to reach an unequivocal result. Again, it is important to take into account that the design hypotheses that are reached following the method are only some of the possible solutions: from the Ecoliv@ble design method, many diverse design ideas can result.

5 Conclusion

The paper has presented the case studies carried out in the HafenCity area of Hamburg and Hankou in Wuhan, following the Ecoliv@ble design method. By checking the consistency between the results of various surveys of the method and the Charter of Urban Livability and Happiness, urban livability and happiness were observed in both case studies. For this reason, the phases of design were not necessary.

The HafenCity project intends to recreate the maritime identity of the historical city, protect it from floods and be firmly connected with the city. The area is emblematic as a case study because this is a new area that is creating a new urban identity to the whole city, improving its livability and the degree of satisfaction in both locals and visitors, and hence its sustainability.

With respect to the experiment, tangible aspects regarding the project of public spaces which, for their variety and articulation, offer multiple possibilities to be experienced by various subjects with different needs and preferences. The area is very close to the historical center of the city and easily reachable with various means of transport, creating facility of access and crossing. The intangible aspects are connected to both the beauty of the place in itself, due to the presence of the sea and landscape, and also to historical memory given by the Speicherstadt warehouses and the sailing ships visible from the various viewpoints on the pedestrian paths and public spaces. Another aspect that is fundamental in these public spaces is the presence of spots where it is possible to take a break or look around with freedom of movement and a sensation of serenity. An important aspect is constituted by the climate and weather as well, which in the winter period is severe. The frequency of public spaces in these seasons is more limited due to factors connected to the weather, although the presence of public buildings and private societies offers life in the place during the whole year. The public spaces of HafenCity can be considered sites where manifestations of livability and happiness, meant in their larger meaning, are experienced, affirming its status as an emblematic place in this sense.

The other case is the new Hankou riverfront of Wuhan, China, which has been built both for flood defense reasons and to create a public space of quality which borders the historic concession areas.

As a result from the method, the happiness and livability of the Hankou Riverfront are given by the variety of functions that this place offers because it is a suitable respite from the road traffic in its vicinity. It is also a place full of history, evidenced by the buildings of the five concessions situated nearby. In several stretches of the waterfront, it is possible to enjoy the nature—with its perfumes and colors, the water games and the sculptures—sitting on the benches or on the steps, and looking at the river. The site also offers the possibility of dynamic activities such as to using the exercise equipment, flying kites, walking on the sand and letting the children enjoy the playground. The equipment for events such as the amphitheater, provides the possibility to attend artistic performances during festivities.

The sculptures are of particular interest, involving visitors and attracting them to this place. As the answers to the questionnaire have shown, in the new waterfront of Wuhan, the activities aforementioned are also the most frequently cited and those that offer the greatest feeling of happiness to people. The success of this area stands in its uniqueness in the City of Wuhan, as there exists the right balance of nature and landscape, games and sports activities and the possibility to take a break. Furthermore, the park is built with quality materials and accurate design, despite a preponderance of the use of cement, offering characteristics of beauty as well.

These case studies show the importance of an holistic approach in the regeneration operations for the protection and enhancement of both natural and cultural heritage. On the other hand, the method that was used shows the possibility of mapping intangible aspects in order to identify and/or design both intangible and tangible elements that are all necessary for designing sustainable places. The Principles of the Charter of Urban Livability and Happiness described in the second section of the paper can be considered in this sense a useful guideline for creating livable places in various contexts.

This research is now following in the direction of both realizing the computer-science tools that support the method and updating the method to identify and create healthy places, namely places which, through the achievement of happiness for the people who live in them, contribute to their mental and physical health, creating, in a virtuous cycle, a more sustainable and healthy city.

References

AAVV. (2017). Health and urban design. *Urban Design Group Journal, 142,* 12–39.
Appleyard, D. (1981). *Livable streets*. Berkeley: University of California Press.
Ballas, D. (2013). What makes a ‘happy city’? *Cities, 32,* 539–550.

Burns, G. W. (2005). Naturally happy, naturally healthy: The role of natural environment in well-being. In F. A. Huppert, N. Baylis, & B. Keverne (Eds.), *The science of well-being*. New York: Oxford University Press.
Burton, L. (2015). Mental well-being. In H. Barton, S. Thompson, S. Burgess, & M. Grant (Eds.), *The Routledge handbook for health and well-being*. London: Routledge.
Carmona, M., Heath, T., Oc, T., & Tiesdell, S. (2010). *Public places-urban spaces*. Oxford: Architectural Press.
Crappsley, R. (2017). Designing streets for good health: Now and in the future. *Urban Design Group Journal, 143,* 10–11.
Evans, B., McDonald, F., & Rudlin, D. (2011). *Urban identity. Learning from place*. London, New York: Routledge.
Florida, R., Mellander, C., & Rentfrow, P. J. (2013). The happiness of cities. *Regional Studies, 47,* 613–627.
Friedmann, J. (2010). Place and place-making in cities: A global perspective. *Planning Theory & Practice, 11*(2), 149–165.
Gehl, J. (2010). *Cities for people*. Washington: Island Press.
Kyttä, M., et al. (2015). Urban happiness: Context-sensitive study of the social sustainability of urban settings. *Environment and Planning B, 43*(1), 34–57.
Lynch, K. (1960). *The image of the city*. Cambridge: MIT Press.
Madanipour, A. (2003). *Public and private spaces of the city*. London, New York: Routledge.
McCay, L. (2017). Designing mental health into cities. *Urban Design Group Journal, 142,* 25–27.
Montgomery, C. (2013). *Happy city*. London: Penguin.
Montgomery, J. (1998). Making a city: Urbanity, vitality and urban design. *Journal of Urban Design, 3,* 93–116.
Porteous, J. D. (1977). *Environmental and behavior: Planning and everyday urban life*. Reading, Massachusetts: Addison-Wesley.
Relph, E. (1976). *Place and placelessness*. London: Pion.
Saunders, L. (2017). Healthy streets. *Urban Design Group Journal, 142,* 35–36.
Sepe, M. (2013). *Planning and place in the city. Mapping place identity*. London, New York: Routledge.
Sepe, M. (2015). Improving sustainable enhancement of cultural heritage: Smart placemaking for experiential paths in Pompeii. *International Journal of Sustainable Development and Planning, 10*(5), 713–733.
Sepe, M. (2017). The role of public space to achieve urban happiness. *International Journal of Sustainable Development and Planning, 2*(4), 724–733.
Taylor, A. F., Kuo, F. E., & Sullivan, W. C. (1998). Growing up in the inner city: Green spaces as places to grow. *Environmental Behavior, 30*(1), 3–27.
Wang, D., & Shenjing, H. (Eds.). (2016). *Mobility, sociability and well-being of urban living*. Heidelberg: Springer.
Zelinka, A., & Brennan, D. (2001). *Safescape, creating safer, more livable communities though planning and design*. Chicago: APA Planner Press.
Zidansek, A. (2007). Sustainable development and happiness in nations. *Energy, 32,* 891–897.

Part III
The "Next Economy" for the City

The Sharing Economy and Real Estate Market: The Phenomenon of Shared Houses

Leopoldo Sdino and Sara Magoni

Abstract During the past decade, new forms of the sharing economy have been developed as an alternative tool for the satisfaction of heterogeneous needs. From both short- and long-distance transportation to the rental of apartments, this expanding economy has created a new private supply of those services that, traditionally, were only provided by professionals. In parallel with its unexpected development, the size of its impact on relatively traditional economic sectors has grown too. This fact has determined the need, an ever more one, for studies on the dynamics of this phenomenon. The short-term housing-rental sector plays a central role within the universe of the sharing economy. In fact, it has spawned a new rental market, parallel to the traditional one, that is characterized by short and very-short-term contracts and by the immediate and easily accessed encounter between demand and supply, made possible through the use of digital platforms. *Airbnb* plays, without any doubt, a leading role in this phenomenon. Born in the US, it has had an astonishing global expansion in just a few years. In fact, currently, it operates in 191 countries, homogeneously, that is to say, without trying to match the enormous differences between local legislation on tourism and real estate to major procedural and systemic differences. This service was born in 2007, but it is only since 2013 that, in Italy, its presence has become massive; until then, only a few hundred listings were published for the whole nation. Its development has thus been exponential, and as the projections confirm, in all likelihood, in the next decade it will maintain the same rate of growth. By now, it has already been several years that researchers and operators have highlighted the influence of *Airbnb* in the market of tourist accommodations. What is still poorly detailed, perhaps because of its low visibility and immediacy, is the relationship that this kind of short-term rental contract has with the traditional real estate market. Therefore, the intent of this study is to take the first step towards the comprehension of the impact that the uncontrolled growth of the sharing economy has, specifically, on the Italian real

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estate market. Logically, the rental submarket is the one that is affected the most by the growth of the sharing economy. In fact, compared to traditional rentals, contracts that are stipulated with *Airbnb* provide lessors with much higher revenues and much lower restrictions. That is one of the reasons that the *Airbnb's* user base has experienced such an enormous expansion. However, this, has also led to the fear that these new dynamics are liable to distort the traditional real estate market.

Keywords Sharing economy · Airbnb · Real estate

1 Introduction

The past decade has been characterized by the wide adoption of collaborative consumption practices, primarily within transport, food and tourism. In fact, in just a few years, the major platforms that host these practices went from being small experimental start-ups to multinational billionaire-sized companies (Konrad and Mac 2014); so far, their growth has been exponential, and they are expected, at least in the near future, to keep expanding at the same rate. As further evidence of this, PwC, which in 2014 quantified the overall revenues of the whole sharing-economy industry as $15 billion, also forecast that it will probably reach the value of $335 billion by 2025 (PwC 2014).

Especially since 2014, the first year of its significant growth, the emergence of this phenomenon has generated a great deal of interest in the mass media (Martin 2016: 149–159) which has described it as a real shift in paradigms that signifies an evolution of the culture of possession to the culture of sharing. However, sharing practices have always been part of human behavior, "*possibly sharing has been the primordial form of economic distribution within hominids for several hundreds of thousands years. It is settled within human biological behaviors…and it becomes a powerful strength for the solidarity between communities*" (Price 1975: 3–27). Therefore, the emergence of these practices, even if they are now digitally mediated, should not come as a complete surprise (Belk 2014: 1595–1600).

Along with its expansion, there have been numerous attempts at its definition. In fact, it is hard to elucidate a definition of "*sharing economy*" that is both clear and explanatory of the heterogeneity of the situations in which this term is used (Schor 2014). In general terms, the *sharing economy* is a socio-economic system based on the pooling of human and physical resources (Wework), that is to say, it is based on a collaborative or peer-to-peer consumption system (Carson 2014) and, precisely because of its structural and functional characteristics, the practice finds an excellent operative basis in digital platforms. Advances that have occurred within the fields of information technology and software engineering are, therefore, some of the main factors that have contributed to the growth and the sustainability of sharing processes (Hasan and Birgach 2016).

Furthermore, one of the advantages of these peer-to-peer platforms is that they encourage a more fair and sustainable distribution of the resources through the reduction of the cost of access to products and services and the satisfaction of consumers' demand (Botsman and Rogers 2010). The advent of the sharing economy has thus also been mostly received as an exceptional opportunity, since it promotes economic growth through the monetization of untapped potentials and recourse to micro-entrepreneurship (Martin 2016: 149–159). However, regardless of their enormous success and perhaps exactly because of them, many platforms have had to face such fierce resistance and criticism. In fact, they have been accused of having opened and nourished non-regulated markets, parallel to traditional ones, because of which negative and hard-to-ignore externalities of both an economic and social nature might arise (Schofield 2014). According to this opinion, it is expected that those non-regulated markets are likely to threaten traditional businesses and, at the same time, they might constitute an actual risk for users whose protection, which should be granted by the legislation and by the platform itself, is inadequate. These criticisms thus mainly address the fact that the sharing platforms transfer risks to the final user, create unfair competition and, possibly, promote tax evasion (Martin 2016: 149–159).

Even though the relevance of this phenomenon is already universally recognized, at the moment, a severe lack of studies on this subject is reported. Particularly, studies that focus on the situation in the Italian national context are almost completely absent. This is possibly caused by the temporal proximity of its diffusion and by its intense and continuous development, both of which do not easily allow broad-based, reasoned considerations.

This work is specifically focused on the sector that, deriving from the sharing-economy's philosophy, treats peer-to-peer sharing of real properties mainly through the much-publicized platform *Airbnb*. The small bibliography that exists on this topic is mostly focused on regulation and taxation issues (Huet 2014) and on the effects that this platform has on the traditional tourist market (Varma et al. 2016: 228–237; Zervas et al. 2016). Addressing this situation, the aim of this article is to start to remedy this lack and, moving the focus towards real estate, to investigate the relationship that occurs between the short-term rental contracts, operated by *Airbnb*, and traditional long-term ones. The ultimate purpose is thus to gain a wide-ranging perspective of the phenomenon in major Italian cities, in order to comprehend its extent and possible future developments and its risks and opportunities.

2 Methodology

The development over time and the magnitude of this phenomenon has been described using, as a starting point, the data query of specific databases, such as *AirDna*, and the consultation of the already existing, even though meager, bibliography. The data used refer to the situation as of the end of 2016. In order to obtain an eloquent description of the current situation and of its implications, the analysis of Airbnb's impact on the health of traditional real estate markets was carried out with respect to those Italian cities that are, notoriously, the most affected by tourism. Finally, the characteristics of Airbnb's offer and demand and their relationship with the traditional long-term rental market have been assessed by looking at their relative impacts on the same housing stock. One of the main criteria used was their profitability by using as an indicator the capitalization rate of the two rental options, the traditional one and the short-term one. The results of this first study are then summarized in a SWOT analysis that develops a clearer perspective of the implications of this phenomenon on the housing market.

3 The Phenomenon

Airbnb is an online platform whose aim is connecting people that look for an accommodation for a brief period, usually for touristic purposes, with owners who are willing to rent out their unused properties. It was founded in 2007 in the US, and, since then, it has become the biggest housing-rental company in the world, offering a wide range of accommodations, moreover, without itself owning any of these properties. In fact, it administers more than three million properties around the globe, distributed in about 65,000 cities and 192 countries. The growth has been so strong that in 2014 the company has reached the value, according to various sources, of $10–$24 billion (Austin 2014; Spector et al. 2014; Newcomer 2015). Moreover, it is foreseeable that, in accordance with its powerful expansion during the past two years and because it is progressively, controversially, moving away from its original "sharing nature" by pushing itself towards a more entrepreneurial approach, this value has now further increased.

Reasons for its success are to be found, among others, in their orientation towards the solution of widespread issues, in the possibility prided to users who lack experience and knowledge of the real estate market to act entrepreneurially, in the use and supply of web-based services that allow for continuous and effective innovation and that innovate themselves (Bailetti 2012), and in the faculty, given to consumers, to base their decisions on trust gained and cultivated trough photos, ratings and review systems (Santana and Parigi 2015: 560–573; Ert et al. 2016: 62–73), and not only on purely economic considerations.

In Italy, the tourism industry is one of the main economic driving forces of the nation; it is mostly concentrated in the art-heritage cities because of the well-known historical and artistic characteristics of the territory, that is to say, in almost all major Italian urban centers. In this context, it is reasonable that an opportunity for business like the one that *Airbnb* offers is being taken whenever possible, and it is intensely exploited. This happens, furthermore, because, at least until now, Italian national and local legislation hasn't hindered these kinds of sharing-businesses as has already happened in other contexts, such as in San Francisco, Berlin and Barcelona. For these reasons, in Italy, *Airbnb* has reported considerable success, and it is still growing at significantly high rates. So far, in this context, the city that has seen the most expansive proliferation of *Airbnb* listings within its territory is Rome. In fact, after exponential growth during the previous few years, by the end of

2016 it reached more than 25,000 active listings uploaded on the platform. This is followed, after a wide gap, by Milan with about 10,000 listings less, and by Florence and Naples with 9000 listings (see Fig. 1).

Nevertheless, when these data are considered in proportion to their respective populations, it is Florence, and immediately after that Venice, that reaches the top rank, respectively with a concentration of ads equal to 24, and 22 for Venice, for every 1000 inhabitants (see Fig. 1). These notable concentrations are, in fact, more than double that of Milan and almost three times that of Rome.

The reasons for these high rates are attributable to the touristic avocation of these cities, which produces strong demand during the whole year and the greater profitability of this kind of short-term contract. In fact, the latter is determined by the fees that are unusually high in comparison with traditional long-term contracts, which unavoidably incline property owners towards this new type of rentals. In line with the previous statement, there is another indicator that assesses and testifies to the diverse nature of this phenomenon in various Italian cities, that is, the ratio between *Airbnb* listings and the available housing-stock of the relevant cities. In fact, this is particularly high in the two cities that are affected the most by the tourism industry, Venice and Florence. They have respectively 11 and 16% of their already small available housing-stock listed in *Airbnb* for short-term touristic purposes (see Table 1). It is foreseeable that this condition will unavoidably have effects on the traditional real estate market of those cities, because this situation will lead to an actual contraction of the availability of traditional long-term rentals and, consequently, their fees will grow until becoming unbearable for the locals.

In order to gain a comprehensive perspective, we now shift our focus to the global level. According to that, Italy has been found to be one of the leading countries in this worldwide phenomenon by placing its capital Rome among the top

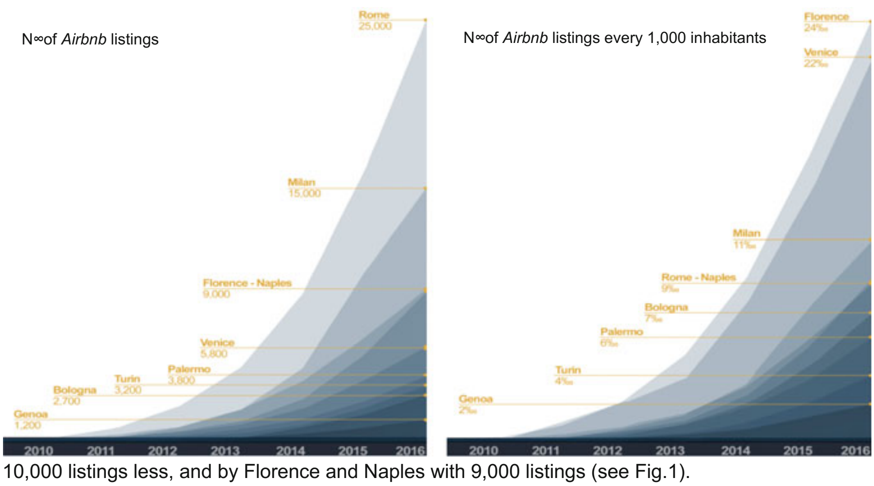

Fig. 1 Magnitude of the phenomenon in some of the major Italian cities

Table 1 Number of *Airbnb* listings/available housing stock

	2008	2009	2010	2011	2012	2013	2014	2015	**2016**
Venice	–	–	0.1	0.6	1.5	2.8	5.6	10.4	16.3
Florence	–	–	0.1	0.4	1.0	2.2	4.3	7.5	11.1
Rome	–	–	–	0.1	0.4	0.8	1.6	3.0	4.6
Naples	–	–	–	0.1	0.2	0.5	1.2	2.5	4.3
Milan	–	–	–	–	0.2	0.5	1.1	2.7	4.0
Bologna	–	–	–	–	0.1	0.3	0.7	1.5	2.7
Palermo	–	–	–	–	0.2	0.4	0.8	1.6	2.6
Turin	–	–	–	–	0.1	0.2	0.4	0.9	1.5
Genoa	–	–	–	–	0.1	0.2	0.3	0.6	1.0

ten cities for number of active listings on the platform (see Fig. 2). In fact, in this context, *Airbnb* has proven to be even more successful in Rome than it has been in those metropolises whose attractiveness are universally recognized but that, as mentioned before, are affected by particularly strict legislation on rental housing, especially for tourism purposes.

An elaboration that compares these data with the demographic peculiarities of each city has also been carried out. That analysis yields a second ranking that is far more significant which actually places three Italian cities, Florence, Venice and Milan among the ten cities that are the most intensely affected by this phenomenon (see Fig. 3). These numbers thus testify to the urgent need to analyze and understand a phenomenon that by now has already unavoidably affected both local touristic and real estate sectors.

In line with what has just been enumerated, one of the reasons for the success resides in the fact that property owners are well-disposed towards short-term rentals since the average fees for *Airbnb* listings in the main Italian cities are a lot higher than the ones charged for long-term rentals. However, at the same time, those fees remain on average below the ones charged for traditional tourist accommodations of the same quality-range (see Table 2).

One of the advantages of the start-ups that operate within the sharing economy is, in fact, their profit margins granted by the fact that they don't have to pay those rental, services and marketing costs that, normally, are associated with traditional

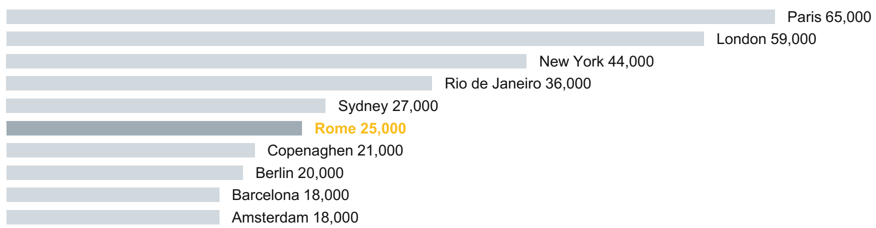

Fig. 2 Top ten cities for their number of *Airbnb* listings

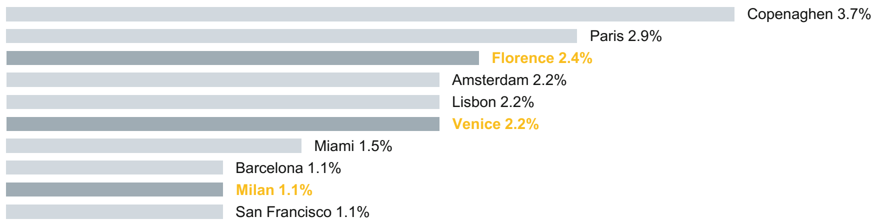

Fig. 3 Top ten cities for number of Airbnb listings per inhabitant

business models. Therefore, the low cost of the operation is directly transferred to the users of the sharing economy, in terms of low margins of service costs. In fact, the platform requires that the tenant pay a 3% fee and the lessee 6–12% (Hasan and Birgach 2016). Nevertheless, it should be pointed out that, compared to traditional rentals, *Airbnb*, by exploiting a more unmet demand and involving a tighter turnover of consumers, requires higher costs of service for the tenant, which however do not invalidate the higher profitability of the latter.

Concerning *Airbnb* fees, it is worth mentioning the existence of a tool for the dynamic pricing, offered and developed by the platform itself, which gives the tenants specific quantitative suggestions about the prices to be applied. This tool, starting from an automatized research of comparables, calibrates fees on the basis of peculiar characteristics of the asset, on the attractiveness of the area (with distinctions on a seasonal basis) and on the intensity of the demand (Hill 2015). Therefore, it is a service that facilitates the entrepreneurial action for those who, under normal circumstances, would not be able to operate in such a dynamic, diverse and non-transparent market not having even the basic knowledge required.

4 Implications for the Housing Sector

As already stated, the phenomenon is recent and it is still growing; for this reason, at the moment it's difficult to determine its actual impact on the traditional real estate market. Undeniably, this has the potential to contribute to the revitalization of a market that, until now, has not shown signs of recovery from the crisis that has affected it.

In fact, *Airbnb* creates business opportunities for whoever owns insufficiently exploited real properties and, at the same time, makes short-term, low-cost accommodations available. In this respect, the platform would seem to follow a *win-win* strategy. However, perhaps unintentionally, negative consequences arise. Among these, far higher incomes than the ones that would result from traditional long-term contracts are granted to those owners who rent out their properties with *Airbnb*. In this regard, on average, the value of the capitalization rate of Airbnb contracts is equal to 6.2%, while the same accommodations under traditional

Table 2 Comparison among average fees (per night) for different types of touristic accommodations

	Traditional hotel room (Federalberghi 2016) (€)	Shared room (€)	Single room (€)	Studio apt (€)	1 bedroom (€)	2 bedrooms (€)	3 bedrooms (€)	4 + bedrooms (€)
Venice	233.1	44.0	93.0	120.0	136.0	176.0	248.0	435.0
Florence	117.9	28.2	51.0	70.1	81.9	111.0	156.5	299.4
Milan	107.9	27.3	45.5	68.3	78.3	118.3	189.3	282.1
Rome	104.3	20.0	46.4	66.4	77.4	98.3	138.3	254.8
Naples	60.7	21.8	51.0	64.6	65.5	90.1	156.5	416.5
Bologna	49.8	16.4	36.4	61.0	62.8	93.7	131.0	199.3
Genoa	59.0	20.0	38.2	60.0	59.2	72.8	92.8	226.6
Turin	54.9	14.6	29.1	43.7	47.3	63.7	83.7	156.5
Palermo	n.a.	8.2	23.7	41.0	38.2	51.9	65.6	132.0

Table 3 Comparison between capitalization rates

	Mean value, Airbnb (%)	Mean value, traditional contracts (%)
Rome	5.2	2.7
Milan	5.9	3.0
Florence	5.4	2.5
Naples	6.0	2.4
Venice	8.9	2.4
Palermo	5.9	2.7
Turin	5.9	2.9
Bologna	6.0	2.7
Genoa	6.9	2.5

contracts only accrue 2.6% (see Table 3). This wide gap in profitability, if stressed, may lead to an actual distortion of the whole real estate market.

In fact, from this perspective, short-term rentals represent a particularly appealing business opportunity. Therefore, locals who rent properties with long-term contracts become an obstacle to the accumulation of that capital (Gant 2016). This fact, as mentioned, will possibly lead to a contraction of the number of offers for long-term rentals and so, consistent with the cyclical nature of the real estate market, their fees will increase. The radicalization of this scenario might lead, as has already happened in some cities' neighborhoods with a major touristic avocation (Sans and Quaglieri 2016: 209), to the phenomenon of tourist gentrification. That is to say, it may lead to the substitution of locals by tourists through the unintended economic eradication of the former from their homes (Gant 2016; Sans and Quaglieri 2016: 209; Lees et al. 2016).

5 Conclusions

In conclusion, as a result of this work, the main strengths and weaknesses of the entrance of *Airbnb* into the real estate market have been identified and expounded via a heterogeneous, in-depth approach, along with the opportunities and threats to the traditional reference market (see Table 4). Nevertheless, the analysis that has been carried out so far has been limited, most of the time, to the generic level. Therefore, in order to remedy the lack of studies about this issue, it will be necessary to go further with this work by deepening specific sub-phenomena that derive from it.

However, it is unquestionable that *Airbnb* is an unprecedented innovative tool that enables anyone to access a market that was previously very exclusive. The low service costs that are required from the platform, have, in fact, enabled the actual possibility for anyone to monetize their underused resources. Moreover, referring to a touristic demand for accommodations and not anymore to the residential one, this

Table 4 SWOT analysis on the *Airbnb* phenomenon

Strengths	*Weaknesses*
Growing business model	Scarcity of the offered services
Lower fees than hotels	Demand and offer are often unbalances
Low service costs	Concentration of the phenomenon in central areas
Ease of operation	Lack of regulations
Opportunities	*Threats*
Potential unlimited expansion	Legal implications and lack of safety for users
Monetization of under-used resources	Clash with traditional referential businesses
Higher revenues than long-term rentals	Increase of long-term rental fees
Real estate revitalization	Touristic gentrification

business model guarantees, as previously shown, much higher revenues than the ones generated by long-term rentals.

This phenomenon, that is undoubtedly affecting the real estate market, if adequately controlled and managed, is an opportunity for the revitalization of the market. However, when it is left uncontrolled, as it currently is in Italy, not acting in accordance with the equilibrium of offer, demand and prices, it will become an actual distortive problem for the whole market. In fact, it interferes with the traditional market through the unnatural increase of long-term rental fees which, if radicalized, will lead, as mentioned, to the alarming occurrence of touristic gentrification.

In conclusion, whether its procedures are accepted or criticized, everybody agrees that it is unlikely, at least for now, that it will experience diminished growth and fade away. For this reason, it is essential not to ignore this phenomenon but rather for all the actors in the real estate market to make efforts to comprehend *Airbnb* peculiarities and its implications in order to reach its actual potential. In this way, within the context of one's own activity, it can become an ally rather than a stranger or, even worse, an enemy.

References

Austin, S. (2014). How does Airbnb´s $10 billion valuation size up? *The Wall Street Journal*. Accessed at: http://blogs.wsj.com/digits/2014/03/20/how-does-airbnbs-10-billion-valuation-size-up/. January 17, 2017.

Bailetti, T. (2012). What technology startups must get right to globalize early and rapidly. *Technology Innovation Management Review, 2,* 5–16.

Belk, R. (2014). You are what you can access: Sharing and collaborative consumption online. *Journal of Business Research, 67*(8), 1595–1600.

Botsman, R., & Rogers, R. (2010). *What's mine is yours: The rise of collaborative consumption*. London: Collin.

Carson, G. (2014). Five key sharing economy sectors could generate £9 billion of UK revenues by 2025. *PwC*. Accessed at: http://pwc.blogs.com/press_room/2014/08/five-key-sharing-economy-sectors-could-generate-9-billion-of-uk-revenues-by-2025.html. January 16, 2017.

Ert, E., Fleischer, A., & Magen, N. (2016). Trust and reputation in the sharing economy: The role of personal photos in Airbnb. *Tourism Management, 55,* 62–73.

Federalberghi. (2016). *Datatur—Trend e statistiche sull'economia del turismo*. Roma: Edizioni ISTA.

Gant, A. C. (2016). Holiday rentals: The new gentrification battlefront. *Sociological Research Online*. Accessed at: http://www.socresonline.org.uk/21/3/10.html. January 16, 2017.

Hasan, R., & Birgach, M. (2016). Critical success factors behind the sustainability of the sharing economy. In *2016 IEEE 14th International Conference on Software Engineering Research, Management and Applications (SERA)*, Towson.

Hill, D. (2015). How much is your spare room worth? *IEEE Spectrum*. Accessed at: http://spectrum.ieee.org/computing/software/the-secret-of-airbnbs-pricing-algorithm. January 16, 2017.

Huet, E. (2014). New York Slams Airbnb, Says most of its rentals are illegal. *Forbes*. Accessed at: http://www.forbes.com/sites/ellenhuet/2014/10/16/new-york-slams-airbnb-says-most-of-its-rentals-are-illegal/#76c404c12613. January 17, 2017.

Konrad, A., & Mac, R. (2014). Airbnb cofounfers to become first sharing economy billionaires as company nears $10 billion valuation. *Forbes*. Accessed at: http://www.forbes.com/sites/alexkonrad/2014/03/20/airbnb-cofounders-are-billionaires/. January 16, 2017.

Lees, L., Shin, H. B., & Lopez-Morales, E. (2016). *Planetary gentrification*. Cambridge: Polity Press.

Martin, C. J. (2016). The sharing economy: A pathway to sustainability or a nightmarish form of neoliberal capitalism? *Ecological Economics, 121,* 149–159.

Newcomer, E. (2015). Airbnb is in talks to raise funds at $24 billion valuation. *Bloomberg Technology*. Accessed at: https://www.bloomberg.com/news/articles/2015-06-18/airbnb-said-in-talks-toraise-funds-at-24-billion-valuation. January 17, 2017.

Price, J. A. (1975). Sharing: The integration of Intimate Economies. *Anthropologica, 17*(1), 3–27.

PwC. (2014). The sharing economy: How will it disrupt your business Megatrends: The collisions? *PwC*. Accessed at: http://pwc.blogs.com/files/sharing-economy-final_0814.pdf. January 16, 2017.

Sans, A. A., & Quaglieri, A. (2016). Unravelling Airbnb: Urban Perspectives from Barcelona. *Reinventing the Local in Tourism: Producing, Consuming and Negotiating Place, 73,* 209.

Santana, J., & Parigi, P. (2015). Risk Aversion and Engagement in the Sharing Economy. *Games, 6,* 560–573.

Schofield, H. (2014). Short-let apartments spark Paris row as Airbnb thrives [Online]. *BBC News,* Paris. http://www.bbc.co.uk/news/world-europe-30580295.

Shor, J. (2014). Debating the sharing economy. *Great Transition Initiative*. Accessed at: http://greattransition.org/publication/debating-the-sharing-economy. January 16, 2017.

Spector, M., MacMillan, D., & Rusli, E. M. (2014). TPG-Led Group Closes $450 Million Investment in Airbnb. *The Wall Street Journal*. Accessed at: http://www.wsj.com/articles/SB10001424052702304626304579509800267341652. January 17, 2017.

Varma, A., Jukic, N., Pestek, A., Shultz, C. J., & Nestrov, S. (2016). Airbnb: Exciting innovation or passing fad? *Tourism Management Perspectives, 20,* 228–237.

Zervas, G., Proserpio, D., & Byers, J. (2016). *The Rise of the Sharing Economy: Estimating the Impact of Airbnb on the Hotel Industry.* Boston U. School of Management Research Paper, (2013–16).

Regional Impact Assessment: A Methodology to Measure the Regional Value Added of Trans-Sectoral Urban Planning

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Abstract In times of increasing interest in sustainability topics, as well as their high degree of urgency due to depletion of resources, global warming and social inequalities, concepts and respective projects that meet the goals of sustainable development experience high popularity. Additionally, phenomena like globalization and urbanization have resulted in central, environmentally deprived areas and long, interregional/international value chains with winning global players and an ever growing gap between rich and poor. Often, urban growth has outpaced the ability of governments to build essential infrastructures and create regional value. Regional value creation can be facilitated by using local trans-sectoral synergies and is fundamental to sustainable development and the strengthening of local economies. To assess the regional and sustainable impact of trans-sectoral planning in urban areas, a consistent concept is needed that, not only includes economic performance indicators, but also social and ecological effects within the region. The visualization of the regional economic, environmental and social impacts cannot only support decision-making processes, but can also be used as a political argument to promote and foster trans-sectoral planning and sustainable development. There are various different approaches for measuring the regional value added, mainly focusing on the economic value added and mostly known in the field of renewable energies. To develop a tool measuring the regional impact in terms of economic, social and ecological performance of identified trans-sectoral interfaces and synergies, the authors have chosen the indicator-based approach to a value chain analysis, where a set of economic, social and ecological indicators is used for measuring the sustainability performance of value creation stages in a region. With the right choice of indicators, the tool is able to quantify the impact within a region and support the decision-making processes of urban planners.

Keywords Regional value added · Regional impact · Trans-sectoral planning
Sustainability evaluation · Performance indicators

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1 Introduction

The research project RAPID PLANNING, funded by the German Federal Ministry of Education and Research, deals with sustainable infrastructure and resource planning for highly dynamic metropoles.[1] It seeks to develop a trans-sectoral urban planning methodology with special focus on the sectors energy, water and wastewater, solid waste and urban agriculture. The cities investigated in the project are Kigali (Rwanda), Da Nang (Vietnam), Assiut (Egypt) and Frankfurt/Main (Germany). After a comprehensive research of existing conditions, structures and procedures in urban supply and disposal infrastructure and resource planning, a methodology will be developed through a participative process to support local authorities in the transition towards a trans-sectoral planning approach to harness synergies and manage trade-offs. Besides data management, technical support and knowledge enhancement, the RAPID PLANNING approach includes administrative change management and the assessment of the regional impact on all three dimensions of sustainability.

In the holistic RAPID PLANNING approach, trans-sectoral synergies shall be used to improve urban service provision and the regional performance. The sectors water, waste water, waste, energy and urban agriculture are closely interconnected and their interfaces are identified within the project. For example, the water and the energy sector are interconnected as follows: The output of the energy sector (electricity) is needed in the water sector for withdrawal, treatment and transport of the water, while water can be used as an input to the energy sector for the generation of hydropower.

To measure the regional and sustainable impact of various activities in urban planning, a consistent concept is needed that not only includes economic performance figures, but also social and ecological effects within the region. A sustainability evaluation captures issues that fall outside economic value added assessments but may have a significant and real impact on the region. The regional value added (RVA) method can not only support the decision-making processes of urban planners because it enables the comparison of various options regarding regional impacts, but can also be used as a political argument to promote and foster sustainable development and trans-sectoral planning approaches. It makes possible and facilitates changes in governmental decision making by giving a different perspective and adding new aspects to the decision basis.

In the present methodological paper, the developed approach will be described and discussed.

[1]The joint research project "RAPID PLANNING—sustainable infrastructure, environmental and resource management for highly dynamic metropolises" is sponsored by the German Federal Ministry for Education and Research (No. 01LG1301); www.rapid-planning.net.

2 Methodological Approach

Measuring the total RVA in all three dimensions of sustainability is a wide-ranging and complex undertaking. Data availability represents a significant limiting factor for most RVA measurement methods (Offermann et al. 2010).

Up to now, there are various different approaches towards the measurement of RVA that are adapted to the relevant research needs in each specific case. Current quantitative research mainly focuses on methods to measure the economic RVA of renewable energies comparing RVAs of various technologies,[2] while qualitative research predominately works with the value chain approach.[3]

There are two approaches to determine the RVA, one showing the origin and the other the allocation of the (economic) performance (see Fig. 1; Graupner 2010: 23–35; Kaufhold 2012: 2–3).

In the statement of origin (output measure), the value added calculation is based on a subtractive method: RVA is the difference between the regional total-output value and the related value of inputs and services from outside a region. The most common economic tool is the Input-Output-Table (IOT).

The additive method, the statement of allocation (income measure), adds the proportions of values- added from the various stakeholder groups within the region: employees, shareholders, lenders, the government and other local players. Here, value chain analysis, material flow analysis and the indicator-based approach are the most common assessment methods. The value chain analysis is a systemic approach to analyze the entire (global) value chain of a certain product or service by separating a value chain into single value-creation steps. The material flow analysis (MFA) quantifies major material and energy flows and stocks within defined system boundaries (Baccini and Bader 1996: 35). Indicator-based approaches can be differentiated into composite indicators and sets of indicators. Composite indicators can be communicated more easily, although aggregation techniques are often yield doubtful results. However, Kulig et al. (2010: 119–126) argue that one number or monetary value is not capable of capturing the full complexity of such a multidimensional issue like sustainability, and therefore, an indicator set is the more appropriate way to measure the sustainability performance with values in his/her own distinct unit, which is not necessarily a monetary unit.

The aim is to develop a method to measure economic, social and ecological impacts of a certain trans-sectoral synergy in terms of regional value creation. Thus, economic, social and ecological parameters have to be part of the measurement tool. The intention is to integrate direct and indirect effects in up- and downstream value chains in these three dimensions of sustainability, as well as induced effects,

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[2]See, e.g., Kaufhold (2012), Hirschl et al. (2010), Hoppenbrock (2010), Hoppenbrock and Albrecht (2010), Offermann et al. (2010), Hoffmann (2009).

[3]See, e.g., GTZ (2007), Herr and Muzira (2009), Gereffi et al. (2001), Schubert and Bühler (2009), Kaplinsky and Morris (2001).

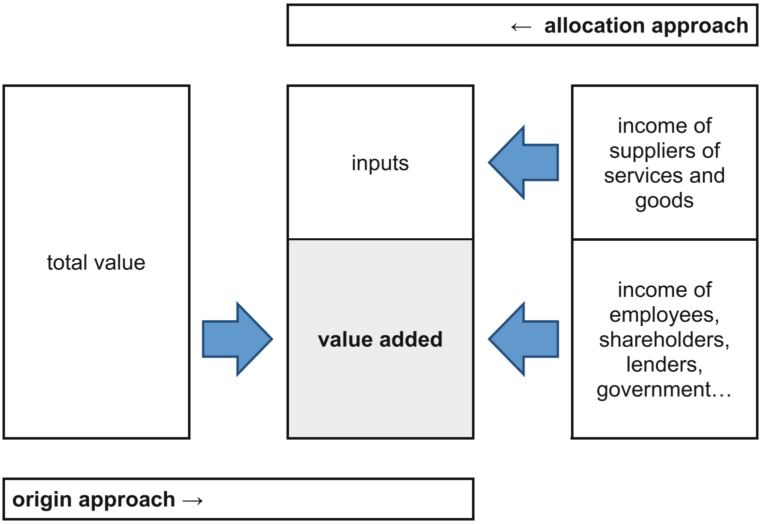

Fig. 1 Origin and allocation statement (adapted from Graupner 2010: 8; Hoppenbrock and Albrecht 2010: 26)

by considering all relevant interconnections and dependencies in regional value networks that are created by the use of the investigated synergy.

The determination of the economically computed RVA results in a static, monetary value. The IOT is a more dynamic approach showing the interlinkages of various sectors or production units in monetary terms. The MFA models flows and stocks of materials and energy in physical quantities based on a value chain map, with the possibility to be extended by additional value factors. The value chain analysis can include the determination of the monetary value added on a regional basis and provides the starting point for the assessment of other value adding factors. The indicator-based approach is the most flexible and dynamic method because it needs to be developed from the start and can therefore be tailored to deliver the results of interest.

What IOT, MFA, value chain analysis and the indicator-based approach have in common is the focus on interconnections in-between the system of value links. A MFA and a value chain analysis are generally performed after the respective process or value chain map is drawn as a basis for further data gathering and analyzing. This system map includes all basic processes and functions, as well as all activities that support basic processes.

For the assessment of the economic, social and ecological RVA, a combination of the described methods shall be used to gain the best possible result: a value chain analysis with its steps to analyze the value chain with special focus on the regional allocation, supplemented by indicators developed to cover economic and social, as well as ecological value aspects.

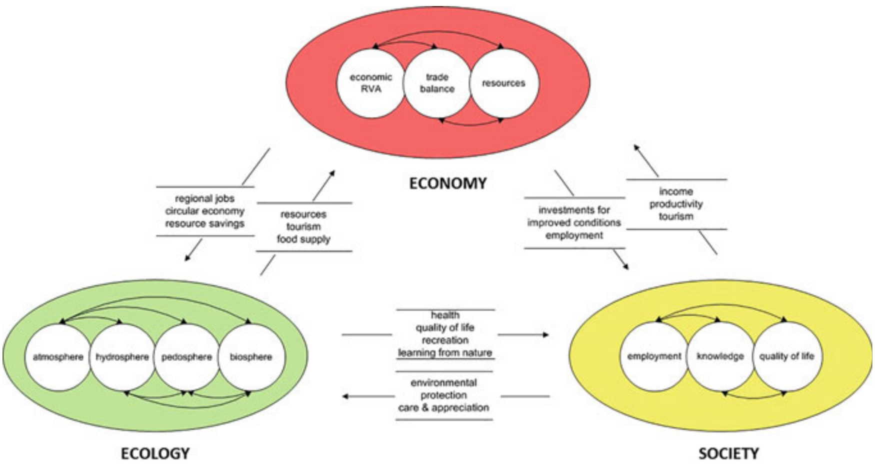

Fig. 2 Interconnections of economic, ecological and social values

The following Fig. 2 shows the interconnections of the three pillars of sustainability and how they support and influence each other. It demonstrates that changes in one field have positive and/or negative effects on the other areas of interest and vice versa. This underlines the importance of integrating indicators of all three dimensions in the RVA assessment.

For the purpose of the impact assessment, an indicator set needs to be developed with adequate indicators for the three dimensions of sustainability, for measuring economic, ecological and social effects within urban structures.

3 Indicator Development

For the development of an adequate indicator set, secondary resources of other indicator sets regarding sustainability performance or value added measures (e.g., Hoffmann 2009; Schoenthaler and Pieck 2013; TEEB 2011; Kulig et al. 2010; Bronger 2004; Fehrenbach et al. 2008; Die Bundesregierung 2017) were studied and evaluated in detail, as well as adapted to the regional perspective of the RVA. As already stated, the indicator set needs to include indicators of the urban economy, the urban society and the urban ecology.

3.1 Urban Economy

Due to their concentrations of industry, commerce and services, cities are driving forces of economic development and provide high potential for the creation of a regional circular economy with the goal of generating the highest possible economic value within the region. Higher value creation generally implies more jobs and higher salaries for the local population; also, it includes increased government revenues that can be spent on infrastructure and service improvements to enhance urban quality of life. It has to be noted that the economic RVA measure is an aggregated value and does not make a statement about the distribution of the generated value added among the various stakeholders.

Tourism, reinforced by an intact environment and favorable social conditions, also creates value within the region as tourists naturally come with relatively high purchasing power. The local economy, government, society and environment determine the touristic attractiveness of a region, as well as the tourists themselves (Freyer 2001: 103).

In a circular economy, resources will be saved due to the "recover and reuse" principle which not only implies lower input and transport costs but also brings about environmental benefits. This also improves the balance of trade[4] and respectively lowers the trade deficit (more imports than exports) due to reductions in imports. Import substitution also prevents capital exports. Although (value added) material exports improve the balance of trade, from the perspective of a regional circular economy, exports should, as well as imports, be avoided to generate the highest possible RVA. When local products are sold on local markets, the income of sales persons, collection of government taxes etc. will be increased or, in the case of intermediate products, other factories in the region will add more value to the products.

3.2 Urban Society

The objective of social RVA is to measure impacts on the living conditions, health, knowledge, well-being and quality of life of the urban population.

Integration and participation in opportunities of the local population are important factors of regional value creation. To provide favorable working conditions, wages and compensation of the workers need to be based on regional good practice, hygiene and occupational safety need to be regulated, and qualifying training need to be offered (Fehrenbach et al. 2008: 110–116).

Job creation within the region not only generates income, as well as better living conditions, and provides security; it also saves potential transport costs and emissions from commuting between the place of abode and place of work, thus improving the environmental as well as the economic performance.

North (1999: 56) states that "knowledge is capital", both for the personal situation as well as for the regional economy. Accumulation of knowledge and local expertise is an important factor for regional value creation and permanent

[4]The trade balance describes the difference between a region's imports and its exports.

improvement, especially in urban areas with keen competition on the job market. Basic and advanced education still are key elements to gain higher incomes and therefore also to achieving higher, more stable and reliable regional purchasing power. Further, environmental education is key to raising environmental awareness. Well-informed persons can share their environmental knowledge and increase public environmental consciousness.

With urbanization on the rise, pressure on human health and well-being also increases. In general, environmental pollution has negative effects on physiological and psychological health. On the other hand, medical services are more available and accessible in urban areas (Endlicher 2012: 210). But, as most medical products are regional imports and not produced within the region, health improvements contribute to the RVA. Furthermore, healthy residents also imply a healthy workforce for the economy with higher productivity that ensures a stable and high economic RVA.

Most common "urban diseases" are cardiovascular and respiratory diseases, as well as general stress due to external factors (Endlicher 2012: 210–11). Disruptive factors causing considerable stress on local ecosystems and residents' health in urban areas include noise, odor and light pollution. Constant noise, as well as odors, affect the psychological condition of the residents, especially during rest periods. Light pollution is caused at night by artificial light (street light, advertising and floodlighting), especially in urban areas. The latest research reveals that it has significant negative effects due to disruptions of the day-night rhythm of people, plants and animals (Endlicher 2012: 79, 210).

Endlicher (2012: 210–14) highlights the importance of urban green areas for recreation purposes to improve well-being and health. An attractive urban environment with recreational spaces and happy residents leads to improvements in quality of life. This in turn contributes to a better image of the region and attracts tourists, creating RVA through their additional purchasing power.

Although there is no universally accepted definition of quality of life, the one of the World Health Organization (WHO 1995, cited in Susniene and Jurkauskas 2009: 59) is often referred to and defines it as "an individual's perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, values and concerns incorporating physical health, psychological state, level of independence, social relations, personal beliefs and their relationship to salient features of the environment; quality of life refers to a subjective evaluation which is embedded in a cultural, social and environmental context".

Approaches to the assessment of quality of life focus either on objective living conditions (see, e.g., Kajanoja 2002) or on subjective well-being (see, e.g., Headey and Wearing 1992; Kajanoja 2002; Gallup-Healthways 2013). The former approach is about "fulfilling the societal and cultural demands for material wealth, social status and physical well-being" (Susniene and Jurkauskas 2009: 59) and is criticized for its objectivism because living conditions have varying significance for different people and quality of life is a very subjective matter that is up to each individual. On the other hand, the latter approach of consideration of being happy and/or satisfied in general is criticized for its subjectivism (see, e.g., Kajanoja 2002: 73–74). Kajanoja

(2002: 63) argues that attributes of a good life "need to be defined". Objective factors include the macro-environment (environment, human rights, politics), external factors like work, material well-being, family standard of living and housing, interpersonal factors like family, and other relationships and social support, as well as personal physical, psychological and spiritual condition (Susniene/Jurkauskas 2009: 59–60). Susniene and Jurkauskas (2009: 59–60) developed an integrative approach including subjective, as well as objective, indicators.

3.3 Urban Ecology

In urban centers, significant environmental impacts are being generated by the large number of people that are living, working, consuming and polluting in a small, concentrated geographical area. Therefore, urban planning also includes tasks of protecting natural goods, such as air, water and soil, as well as supporting flora and fauna diversity (Endlicher 2012: 62–63). Protection and maintenance of urban ecosystems and their services avoid unnecessary losses of "local welfare, city budgets and business opportunities" (TEEB 2011: 1).

Also, downwind and downstream effects of urban air, water and soil pollution in rural areas contribute to rural-urban migration, which in turn increases stress on urban infrastructures and socioeconomic conditions (Wilbanks et al. 2007: 361).

Ecological value added is generated by using fewer natural resources and protecting the natural ecosystems and biodiversity, as well as polluting less.

The urban ecology consists of various subsystems, namely the atmosphere, hydrosphere, pedosphere and biosphere. These subsystems interact with the economy and the society, as well as with each other (Endlicher 2012: 80–163; Kulig et al. 2010: 124; TEEB 2011: 3–4; Schoenthaler and Pieck 2013: 7–11).

Sources of urban air pollution mainly are emissions of sulphur dioxide, carbon monoxide and dioxide, and nitrogen oxides, as well as particulate matter. The regional correlation of most mobile air contaminants has been challenging scientists, regulators and decision-makers for years due to the geographic separation between cause and downwind effects (EPA 2002: 8). According to the WHO, fine particulate matter has the greatest negative effect on human health, namely, respiratory and heart diseases. The main source of urban particulate matter is from traffic and other combustion processes (WHO 2013; Endlicher 2012: 81; UBA 2013). It causes direct local impacts and is therefore strongly and negatively correlated to regional value creation. Carbon dioxide (CO_2) is generally well-mixed in the atmosphere; therefore impacts are the same, regardless of where emissions occur. Besides this common understanding, recent US research found out that locally emitted CO_2 increases local air pollution, indicating that mixing ratios are higher in urban areas compared to the surrounding rural areas, building so-called strong but variable "urban CO_2 domes" (Jacobson 2010: 2497; Idso et al. 2001).

"The presence of a city affects runoff, moisture availability and precipitation" (Trenberth et al. 2007: 259). Water quality and quantity mainly depend on soil

Table 1 RVA indicators

Economic indicators	Social indicators	Ecological indicators
Investment/profitability/value added	Quality of life	Atmosphere
Stability of market	Knowledge/education	Hydrosphere
Local economy/trade balance	Employment	Pedosphere
Resources	Fair access/self-supply	Biosphere/biodiversity
	Gender equity	Material & energy balance

sealing and pollution with organic and inorganic materials, as well as methods of waste water treatment.

Land use, soil compaction and pollution with natural and technological substrates influence the soil quality. Urban soils are fundamentally different from rural, natural soils in terms of material composition and functioning (Endlicher 2012: 106).

According to Endlicher (2012: 107–109), increasing land use and soil sealing is the most serious problem of urban planning and, therefore, minimizing the rate of land use is an important factor in urban decision making. It is estimated that nearly 60% of current soil erosion is induced by human activity, especially by land use through structural measures and agricultural practices. This problem increases with urbanization, population growth and the consequences of global warming of more extreme weather events and precipitation (Yang et al. 2003: 2913).

High urban biodiversity contributes to the regulation, stabilization and functionality of biological systems through, e.g., carbon storage, water treatment and air-quality regulation, and it also provides recreational and educational value and better quality of life to citizens. Endlicher (2012: 163) also emphasizes the high value of biodiversity within urban areas in the context of environmental education, quality of life, image and biomonitoring.

3.4 Summary

Table 1 summarizes the indicator categories that will be part of the RVA assessment. Concrete indicators and its respective measurement units will be adapted to the special focus of the assessment, as well as to data availability.

4 Regional Impact Assessment

First of all, the investigated region has to be defined. Usually, in the case of this RVA measure, the region to be assessed will be an urban area within its administrative boundaries.

For the assessment of the RVA, the respective regional value network needs to be analyzed in detail to identify all relevant stages, functions and actors.

The investigated synergy will be broken down into the various value adding steps. Further, the different stages, inputs and outputs as well as actors will be analyzed according to their origin respectively site (regional/non-regional) and relevance.

The RVA measure will be conducted in a comparative design: A business-as-usual scenario will be compared to a new scenario. To conduct a comparative analysis, also the business as usual (=reference) scenario needs to be defined and analyzed to be able to assess the actual impact and not only a theoretical impact without considering alternative options.

After a holistic analysis and illustration of all relevant inputs, outputs and processes for the various scenarios, various steps of the value chain can be assessed and evaluated with the developed set of indicators.

The methodological approach can be summarized as follows:

- Definition of investigated region/city
- Definition and value chain assessment of trans-sectoral synergy
- Definition and value chain assessment of reference scenario
- Visualization in regional value network map
- Use of indicator set
- Comparison of scenarios and analysis of results.

5 Discussion

In general, a simplification and concentration on a selected set of indicators, or even on only one indicator, is both a blessing and a curse: Demand is high for indicators that are easy to understand and communicate but, on the other hand, the indicators might not be adequate for every local condition and might mislead the decision-making process due to incomplete information. Therefore, it is important to raise awareness for the limited message that these indicators communicate and that there is a risk of being misled due to a specific selection of indicators that has been made on basis of personal or case-specific preferences and might lack critical information.

The regional aspect of the impact assessment might also be critical when it comes to the ecological dimension. In many cases, ecological impacts do not (only) occur within the borders of the defined region but have inter-regional (e.g., water pollution) or even global (e.g., CO_2 emissions) effects that will not be part of the assessment as it only looks at the investigated region/city.

Nevertheless, the RVA measure is an appropriate, concrete and easy-to-read tool for a holistic sustainability evaluation within the borders of its values.

Further, the indicator set enables city planners to set priorities according to their strengths, weaknesses and deficits. If a city, for example, has deficits in ecological performance but has fewer problems with employment and economic activities, its planners can focus on trans-sectoral synergies that mainly foster ecological improvements.

6 Conclusion

In general, RVA is a fixed economic term. The way it is used in the present article deviates from this definition and constitutes a more holistic picture of regional values. As the term RVA already evolved into an attractive catchword in politics for local sustainable development, the present RVA measure now provides the respective evidence providing fundament.

An indicator set, including the economic, social and ecological dimension, is a holistic collection of indicators relevant to urban sustainable development. It represents a helpful tool for evidence-based decision making, providing evidence beyond financial arguments.

In a next step, the developed and described methodology will be applied to the trans-sectoral synergies that have been and further will be identified within the RAPID PLANNING project.

A monetary valuation of selected social and ecological performance indicators to arrive at one allocated monetary value is a further step that might not be adequate to show the full spectrum of impacts, but would be a desired outcome for communication of the regional impact in the political and public dialogue.

References

Baccini, P., & Bader, H. -P. (1996). *Regionaler Stoffhaushalt: Erfassung, Bewertung und Steuerung*. Heidelberg, Berlin, Oxford: Spektrum Akademischer Verlag GmbH.

Bronger, D. (2004). *Metropolen, Megastädte, Global Cities: Die Metropolisierung der Erde*. Darmstadt: Wissenschaftliche Buchgesellschaft.

Die Bundesregierung [The federal government of Germany]. (2017). *Deutsche Nachhaltigkeitsstrategie: Neuauflage 2016*. Berlin: Die Bundesregierung.

Endlicher, W. (2012). *Einführung in die Stadtökologie: Grundzüge des urbanen Mensch-Umwelt-Systems*. Stuttgart: Eugen Ulmer.

EPA [United States Environmental Protection Agency]. (2002). *Nitrogen: Multiple and regional impacts*. Washington, DC: EPA.

Freyer, W. (2001). *Tourismus: Einführung in die Fremdenverkehrsökonomie*, 7th revised ed. Munich and Vienna: Oldenbourg.

Gallup-Healthways Inc. (2013). Gallup-Healthways Well-Being Index. Accessed at: http://well-beingindex.com. July 25, 2013.

Gereffi, G., Humphrey, J., Kaplinsky, R., & Sturgeon, T. (2001). Introduction: Globalisation, value chains, and development. *IDS Bulletin, 32*(3), 1–8.

Graupner, M. (2010). *Ansätze zur Messung der regionalen Wertschöpfung als Beitrag zum Aufbau einer Regionalmarke.* Korrigierte Fassung der Diplomarbeit, Fakultät Wirtschaftswissenschaften, Technischen Universität Dresden.

GTZ [Gesellschaft für Technische Zusammenarbeit]. (Ed.). (2007). *Value links manual: The methodology of value chain promotion.* Eschborn: GTZ.

Headey, B., & Wearing, A. (1992). *Understanding happiness: A theory of subjective well-being*. Melbourne, Australia: Longman Cheshire.

Herr, M. L., & Muzira, T. J. (2009). *Value chain development for decent work: A guide for development practitioners, government and private sector initiatives*. Geneva: ILO [International Labour Office].

Hirschl, B., Aretz, A., Prahl, A., Böther, T., Heinbach, K., Pick, D., & Funcke, S. (2010). *Kommunale Wertschöpfung durch Erneuerbare Energien*. Schriftenreihe des IÖW 196/10.

Hoffmann, D. (2009). Creation of regional added value by regional bioenergy resources. *Renewable and Sustainable Energy Reviews, 13*(2009), 2419–2429.

Hoppenbrock, C. (2010). Regionale Wertschöpfung. *ηgreen, 04*(2010), 26–28.

Hoppenbrock, C., & Albrecht, A. K. (2010). *Diskussionspapier zur Erfassung regionaler Wertschöpfung in 100%-EE-Regionen*. In Deenet (Ed.), *Grundlagen und Beispiele am Beispiel von Fotovoltaik*. Arbeitsmaterialien 100 EE Nr. 2.

Horst, F., Giegrich, J., Reinhardt, G., Schmitz, J., Sayer, U., Gretz, M., Seizinger, E., & Lanje, K. (2008). *Criteria for a sustainable use of bioenergy on a global scale*. Texte 30/08. Dessau-Roßlau: UBA [Umweltbundesamt].

Idso, C. D., Idso, S. B., & Balling, R. C., Jr. (2001). An intensive two-week study of an urban CO_2 dome in Phoenix, Arizona, USA. *Atmospheric Environment, 35*, 995–1000.

Jacobson, M. Z. (2010). Enhancement of local air pollution by urban CO_2 domes. *Environmental Science and Technology, 44*(2010), 2497–2502.

Kajanoja, J. (2002). Theoretical bases for the measurement of quality of life. In: E. Gullone & R. A. Cummins (Eds.), *Social Indicators Research Series: Vol. 16. The Universality of subjective wellbeing indicators*. Dordrecht, Boston, London: Kluwer Academic Publishers.

Kaplinsky, R., & Morris, M. (2001). *A handbook for value chain research*. Accessed at: http://www.prism.uct.ac.za/Papers/VchNov01.pdf. January 12, 2017.

Kaufhold, S. (2012). *Die Regionale Wertschöpfung Erneuerbarer Energien durch Bürgerbeteiligung stärken: Handlungsoptionen zur finanziellen Bürgerbeteiligung am Beispiel der Stadtwerke Meiningen*. Masterarbeit, Fakultät für Wirtschaftswissenschaften, Universität Kassel.

Kulig, A., Kolfoort, H., & Hoekstra, R. (2010). The case for the hybrid capital approach for the measurement of the welfare and sustainability. *Ecological Indicators, 10*(2010), 118–128.

North, K. (1999). *Wissensorientierte Unternehmensführung: Wertschöpfung durch Wissen* (2nd ed.). Wiesbaden: Dr. Th. Gabler Verlag.

Offermann, R., Stinner, W., Baur, F., Wern, B., Fritsche, U., & Künecke, K. (2010). *Wertschöpfung durch die energetische Biomassenutzung*. Vorlage für Unterarbeitsgruppe im Rahmen des Förderprogramms „Optimierung der energetischen Biomassenutzung". Unpublished.

Schoenthaler, K., & Pieck, S. (2013). *Weiterentwicklung der umweltbezogenen Nachhaltigkeitsindikatoren und des Umwelt-Kernindikatorensystems zur Bilanzierung der Fortschritte in der deutschen Nachhaltigkeitsstrategie*. Texte 33/2013. Dessau: UBA [Umweltbundesamt].

Schubert, D., & Bühler, J. (2009). *A guideline for the management of regional value added partnerships*. Salzwedel, Germany: Regional Planning Authority Altmark.

Susniene, D., & Jurkauskas, A. (2009). The concepts of quality of life and happiness—correlation and differences. *Inzinerine Ekonomika-Engineering Economics, 3*(2009), 58–66.

TEEB [The Economics of Ecosystems and Biodiversity]. (2011). *TEEB manual for cities: Ecosystem services in urban management*. www.teebweb.org.

Trenberth, K. E., Jones, P. D., Ambenje, P., Bojariu, R., Easterling, D., Klein Tank, A., Parker, D., Rahimzadeh, F., Renwick, J. A., Rusticucci, M., Soden, B., & Zhai, P. (2007). Observations: Surface and atmospheric climate change. In S. Solomon, D. Qin, M. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, & H. L. Miller (Eds.), Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press.

UBA [Umweltbundesamt]. (2013). *Luftschadstoffe*. Accessed at: http://www.umweltbundesamt.de/luft/schadstoffe/index.htm. July 15, 2013.

WHO [World Health Organization]. (2013). *Outdoor air pollution*. Accessed at: http://www.who.int/gho/phe/outdoor_air_pollution/en/index.html. July 10, 2013.

Wilbanks, T. J., Romero Lankao, P., Bao, M., Berkhout, F., Cairncross, S., Ceron, J.-P., Kapshe, M., Muir-Wood, R., & Zapata-Marti, R. (2007). Industry, settlement and society. In M. L. Parry, O. F. Canziani, J. P. Palutikof, P. J. van der Linden, & C. E. Hanson (Eds.), Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the *Fourth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 357–390). Cambridge, UK: Cambridge University Press.

Yang, D., Kanae, S., Oki, T., Koike, T., & Musiake, K. (2003). Global potential soil erosion with reference to land use and climate changes. *Hydrological Processes, 17*(2003), 2913–2928.

Incentive Policies for Residential Buildings Energy Retrofit: An Analysis of Tax Rebate Programs in Italy

Pietro Bonifaci and Sergio Copiello

Abstract Starting from the oil crisis that occurred in the early 1970s, the issue of energy efficiency has occupied an ever more prominent place in the economic, political, and academic debate. In this context, the construction industry has been considered among the sectors that have the greatest potential for the reduction of energy consumption and greenhouse gas emissions, as well as for the use of energy from renewable sources. With regard to the European situation that is the focus of this research, the first regulations on building energy performances date back to the mid-seventies. These regulations, which had a significant spread until the 1980s, have focused on the definition of minimum requirements for the building elements. Over the years, the introduction of new regulations has established a series of economic instruments for the promotion of energy-saving technologies. During the last decade, the use of incentive programs has strengthened. Meanwhile, what has been gradually better recognized is the role played by the refurbishment of existing buildings in reducing energy consumption and greenhouse gas emissions, as stressed by the most recent Directive 2010/31/EU on the energy performance of buildings. Under this framework, the incentive policies intended to achieve energy improvements in buildings face a twofold challenge. On the one hand, they have to stimulate the increase of the rate of building renovation; on the other, they should ensure the achievement of minimum performance standards, according to the EU's goals. Given these premises, this research aims to verify, using a Discounted Cash Flow Analysis, the suitability of the tax rebates currently in force in Italy to stimulate private investments and to be an effective tool to reduce the EU's energy consumption. The investment costs of 14 refurbishment alternatives, applied to seven single-family houses located in Italy, are estimated. The cost appraisal considers the retrofit expenses and all the ancillary costs that affect the decision-making process of a private investor, as well as the effect of the tax rebates. The results we achieve underline that the analyzed programs are not completely able to stimulate the enhancement of minimum energy standards in

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buildings. Indeed, the maximum amount of works eligible for the deduction is too high, if linked to an actual increase in global energy performance. This mechanism makes more profitable the exploitation of incentives related to the adoption of specific technologies, which, however, do not guarantee the overall increase of the buildings' performances.

Keywords Energy policy · Buildings energy efficiency · Tax rebates
Decision making process · Retrofit investment costs

1 Introduction

The awareness that the building sector plays a pivotal role in reducing energy consumptions and greenhouse gas emissions has grown during the last decades together with the recognition of its increasing potential in the exploitation of energy from renewable sources. This phenomenon can be observed through the evolution of the policies on building energy performances that have been implemented starting in the 1970s. The regulations initially introduced in the European countries were mainly aimed at defining minimum requirements for the building elements and the installations. Later, the governments have gradually introduced various kinds of economic incentives in support of the command and control instruments. An example of the mentioned evolution is the Directive 2010/31/EU on the energy performance of buildings in which performance standards and economic instruments coexist.

Economic incentives are meant to stimulate both an increase in building renovation rate and the achievement of optimal performance standards. Therefore, they have to deal with the effectiveness and the attractiveness of the policy for the private investor, assuring, at the same time, the balance between benefits and costs for the whole society (Lee and Yik 2004). Although a number of studies have recognized the efficacy of mixed command and control and economic policies in triggering the adoption of energy-efficiency measures (Bonifaci et al. 2016), several authors identify certain pitfalls that affect incentive programs. In particular, they point out the growing number and the continuous evolution of these schemes as a barrier to the optimal implementation of energy-saving strategies (Berardi 2013; Murphy et al. 2012; Wong and Abe 2014; Moroni et al. 2016).

The Italian context is well-suited to represent the above pitfalls. Indeed, incentive initiatives are shared among various governance levels and are affected by a continuous redefinition of their characteristics, such as the amount of the tax deduction.

This research aims to analyze, employing a Discounted Cash Flow Analysis, and a business perspective, the efficacy of the incentive programs that are currently in force in Italy to stimulate an increase of the building renovation rate and the adoption of energy-efficiency measures in the residential sector.

The analysis is carried out by estimating the refurbishment costs of 14 retrofit alternatives applied to seven single-family houses (SFHs) chosen as representative of the Italian building stock. The information on buildings and retrofit works are gathered from the TABULA (Typology Approach for Building Stock Energy Assessment) project, recently developed within the Intelligent Energy Europe program (Corrado et al. 2014).

Since the incentives vary according both to the building energy performance and to the climate zone in which they are located, we hypothesize to deal with buildings situated in the cities of Padua (PD) and Pesaro (PS), both included in the climate zone E, but characterized by a different amount of heating degree days.

This paper is structured as follows. Section 2 discusses the main incentive schemes currently implemented in Italy at various governance levels. Section 3 presents the main characteristics of the analyzed buildings, the retrofit works, and the cost estimation method. Results are discussed in Sect. 4, and conclusions are drawn in Sect. 5.

2 Incentive Policies for Building Energy Retrofit

As mentioned in the introduction, the Italian incentive policies for building energy retrofit are shared among several governance levels. The main national incentive scheme is the so-called *Ecobonus* program, which establishes deductions from income taxes of up to 65% of the eligible expenses, when works are carried out to improve the building envelope and to replace the installations. These deductions are provided as equal annual amounts over a ten-year period. Depending on the work typology, the maximum amount that can be deducted varies between 30,000€ for the substitution of the heating systems and 100,000€ for the global retrofit (Table 1). It is worth noting that only in the global retrofit case the deduction is linked to the improvement of the building energy performance, while in the other cases the deduction is linked to the fact that the building elements and installations meet certain standards.

In addition, other kinds of incentive programs are implemented at regional and local levels. In particular, the regional governments have established the possibility to increase the building volume when refurbishing a residential building. The amount of the increase varies from region to region. With regard to the two locations taken into account in our research, in Padua (Veneto region) the base increase

Table 1 *Ecobonus*: breakdown of the works entitled to be subsidized

Works typology	Maximum expenses [€]	Deduction amount [€]	Yearly deduction [€]
Global retrofit	153,846	100,000	10,000
Building envelope	92,308	60,000	6,000
Heating system	46,154	30,000	3,000
Solar shading system	92,308	60,000	6,000
Photovoltaic system	192,000	96,000	9,600

of 20% can be further raised up to 35% if the building reaches the B class after the refurbishment. In Pesaro (Marches region), a maximum of 20% increase can be exploited regardless of the energy features of the refurbishment.

Moreover, each municipality is free to provide partial or total exemptions from the payment of planning fees.

3 Case Study: Retrofit Alternatives and Cost Estimation

The aim of the TABULA project is to define the main typologies of the European building stock (Corrado et al. 2014). Concerning the Italian context, residential buildings are clustered on the basis of their construction period and size. The same energy performance may characterize every single category. Moreover, for each group, the research provides information about two different retrofit alternatives, a standard option (std) and an advanced one (adv). Table 2 summarizes the key features of the seven single-family houses considered in this research.

The cost appraisal of the retrofit alternatives is carried out through bills of quantities. In addition to the expenses strictly related to the improvement of the building energy performance, the estimation takes into account all the preparatory and ancillary costs that a private investor must bear to carry out the retrofit (Table 3). The investment cost includes the expenses due to raw materials, labor, freight, and transport. Moreover, profit, overhead cost of the construction firm, and planning fees are considered. The increase of the building volume, as allowed by regional regulations, is evaluated on the basis of the standard construction cost to erect a new building in the analyzed locations. As regards the incentives, the annual amounts of the tax rebates are computed under the framework of a Discounted Cash Flow Analysis (Copiello 2016). The adopted interest rate is equal to 5.5% to represent the private investor perspective (Copiello and Bonifaci 2015).

Table 4 summarizes the works applied for each alternative. Rows b2 and b3 show the percentage of the total plaster surface to which the works are applied.

Table 2 Breakdown of buildings characteristics

Code	Construction period	Surface [m^2]	Volume [m^3]	S/V[a]
SFH_1	Up until 1900	139	533	0.77
SFH_2	1901–1920	115	448	0.82
SFH_3	1921–1945	116	455	0.81
SFH_4	1946–1960	162	583	0.75
SFH_5	1961–1975	156	679	0.73
SFH_6	1976–1990	199	725	0.72
SFH_7	1991–2005	172	605	0.73

[a]Ratio between the external surface and the heated volume of the building

Table 3 Breakdown of the works included in the bill of quantities

Works category	Works
(A) Building site	(a1) Scaffoldings (a2) Construction-site toilets (length of rental: 2 months)
(B) Envelope	Exterior Insulation and Finishing System (b1) Test of stability of existing plaster (b2) Removal of the deteriorated plaster (b3) Application of a new plaster (b4) Stabilization treatment on the plastered surfaces (b5) Installation of the exterior insulation (b6) Application of the new plaster
(C) Ancillary works on the envelope	(c1) Removal of window and door sills (c2) Installation of new window and door sills
(D) Roof	(d1) Removal of roof tiles and storage of part of them (d2) Removal of waterproofing layer (d3) Removal of roof secondary framing (d4) Installation of plywood layer (d5) Installation of a new insulation layer and vapor barrier (d6) Construction of the outer layer with new and recycled roof tiles
(E) Upper slab	(e1) Insulation of the upper slab
(F) Ancillary works on roof and upper slab	(f1) Removal of gutters, drainspouts, and flashings (f2) Installation of new gutters, drainspouts, and flashings
(G) Ancillary works on envelope, roof and upper slab	(g1) Construction of a perimeter drain (g2) Installation of concrete shaft for drainspouts
(H) Windows	(h1) Removal of old windows and doors (h2) Installation of new windows and doors
(I) Slab on grade	(i1) Removal of old radiators (i2) Demolition of the flooring (i3) Demolition of the screed (i4) Construction of a crawl space (i5) Installation of a new insulation layer (i6) Installation of the underfloor heating system (i7) Construction of a new screed (i8) Laying of new flooring and skirtings
(J) Middle slab	(j1) Removal of old radiators (j2) Demolition of the flooring (j3) Demolition of the screed (j4) Installation of the underfloor heating system (j5) Construction of a new screed (j6) Laying of new flooring and skirtings
(K) Heating system	(k1) Removal of the old heater (k2) Installation of the new heater
(L) Solar panels	l1) Installation of solar panels
(M) Domestic hot-water production system	(m1) Installation of the boiler for domestic hot-water production
(N) Accumulator tank	(n1) Installation of the accumulator tank
(O) Circulation pump	(o1) Installation of the circulation pump

Table 4 Breakdown of works applied to each alternative

	SFH_1 Std	SFH_1_ Adv	SFH_2_ Std	SFH_2_ Adv	SFH_3_ Std	SFH_3_ Adv	SFH_4_ Std	SFH_4_ Adv	SFH_5_ Std	SFH_5_ Adv	SFH_6_ Std	SFH_6_ Adv	SFH_7_ Std	SFH_7_ Adv
A	•	•	•	•	•	•	•	•	•	•	•	•	•	•
b1	•	•	•	•	•	•	•	•	•	•	•	•		
b2	50%	50%	35%	35%	25%	25%	20%	20%	15%	15%	10%	10%		
b3	50%	50%	35%	35%	25%	25%	20%	20%	15%	15%	10%	10%		
b4	•	•	•	•	•	•	•	•	•	•	•	•	•	•
b5	10	14	10	14	9	13	9	13	9	13	7	11	6	9
b6	•	•	•	•	•	•	•	•	•	•	•	•	•	•
C	•	•	•	•	•	•	•	•	•	•	•	•	•	•
d1	•	•	•	•	•	•	•	•	•	•	•	•	•	•
d2	•	•	•	•	•	•	•	•	•	•	•	•	•	•
d3	•	•	•	•	•	•	•	•	•	•	•	•	•	•
d4	•	•	•	•	•	•	•	•	•	•	•	•	•	•
d5	11	15	11	15	11	15	12	16	12	16	10	14	3	3
d6	•	•	•	•	•	•	•	•	•	•	•	•	•	•
e1													8	12
F	•	•	•	•	•	•	•	•	•	•	•	•	•	•
G	•	•	•	•	•	•	•	•	•	•	•	•	•	•
H	•	•	•	•	•	•	•	•	•	•	•	•	•	•
i1	•	•	•	•	•	•	•	•	•	•	•	•	•	•
i2	•	•	•	•	•	•	•	•	•	•	•	•	•	•
i3	•	•	•	•	•	•	•	•	•	•	•	•	•	•
i4	•	•	•	•	•	•	•	•	•	•				

(continued)

Table 4 (continued)

	SFH_1 Std	SFH_1_ Adv	SFH_2_ Std	SFH_2_ Adv	SFH_3_ Std	SFH_3_ Adv	SFH_4_ Std	SFH_4_ Adv	SFH_5_ Std	SFH_5_ Adv	SFH_6_ Std	SFH_6_ Adv	SFH_7_ Std	SFH_7_ Adv
i5	11	15	11	15	11	15	11	15	11	15	9	13	8	12
i6	•	•	•	•	•	•	•	•	•	•	•	•	•	•
i7	•	•	•	•	•	•	•	•	•	•	•	•	•	•
i8	•	•	•	•	•	•	•	•	•	•	•	•	•	•
J	•	•	•	•	•	•	•	•	•	•	•	•	•	•
k1	•	•	•	•	•	•	•	•	•	•	•	•	•	•
k2	cb	cb	cb	ghp	ahp	ghp	cb	cb	ahp	ahp	ahp	ahp	cb	ghp
l1		•				•		•		•		•		
m1			cb		cb					cb		cb	cb	
n1	•	•		•	•	•	•	•	•	•	•	•		•
o1	•	•	•	•	•	•	•	•	•	•	•	•	•	•

Lines b5, d5, e1, and i5 show the thickness (cm) of the insulation layer. Finally, the heating-system typology is shown in rows k2 and m1 (ghp: geothermal heat pump; ahp: air-source heat pump; cb: condensing boiler).

4 Results and Discussion

Figure 1 compares retrofit costs (without considering the volumetric increase) and the enhancement of the building energy performance. In black are represented standard retrofits and in red the advanced ones; lines indicate the costs while bars represent the energy performance increase. It can be observed that there is not a direct relationship between retrofit costs and energy performance improvements, in particular by excluding the buildings constructed after 1991 that are characterized by lower retrofit costs against lower energy improvements.

Figures 2 and 3 report the percentage incidence of retrofit costs divided into works categories.

Considering the standard alternatives (Fig. 2), a remarkable incidence of the structural works on the total can be observed. For the buildings constructed until 1975, this work category is the one that contributes the most to the total investment. It is followed by the retrofit works on the envelope and by the installations, generally with a higher incidence of the second category. Moreover, it is worth noting that for all the alternatives, except for SFH_6, the sum of all ancillary costs is higher than the sum of the costs of works strictly related to the enhancement of the energy performance.

The incidence of the structures, retrofit, and installations categories is more balanced for the advanced alternatives (Fig. 3) if compared with the standard ones. Moreover, also noticeable is the overall predominance of the incidence of

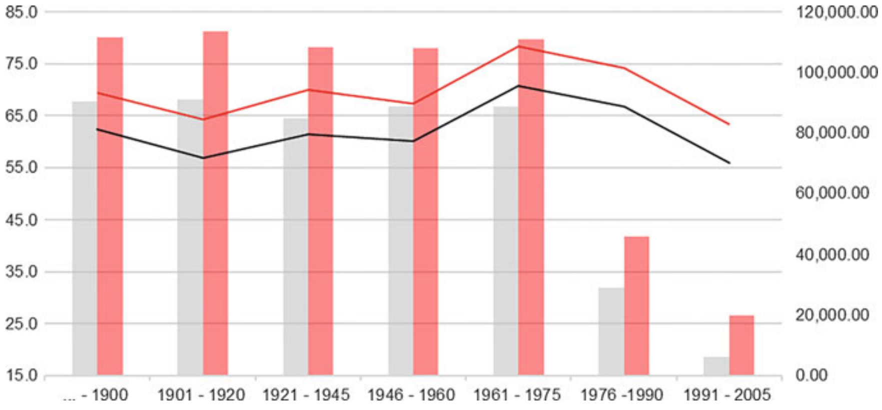

Fig. 1 Breakdown of costs and enhancement of the building energy performance

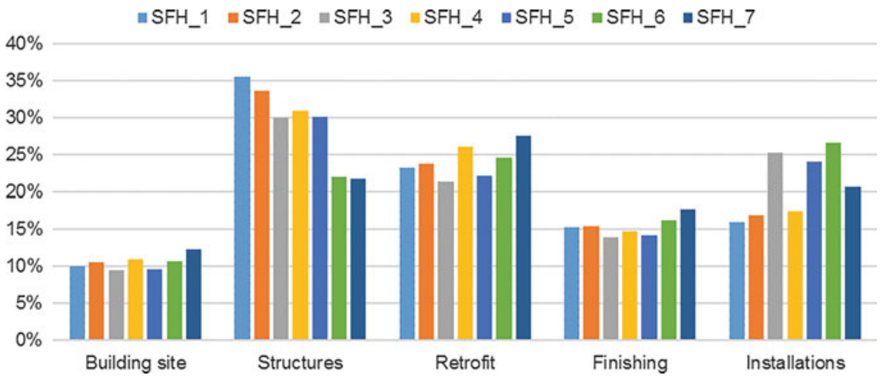

Fig. 2 Percentage incidence of cost categories on total refurbishment costs for standard alternatives

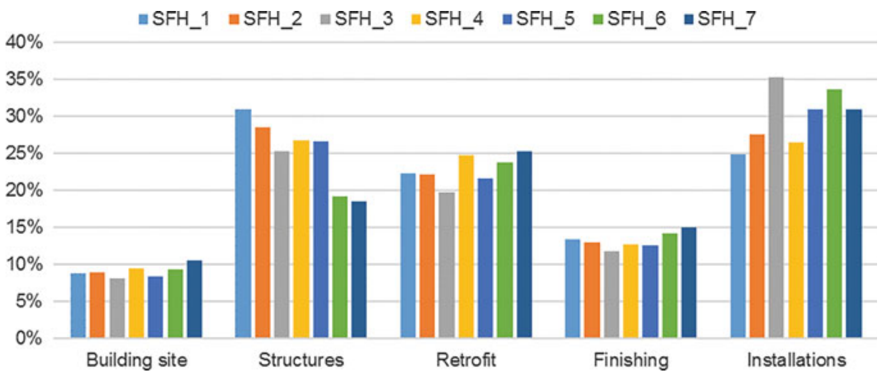

Fig. 3 Percentage incidence of cost categories on total refurbishment costs for advanced alternatives

installations with respect to the retrofit costs. Finally, structures have the greater incidence for older buildings (constructed up until 1920).

Tables 5 and 6 present a breakdown of the result of cost estimation and incentives. For each retrofit alternative, the tables show the total investment costs (both retrofit costs and building volume increase costs), the amount that can be deducted, the additional building volume that can be constructed, the amount of planning fees, and the related reduction. Finally, the unit cost before and after the application of tax rebates are reported. Alternatives marked with an asterisk are the ones that reach the standards that allow owners to benefit from the maximum tax rebate provided by the *Ecobonus* incentive scheme.

As expected, the number of cases that can benefit from global retrofit rebates is greater among the advanced alternatives and among the ones located in Padua

Table 5 Breakdown of costs and incentives for standard alternatives

Loc.	Case	Investment costs [€]	Amount of deductible costs [€]	Additional build volume [%]	Planning fees [€]	Planning fees reduction [%]	Unit cost before incentives [€/m^2]	Unit cost after incentives [€/m^2]
PD	SFH_1	172,192	85,788	35	4,906	50	917.63	645.80
PD	SFH_2	119,044	75,602	20	4,005	50	862.64	549.26
PD	SFH_3	128,127	84,137	20	4,410	50	920.45	576.33
PD	SFH_4	181,217	81,444	35	4,854	50	828.61	602.96
PD	SFH_5	159,615	101,410	20	5,546	50	852.64	542.78
PD	SFH_6	215,202	93,402	35	5,630	50	801.05	588.95
PD	SFH_7*	178,804	73,365	35	4,541	50	770.04	575.10
PS	SFH_1	139,262	85,788	20	4,907	20	834.91	539.39
PS	SFH_2	120,477	75,602	20	4,295	20	873.02	559.10
PS	SFH_3	129,669	84,137	20	4,684	20	931.53	586.83
PS	SFH_4	142,575	81,444	20	4,850	20	733.41	489.91
PS	SFH_5	161,426	101,410	20	5,730	20	862.32	551.95
PS	SFH_6	167,658	93,402	20	5,655	20	702.09	473.85
PS	SFH_7	137,651	73,365	20	4,609	20	666.91	457.99

Table 6 Breakdown of costs and incentives for advanced alternatives

Loc.	Case	Investment costs [€]	Amount of deductible costs [€]	Additional build. volume [%]	Planning fees [€]	Planning fees reduction [%]	Unit cost before incentives [€/m^2]	Unit cost after incentives [€/m^2]
PD	SFH_1*	185,759	99,053	35	5,509	50	989.93	679.69
PD	SFH_2*	161,967	89,607	35	4,916	50	1,043.27	706.09
PD	SFH_3	173,491	100,282	35	5,428	50	1,107.86	736.36
PD	SFH_4*	194,920	94,842	35	5,463	50	891.27	632.33
PD	SFH_5	212,781	115,550	35	6,378	50	1,010.35	688.86
PD	SFH_6*	229,782	107,658	35	6,278	50	855.32	614.39
PD	SFH_7*	192,958	87,204	35	5,170	50	831.00	603.67
PS	SFH_1	153,010	99,053	20	5,510	20	917.33	578.55
PS	SFH_2	134,992	89,607	20	4,932	20	978.20	609.07
PS	SFH_3	146,401	100,282	20	5,418	20	1,051.73	643.94
PS	SFH_4	156,461	94,842	20	5,459	20	804.84	523.85
PS	SFH_5	176,080	115,550	20	6,373	20	940.60	589.14
PS	SFH_6*	182,433	107,658	20	6,303	20	763.96	503.25
PS	SFH_7*	151,993	87,204	20	5,238	20	736.40	491.01

(for the effect of the higher number of heating degree days that characterizes this location). In particular, only one out of the 14 standard alternatives located in Padua and half of the advanced alternatives can benefit from the maximum deduction.

5 Conclusions

The analysis so far exemplifies highlights of some critical aspects of the Italian incentive schemes for building energy efficiency.

Firstly, tax rebates appear not completely able to contribute to an actual reduction of building energy consumption. Some buildings are suited to achieve the maximum amount of deduction; nevertheless, their refurbishment cost is lower than the cap defined by the *Ecobonus* scheme (153,846€). This mechanism could induce private investors to adopt a series of partial retrofit measures, which are anyway subsidized but are not directly linked to an effective increase in the building energy performance. Therefore, while the *Ecobonus* scheme could be able to trigger the growth of the building renovation rate, nonetheless, the amount of the incentive appears not to consider the collective costs and benefits.

From the perspective of a private investor, the possibility to carry out works by parts reduces the investment risk and the burden of demonstrating the achievement of a global energy performance after the retrofit.

Secondly, the deduction of planning fees appear to be not completely capable of stimulating the increase of the refurbishment works. Indeed, planning fees constitute less than 10% of investment costs even in the cases of increased building volume, so their reduction only slightly influences the decision-making process.

Thirdly, the volume increase varies, particularly for the cases located in Padua, from 17 to 30 m^2 in absolute terms. This amount of new space is able to meet the changing housing needs of families, but is not suitable to actually raise building market values from a business-oriented perspective.

As a final remark, it is worth underlining again the subdivision of investment costs: costs of works strictly linked to the increase of energy performances (both on the building envelope and on the installations) are generally lower than all the other ancillary costs. So the definition of the financial feasibility of refurbishment works cannot take into account only the costs related to energy improvements, but it has to consider all the costs on which the investment decision-making is based. Even if initial costs are considered by some authors (Myers et al. 2005; Antoniucci et al. 2015) as the main criterion used by private entities to decide whether to invest in energy-efficiency measures, other aspects should be taken into account to determine the financial feasibility of the retrofit, such as the effect of energy-efficiency improvements on real estate values (Bonifaci and Copiello 2015a, b).

References

Antoniucci, V., D'Alpaos, C., & Marella, G. (2015). Energy saving in tall buildings: from urban planning regulation to smart grid building solutions. *International Journal for Housing Science and Its Applications, 39*(2), 101–110.

Berardi, U. (2013). Stakeholders' influence on the adoption of energy-saving technologies in Italian homes. *Energy Policy, 60,* 520–530.

Bonifaci, P., & Copiello, S. (2015a). Price premium for buildings energy efficiency: Empirical findings from a hedonic model. *Valori e Valutazioni, 14,* 5–15.

Bonifaci, P., & Copiello, S. (2015b). Real estate market and building energy performance: Data for a mass appraisal approach. *Data in Brief, 5,* 1060–1065.

Bonifaci, P., Copiello, S., & Stanghellini, S. (2016). Assessing policy measures on building energy efficiency through a multi-actor multi-criteria analysis. In *CESB 2016—Central Europe towards Sustainable Building 2016: Innovations for sustainable future* (pp. 1343–1350).

Copiello, S. (2016). A discounted cash flow variant to detect the optimal amount of additional burdens in Public-Private Partnership transactions. *MethodsX, 3,* 195–204.

Copiello, S., & Bonifaci, P. (2015). Green housing: Toward a new energy efficiency paradox? *Cities, 49,* 76–87.

Corrado, V., Ballarini, I., & Corgnati, S. P. (2014). *Bulding Typology Brochure—Italy: fascicolo sulla tipologia edilizia italiana*. Politecnico di Torino—Dipartimento Energia—Gruppo di ricerca TEBE.

Lee, W. L., & Yik, F. W. H. (2004). Regulatory and voluntary approaches for enhancing building energy efficiency. *Progress in Energy and Combustion Science, 30*(5), 477–499.

Moroni, S., Antoniucci, V., & Bisello, A. (2016). Energy sprawl, land taking and distributed generation: towards a multi-layered density. *Energy Policy, 98,* 266–273.

Murphy, L., Meijer, F., & Visscher, H. (2012). A qualitative evaluation of policy instruments used to improve energy performance of existing private dwellings in the Netherlands. *Energy Policy, 45,* 459–468.

Myers, G., Reed, R., & Robinson, J. (2005). Sustainable property—the future of the New Zealand. *Pacific Rim Property Research Journal, 14*(3), 298–321.

Wong, S., & Abe, N. (2014). Stakeholders' perspectives of a building environmental assessment method: The case of CASBEE. *Building and Environment, 82,* 502–516.

Evaluating Health Benefits of Urban Energy Retrofitting: An Application for the City of Turin

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Abstract The European Union (EU) has committed to lower GHG emissions for a 20% with respect to 1990 by 2020, reaching an 80% reduction by 2050. Renewable energy and buildings retrofitting will be key measures in cutting environmental impacts according to the new climate targets. The development of these energy-efficiency measures requires significant financial resources. The promotion of renewable-energy sources needs public acceptance to facilitate financial support for government. There is a growing body of literature that recognizes how the benefits of applying energy-efficiency measures outweigh the realization costs. Within this context, an evaluation of the whole range of co-impacts is crucial to compare different alternatives with the same objective. To implement a tool to assess the feasibility of a retrofitting project, firstly it is indispensable to identify the various possible benefits in a standardized manner and monetary terms. Secondly, it is fundamental to specify a logical path for assessing the attainment of these benefits, based on the features of the project. Recently, researchers have shown an increased interest in the evaluation of benefits. Despite this interest, very few studies have investigated the impact of the energy improvements of buildings on indoor comfort and human- health conditions. This work contributes to close the data gap in this context, investigating the health benefits connected to retrofitting interventions in residential buildings. A hybrid approach based on Contingent Valuation Method and economic analysis was applied to assess the impacts delivered by the energy retrofitting to an urban district in the city of Turin (Italy). A questionnaire was employed to elicit an estimate of consumers' Willingness-To-Pay for better indoor comfort conditions and fewer hazards to health,

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reducing poor building features in terms of energy efficiency and air quality. A bidding game model was created to converge to the expected annual economic value of acceptable comfort conditions in the residential houses.

Keywords Co-benefits · Energy retrofit · Stated preferences · Socio-economic assessment · Bidding game

1 Introduction

According to the current European energy policies, the building sector can play an important role in addressing the issue of low-carbon transition and responding efficiently to the threats from climate change (Barthelmes et al. 2016; Soriano and Mulatero 2011). The Paris Climate Conference in 2015 highlighted the importance of renewable-energy sources (RESs) for reducing greenhouse-gas (GHG) emissions, and each country decided to set new environmental targets to lower pollutions levels (UNFCCC. Conference of the Parties (COP) 2015). The European Union (EU) has committed to lower GHG emissions for a 20% with respect to 1990 by 2020, reaching an 80% reduction by 2050 (EC 2013). To reach these targets in the building sector, the government should employ significant financial resources to develop innovative and modernized technologies, which are more expensive compared to conventional energy ones. High approval levels of RESs by the population play a significant role in facilitating financial support and reduce aversion towards government (Nomura and Akai 2004; Napoli et al. 2017). More recent attention has focused on the incorporation of co-benefits (co-impacts) into decision-making (DM) frameworks to take in consideration the full range of stakeholders involved in the energy projects (Giordano et al. 2011; Ürge-Vorsatz et al. 2014). When dealing with energy problems, the most frequently used approaches are the Life Cycle Assessment (LCA) and the Life Cycle Cost (LCC), the Multi-Criteria Decision Aid (MCDA), and the Cost Benefit Analysis (CBA) (Strantzali and Aravossis 2016). According to the European Commission (European Commission 2014), these evaluation methods enable the assessment of an energy project from various points of view by considering different possible externalities (Lombardi and Cooper 2016). In the international literature, the criteria to evaluate energy investments are mainly divided into four criteria families, which consider technical, economic, environmental, and social factors (Wang et al. 2009; Bisello et al. 2017; Giuffrida et al. 2016; Becchio et al. 2017). Technical criteria refer to the efficiency of the system, to the reliability of the energy system and its resistance to failure, and to the degree of maturity of the technology at both national and international level. On the other hand, economic criteria refer to the whole life-cycle costs of the products or services, i.e., investment, operational and maintenance costs, and their economic indicators, such as Net Present Value (NPV) and Payback Period (PBP). The impacts on external air quality, linked to GHG emissions and air pollutions (NOx, SOx, Particulate Matter-PM), and on land use are considered via the environmental criteria. In recent years, an increasing amount of literature treats the relationship between Energy Efficiency Measures (EMMs) and their social acceptance by the population. The present paper focuses in particular on the social aspects that enable investigation of opinions related to the energy system by the local population (Devine-Wright et al. 2017; Kondili and Kaldellis 2012; Stigka et al. 2014; Turney and Fthenakis 2011). Despite the importance of social aspects, there remains a paucity of evidence regarding their evaluation. Data from several studies suggest that the key social criteria of energy-project evaluation are social acceptability, job creation (Deschenes 2015; Tourkolias and Mirasgedis 2011), the social benefits related to a consolidate local know-how (Zahnd and Kimber 2009), and the health benefits for the community (Howden-Chapman et al. 2005; Schucht et al. 2015). Previous studies have examined the relationship between external pollution factors and health impacts (Silveira et al. 2016; Tang et al. 2014). Despite this, there is a general lack of studies based on epidemiological findings that investigate the impact of indoor-discomfort conditions on human health and well-being. To close the gap of research on social impacts related to energy projects, we propose an interdisciplinary approach that combines Contingent Valuation Method (CVM) and economic analysis. This study aims to contribute to this growing area of research by estimating consumers' Willingness-To-Pay (WTP) for the buildings retrofitting. The aim of this paper is examining a monetary evaluation of health benefits in residential buildings, starting with a case study in the city of Turin (Italy).

2 What Endangers Human Health?

A recent systematic literature review discovered the associations between air-pollution exposure and human health and the ecological-system damages (Galvis et al. 2015; International Energy Agency 2014; Capolongo et al. 2013; Simkhovich et al. 2008). As summarized by Maxim (2014), air pollutants are closely linked to mortality and morbidity. PM, SO_x and NO_x reduce life expectancy and cause cerebrovascular and respiratory problems, while CO contributes to congestive heart failure (European Commission 2003). According to Bonnefoy (2007) and Zaharna and Guilleminault (2010), outdoor noises related to traffic or events in general cause disturbance and annoyance. Prolonged exposure to noise influences users' performance, as well as cardiovascular and endocrine functions. Another factor that plays a role in the impact of human health is the urban heat island caused by high smog levels. It compromises human health, influencing the daytime temperatures and reducing nighttime cooling (Harlan and Ruddell 2011). Apart from this literature about urban factors, far too little attention has been paid to domestic factors that shape the consumers' well-being. Indoor pollutants are the main factor that influences indoor comfort conditions and occupants' health. As reported by Liddell and Guiney (2015) and Liddell and Morris (2010), cold houses are also likely to be damp, which can lead to the growth of mold, causing respiratory symptoms. Better indoor comfort conditions, related to avoiding Sick

Building Syndrome (SBS) and reducing pollutant levels, could be ensured by high-quality features of the building in terms of thermal performance and air quality. EEMs can increase users' well-being, reducing respiratory and cardiovascular disease, and lowering anxiety, depression and stress levels (WHO Regional Office for Europe 2010). Warm Front Better Health (NAO 2009) has evaluated the health impacts related to several EEMs at the building level. This study identified two main available EEMs that aim to deliver significant health gains. The first is the replacement or the new installation of a more efficient heating system, combined with a high global efficiency rate related to distribution, regulation and emission systems. The second consists of the building-envelope insulation and the replacement of windows and doors. The previously mentioned measures, combined with proper ventilation, represent the best solutions to produce lower humidity and less dampness inside the house (Oreszczyn et al. 2006).

3 Methodology

This study sets out to assess the perceived benefit of building retrofitting, estimating the positive consequences in terms of households' health and well-being. There are a number of approaches available for determining the consumers' WTP for energy projects (Damigos et al. 2016; Lee and Heo 2016). The WTP reveals the amount an individual is willing to pay to obtain certain benefits or prevent negative impacts (Carson 2000). Focusing on energy-project evaluation, the WTP evaluates people's contribution to the implementation of EEMs. The main approaches to measure the WTP are the revealed-preference or stated-preference methods. Of the stated-preference approaches, the Contingent Valuation Method (CVM) is one of the most practical ways to estimate the value of impacts that cannot be considered by assigning monetary values (Whitehead and Blomquist 2006). The CVM employs a survey in which respondents are asked to state their preferences in hypothetical or contingent markets and allows the analyst to estimate demands for goods or services that are not traded in the real market (Kroes and Sheldon 1988). The CVM has been used in the past in the DM process of the medical and health-care field, including the Cost Of Illness (COI) or the WTP approach in the economic estimation (Bayoumi 2004; Klose 1999). The COI combines the direct costs of medical goods and services that serve to repair the damage suffered and indirect costs, considering, e.g., lost income from days out of work and low productivity level at work. However, the approach does not reflect the full damage from illness, underestimating costs and not considering patients' psychological suffering and physical pain. The CVM was adopted by Banfi et al. (2008) in the energy field to investigate the consumers' WTP for energy-saving measures in Switzerland's residential buildings. The respondents were asked to choose between their housing status quo and each one of the several hypothetical situations with various attributes and prices. Scarpa and Willis (2010) use the choice experiment (CE) approach to measure how much UK households are willing to pay for adopting micro-generation systems. To contribute in the closing of this gap, the paper aims to evaluate the expected annual economic value for acceptable comfort conditions in the house. A random sample of people was asked to complete a survey to estimate their WTP for low-energy measures that guarantee an improvement in health conditions. The method used to collect the stated data is the Bidding Game (BG) (Sudman et al. 1989). To implement the BG method, the interviewer guides the respondent to express his or her maximum WTP along an iterative path. The respondent accepts or rejects the proposed higher or lower bids according to his/her decisions. Damigos et al. (2009) applied the BG to capture consumers' perceptions and WTP regarding securing gas supply for electricity production in Greece. The survey results stated that consumers are willing to pay an additional tax to ensure energy security and to reduce dependence on imported fossil fuels. However, the CVM has methodological limits. The first hypothetical bias regards the stated WTP by individuals, because it could be different from what he or she would actually do. Therefore, the stated WTP value may not match the "true" economic price (Cummings et al. 1986; Oerlemans et al. 2016; Venkatachalam 2004). A suspected weakness of the BG is its vulnerability to starting-point bias. The final value of the stated WTP could be influenced by the starting point proposed by the interviewer (Frew et al. 2004; Loomis 2014). Once stated preferences had been estimated, we conducted multivariate linear regressions to determine factors that may affect the WTP. We considered respondents' characteristics and attitudes as the main factors that influence WTP (Hou et al. 2014).

3.1 Design Experiment

A simple BG method was employed to estimate the amount of money that respondents are willing to pay to apply EEMs, and guarantee good indoor-comfort conditions and reduce health impacts. The BG is a technique commonly used in the CVM studies, where the interviewer bids up or down the respondent in an iterative path to meet his or her maximum willingness to pay. The elicitation question requires only a "Yes" or "No" response to each bid, which is based on the actual investment costs to implement the EEMs. The BG replies are closer to market reality than asking respondent for their maximum WTP through a single open-ended question (O'Brien and Viramontes 1994).

3.2 Survey Description

This study was performed online (via Google Form) and by face-to-face interviews. The respondents were selected from households in Turin by random sampling. The complete questionnaire is available in Appendix 1 of this paper. The first part of the questionnaire includes initial comments that inform the respondents about the topic of the research and the goals of the study. The second section elicits WTP question through the bidding game. Finally, respondents' socioeconomic characteristics (e.g., age, gender, income) were used to analyze the investigated sample and to correlate them with the stated WTP. With specific reference to the second part, the elicitation question aims to investigate the maximum consumers' WTP for the fixed condition in a hypothetical market, while advising about the EEMs to be applied and the relative risk reduction of human health impacts. The WTP starting point question was of the type: "Let us suppose that you live in an apartment of 90 m^2 in a multifamily building of the '70s located in Turin, with the standard natural gas heating system, in a bad/mediocre state of conservation of envelope. Let us assume that interventions on the property allow to improve energy efficiency and maintain a good level of indoor comfort conditions improving the occupants' health. Would you be willing to pay €6,500 to improve the thermal conditions in your house thanks to the external walls insulation and the windows replacement? This could result in a reduction of occupants' diseases related to colds and seasonal influences". The reference question relates to a building that is representative of the pool of energy-intensive buildings among the Italian building stock, that needs to be retrofitted, and where it is possible to achieve perceptible comfort conditions. Owners and tenants were asked questions of varying formats, as will be described in the following sections.

3.3 Bidding Game Structure

The amounts in the Bidding Game reflect the investment costs to implement the various EEMs that can improve the indoor-comfort condition of buildings and their occupants' well-being. From the literature (NAO 2009), four measures were identified; envelope (external walls, roof, and basement) insulation; double-glazed windows installation; high-efficiency heating systems; and the installation of a Mechanical Ventilation System (MVS). Moreover, various combinations of these measures were proposed to achieve multiple levels of health-benefit impacts and, as a consequence, different amounts of WTP. The building envelope retrofitting costs and HVAC (Heating, Ventilation and Air Conditioning) system elements are estimated in an analytical way, thanks to a proper survey of bills of quantities. The unit-investment cost for each package was determined by reference price lists or through direct research of the market. The price list of the Piedmont Region (2016) was the main reference chosen to identify the current costs in the region of the case study. Where costs were absent, the information costs were directly provided by the producers. For each measure, the investment costs consider labor, rental and material costs. For building opaque envelope insulation, the works were considered at the block level, and the costs for scaffolding were taken into account. The amounts of the WTP in the BG are considered in different ways for owners and tenants. The total investment costs were taken into consideration for owners, while additional charges on the fixed rental cost constitute the WTP levels for tenants.

Table 1 WTP amounts for owners and tenants

Energy efficiency measures to improve indoor comfort conditions	Owners (€)	Tenants (€/month)
Heating replacement	2,500	20
MVS installation (+windows replacement)	3,500	30
Heating replacement and MVS installation	6,000	60
Facade insulation and windows replacement	6,500	70
Facade insulation, windows replacement, and MVS installation	7,700	80
Facade insulation, windows replacement, and heating replacement	9,000	100
Facade insulation, windows replacement, heating replacement, and MVS installation	10,500	110

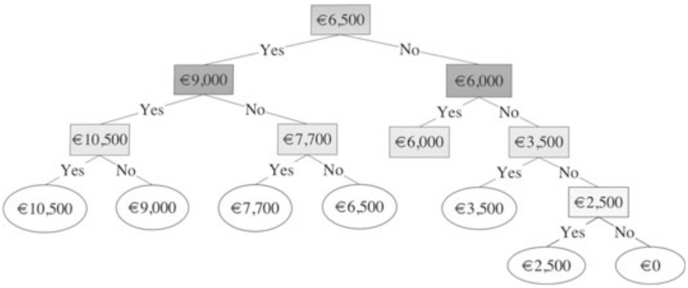

Fig. 1 Bidding game algorithm for owners

This extra payment is calculated by dividing the capital costs by the months of a standard real-estate rental contract in Italy, which amounts to 96 months (8 years) (Table 1).

From the fixed starting point, the interviewer followed a set bidding algorithm (see Fig. 1). According to the respondent's choice, the game follows different paths based upon his or her maximum WTP. The starting point was fixed as the minimum EEM that ensures a minimum advantage in terms of health and comfort.

4 Results

Before going live, the questionnaire was subjected to a pre-test involving 20 interviews. Experts from real estate, energy, and planning fields were involved. Each expert completed the questionnaire and provided comments and suggestions about the survey. Since the questionnaire is addressed to consumers, non-specialist respondents were asked to complete the questionnaire in the preliminary phase.

The survey was conducted in March 2017. By the end of the survey period, data had been collected from 172 individuals by on-line and face-to-face interviews.

4.1 Descriptive Analysis of the Sample

The main socioeconomic data collected from the respondents are shown in Table 2. This information helps us to validate the WTP answer and to describe the sample. Concerning the respondents' ages, 66.7% of the respondents were between 20 and 39 years old. At national level, 54.9% of Italians earn an average monthly salary of 1000–2000€, the most frequently exported in the survey.

As Table 3 shows, more than 70% of the respondents owns the house in which they live. This is in line with the data provided in the ISTAT (Italian National Institute of Statistics) Yearbook 2014. Currently, the percentage of the population who rent in the north-west of Italy is 22.7%. We can get a complete and accurate picture of the nation's circumstance, obtaining information from the sample thus selected. Approximately half of the respondents live in a retrofitted building. The most common energy-retrofitting action is the replacement of the heating system.

Table 2 Characteristics of survey respondents (n = 172)

Age		20–29 year	30–39 year	40–49 year	50–59 year	60–75 year	
	Freq. (%)	61 (35.4)	54 (31.3)	30 (17.5)	18 (10.5)	9 (5.3)	
Gender		Male		Female			
	Freq. (%)	102 (59.3)		70 (40.7)			
Income		0–1000	1–2000	2–3000	3–4000	>4000	No response
€/month	Freq. (%)	26 (15.0)	95 (54.9)	23 (13.3)	7 (4.0)	5 (2.9)	17 (9.9)

Table 3 Characteristics of respondents' current residence

Owner		Yes		No	
	Freq. (%)	121 (70.3)		51 (29.7)	
Retrofitted building		Yes		No	I don't know
	Freq. (%)	85 (49.4)		83 (48.2)	4 (2.4)
If YES, which is the retrofit measure applied?		Heating system replacement	Envelope insulation (external walls, roof, basement)	Windows replacement	Thermostatic valves installation
	Freq. (%)	51 (31.7)	46 (28.6)	39 (24.2)	25 (15.5)

Table 4 Frequency of disease events in respondents' house

External noise		Never	Rarely	Sometimes	Often	Very often
	Freq. (%)	19 (11.0)	67 (39.0)	56 (32.5)	26 (15.2)	4 (2.4)
Exhausted indoor air						
	Freq. (%)	36 (21.0)	64 (37.2)	51 (29.6)	17 (9.9)	4 (2.3)
Uncomfortable indoor thermal temperature						
	Freq. (%)	11 (6.4)	56 (32.5)	70 (40.7)	31 (18.1)	4 (2.3)
Eyes and mucous irritation						
	Freq. (%)	60 (34.8)	50 (29.0)	50 (29.0)	10 (5.9)	2 (1.2)

This measure is preferred for both technical and economic affordability because it allows savings in bills but is less effective than other solutions. We should emphasize that insulation of the building envelope is the choice to be preferred before installing best performing HVAC systems.

A number of questions are posed to collect information about the occurrence of discomfort and disease events in the respondent's house. This part of the questionnaire was used to define the association between symptoms of SBS and stated WTP by the econometric model, defined in Sect. 4.2. In keeping with the replies, Table 4 reports the experiences of perceived comfort in the respondent's house. The most frequently perceived discomforts deal with acoustic and thermal events, with frequencies of 89 and 93%, respectively. Moreover, inadequate fresh air and eye and mucous irritations afflict the occupants in their houses.

4.2 Aggregating and Interpreting WTP

Only 6% of respondents (N = 12) indicated a null WTP, including eleven owners and one tenant. The difference in the responses between owners and tenants is given by the different scenarios in the elicitation question. Owners were asked to face a large initial investment cost, while renters have a smaller one-time sum, and then they may be more willing to pay. About the BG outcomes, the owners are willing to pay 7,541€ on average, while the tenants 82€/month for improved comfort conditions and reduced negative health impacts. The different answers of the respondent sample do not allow a direct comparison of results to identify the annual benefit by EEMs. In order to aggregate both owners' and tenants' WTP, the individual figures have been reported in annual values (the formulas are described in Appendix 2). The obtained results were divided by the gross floor area of the

Table 5 Sample willingness to pay

	Mean [€]	St. dev [−]	Median [€]	Mode [€]	Min [€]	Max [€]	N. [−]	WTP [€/m^{2}year]
Owners' WTP	7,541	3,310	9,000	10,500	0	10,500	121	5.11
Tenants' WTP	82	28	80	110	0	110	51	10.78
Weighted WTP								6.79

sample apartment considered in the elicitation question, obtaining a WTP value expressed in €/m^{2}year (Table 5).

4.3 *Econometric Model*

An econometric model was performed in this study in order to verify potential associations between respondents' WTP and their attitudes and characteristics. The chosen statistical method was the multivariate analysis. A linear multiple-regression analysis, carried out by the IBM SPSS Statistics software, was applied. The inclusion of all variables in the analysis was the first step. Next, the estimation model was refined by involving only relevant variables, which were selected according to their significance. Therefore, only the variables showing *t-stat* value outside the range from −2 to +2 were included in the final estimation model (Table 6). The mean WTP value represented the dependent variable, while socio-economic characteristics, pharmaceutical expenditures, and perception of discomfort events were the independent variables. The significant variables are DOUBLE-GLAZED ("Are double-glazed windows installed in your house?"),

Table 6 Econometric model

Coefficients	Questions	B	t-stat
DOUBLE-GLAZED	Are double-glazed windows installed in your house?	−1504.400	−2.454
CENTRALHEATING	Is a central heating system installed in your house?	−2377.827	−2.482
AGAINSTCOLD	How much did you spend on drugs against cold and flu symptoms in the last year for you and your family?	27.457	2.224
IRRITATIONS	Did you experience eyes, nose, or throat irritations in your house?	568.294	1.839
	R^2	0.18	
	F-value	1.81	
Dependent variable	Mean WTP		

CENTRALHEATING (“Is a central heating system installed in your house?”), AGAINSTCOLD (“How much did you spend on drugs against cold and flu symptoms in the previous year for you and your family?”), IRRITATIONS (“Did you experience eyes, nose, or throat irritations in your house?”). It is possible to affirm that those who spent on drugs to treat cold symptoms and seasonal influences and who suffered eyes and mucous irritations are willing to pay €27 and €568 more respectively. These results suggest that respondents who reported disease events prefer to invest in energy-efficiency implementations than in health-care procedures.

A second analysis was carried out to find correlations between the independent variables (Table 7). To study the possible linearity relationship among the investigated variables, the Pearson’s product-moment correlation coefficient was used. In particular, the bivariate correlation measures the intensity and the direction of a linear relationship between two variables. The correlation is positive when it is close to +1.0, while it is not significant when close to 0. There is a positive correlation between “window replacement” and “indoor exhausted-air events” because the double-glazed windows allow the reduction in uncontrolled air leakages. A negative correlation between “heating-system replacement”, “external wall insulated”, “double-glazed windows”, and the occurrences of indoor “thermal-discomfort events” were found, since a more energy-efficient system and building-envelope improvement facilitate achieving ideal temperature values in the domestic environment. Regarding the occurrence of “external noise events”, the contribution of “external wall insulated” to acoustic insulation is affirmed. Finally, the correlation between “heating condominium” system and “pharmaceutical expenses for headache” is interesting, because the user is not able to control the regulation system, and he or she suffers from the unsuitable indoor temperature.

Table 7 Pearson’s correlation outputs

	Heating system replacement	Windows replacement	External wall insulated	Double glazed windows	Heating condominium
Exhausted-air events	–	0.300[b]	–	–	–
Thermal-discomfort events	−0.230[a]	–	−0.322[b]	−0.157[a]	–
External noise events	–	–	−0.223[a]	–	–
Pharmaceutical expenses for headache events	–	–	–	–	+0.171[a]

[a]correlation is significant at 0.05 level
[b]correlation is significant at 0.01 level

5 Discussion and Conclusions

In the present study, the effects of improved indoor-comfort conditions in residential buildings and the relative consequences on occupants' well-being were investigated. A Contingent Valuation Method, specifically a Bidding Game, was used to determine the WTP of owners and tenants to enjoy good comfort conditions in the house. The aim was to identify the perceived benefit for comfort by the consumers, as a co-benefit to be considered in the feasibility evaluation of energy-retrofitting interventions. The combination of three EEMs, which range from envelope measures to HVAC systems, allows examining various private user's points of view. A significant positive WTP for Energy Efficiency Measures are suggested by the results, according to previous studies (Banfi et al. 2008; Buso et al. 2017; Poortinga et al. 2003). The WTP was high which results in implementation of some EEMs able to assure more comfortable conditions. The WTP mean value for owners and tenants is equal to 7,541€ and 82€/month, respectively. These investment amounts enable installing various EEMs in an apartment located in a multi-family building, such as "heating replacement", "MVS installation and windows replacement", "heating replacement and MVS installation", "facade insulation and windows replacement", and "facade insulation, windows replacement, and MVS installation". These measures have the potential to improve preservation of human health and reduce some external effects, such as outside noises. Taking into consideration the responses of both owners and tenants, the annual perceived comfort benefit for owners and tenants was calculated, yielding a value equal to 6.79 €/m^{2}year. The obtained WTP represents the estimated economic value of human health, which could be used in the DM process. Future research should implement the indoor EEMs effects and external ones, to obtain the full economic value and to extend the application to other building sectors (offices, hotels, schools, etc). A greater number of responses would help to perfect the model and would yield more reliable results. Also, integration with GIS (Geographic Information Model) could be investigated, in order to obtain an integrated model analysis to associate preferences derived from the CVM with spatial data.

Appendix 1—Questionnaire for the CVM Survey

Evaluating Health Benefits Related to Energy Efficiency Measures in Buildings

The questionnaire goal is estimating the economic value of benefits associated with energy efficiency measures of buildings, able to produce good health conditions within residential environments. The questions investigate the awareness of owners and renters towards suitable thermal comfort and air quality in own house. In addition, the questionnaire assesses the possible Willingness to Pay of the occupants to enjoy better health within the domestic environment. The present questionnaire was designed for academic purposes.

Characteristics of Your Current Residence

1. Which is the building typology of your house? *(single choice)*

☐ Single-family house
☐ Terraced house
☐ Flat in multi-family building

2. What is the construction period of your house? *(single choice)*

☐ <1920
☐ 1921–1975
☐ 1976–2005
☐ >2006
☐ I don't know

3. Has your house recently been subject to operations to improve the energy efficiency? ("Operations to improve the energy efficiency" means, for example, the replacement of the heating system, the insulation of the external walls, of the roof, of the basement, the replacement of windows). *(single choice)*

☐ Yes
☐ No *(Continue with question 5)*
☐ I don't know *(Continue with question 5)*

4. If yes, which energy-efficiency measure was applied? *(multiple choice allowed)*

☐ Heating system replacement
☐ External walls insulation
☐ Roof insulation
☐ Basement insulation
☐ Windows replacement
☐ Thermostatic valves installation
☐ Other: ____
(please, specify)

5. Are double-glazed windows installed in your house? *(single choice)*

☐ Yes
☐ No
☐ I don't know

6. Which heating system typology is installed in your house?

☐ Autonomous gas boiler
☐ Central heating system (fueled by gas or oil boiler)
☐ Stove (fueled by pellet or wood)
☐ District heating

☐ Heat-pump heating
☐ I don't know
☐ Other: ____
(please, specify)

7. Is there an insulating layer on external walls of your house? *(single choice)*

☐ Yes
☐ No
☐ I don't know

8. Is a Mechanical Ventilation System installed in your house? *(single choice)*

☐ Yes
☐ No
☐ I don't know

Life-Style Habits—Pharmaceutical Expenditures

The following questions are intended to quantify the annual pharmaceutical expenditure which supported your family (€/year). Please, answer the following questions thinking about the costs incurred during the last year not taking into consideration any agreements with the National Health System.

9. How much did you spend on drugs to treat headache in the last year for you and your family?
   ______________________ €/year
10. How much did you spend on drugs against cold and flu symptoms in the last year for you and your family?
   ______________________ €/year
11. How much did you spend on drugs to treat sore throats in the last year for you and your family?
   ______________________ €/year
12. How much did you spend on drugs to treat asthma and respiratory problems in the last year for you and your family?
   ______________________ €/year

Indoor-Comfort Conditions in Your House

The following questions are intended to understand if and how often you were dissatisfied with the conditions of comfort in your house.

In particular, the questions focus attention on personal experiences relating to:

- external noise;
- air quality;
- temperature;

Please answer the following questions thinking about the events that occurred during the last year.

Indoor Comfort Conditions in Your House—External Noise

13. How often were you annoyed by the external noise? *(single choice)*

☐ Never *(Continue with question 16)*
☐ Rarely
☐ Sometimes
☐ Often
☐ Very often

14. What kind of noise was it? *(multiple choice allowed)*

☐ Shows or events
☐ Construction sites
☐ Other temporary noisy activities
☐ Transport infrastructures (e.g., traffic, public transport, railway, airport)
☐ Specific noise sources (e.g., bells, alarms, open-air activities)

15. What did you usually do to solve the problem? *(multiple choice allowed)*

☐ Nothing
☐ I moved to more quiet areas
☐ I wore ear protection
☐ Other: ____
(please, specify)

Indoor Comfort Conditions in Your House—Exhausted air

16. How often did you perceive exhausted air in your house? *(single choice)*

☐ Never *(Continue with question 18)*
☐ Rarely
☐ Sometimes
☐ Often
☐ Very often

17. What did you usually do to solve the problem? *(multiple choice allowed)*

☐ Nothing
☐ I opened the windows
☐ Other: ____
(please, specify)

Indoor Comfort Conditions in your House—Temperature

18. How often did you perceive an uncomfortable temperature in your house? *(single choice)*

☐ Never *(Continue with question 20)*
☐ Rarely
☐ Sometimes
☐ Often
☐ Very often

19. What did you usually do to solve the problem? *(multiple choice allowed)*

☐ Nothing
☐ I modified my clothes
☐ I modified the thermostat temperature
☐ I opened the windows
☐ I modified drapes/shutters
☐ Other: ____
(please, specify)

Indoor-Comfort Conditions in your House—Irritations

20. How often did you experience eyes, nose, or throat irritations in your house? *(single choice)*

☐ Never *(Continue with question 20)*
☐ Rarely
☐ Sometimes
☐ Often
☐ Very often

Willingness to Pay—Bidding Game

Please Read the Description Below Before Responding.
There is an evidence that a good level of comfort improves the quality of sleep, stress level, productivity, and health. The factors contributing to ensure a comfortable environment depend largely on indoor environmental parameters. In particular, the main requirements to be met are:

- air quality,
- temperature,
- noise level,
- possibilities for indoor climate control.

The installation of appropriate efficiency measures allows to maintain good environmental quality values within the environment.

21. Are you the owner of the house where you live?

☐ Yes *(Continue with question 22)*
☐ No, I am a tenant *(Continue with question 29)*

22. Let us suppose that you live in an apartment of $90m^2$ in a multifamily building of the '70s located in Turin, with standard natural gas heating system, in a bad/mediocre state of conservation. Let us assume that interventions on the property allow to improve efficiency and maintain a good level of indoor comfort apartment and improve the occupants' health. Would you be willing to pay €6,500 to improve the thermal conditions in your house thanks to the external walls insulation and the windows replacement? This would result in a reduction of diseases related to colds and seasonal influences.

☐ Yes *(Continue with question 23)*
☐ No *(Continue with question 26)*

23. Would you be willing to pay €9,000 to improve the thermal conditions in your house thanks to the external walls insulation, the windows replacement, and the existing heating replacement with a more efficient? This would result in a reduction of diseases related to colds and seasonal influences.

☐ Yes *(Continue with question 24)*
☐ No *(Continue with question 25)*

24. Would you be willing to pay €10,500 to improve the thermal conditions in your house thanks to the external walls insulation, the windows replacement, and the existing heating replacement with a more efficient, and increase the indoor air quality installing a Mechanical Ventilation System? This would result in a reduction of diseases related to colds and seasonal influences, and to respiratory problems.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 36)*

25. Would you be willing to pay €7,700 to improve the thermal conditions in your house thanks to the external walls insulation, the windows replacement, and the existing heating replacement with a more efficient, and increase the indoor air quality installing a Mechanical Ventilation System? This would result in a reduction of diseases related to colds and seasonal influences, and to respiratory problems.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 36)*

26. Would you be willing to pay €6,000 to improve the thermal conditions in your house thanks to the existing heating replacement with a more efficient, and increase the indoor air quality installing a Mechanical Ventilation System? This would result in a reduction of diseases related to colds and seasonal influences, and to respiratory problems.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 27)*

27. Would you be willing to pay €3,500 to increase the indoor air quality installing a Mechanical Ventilation System? This would result in a reduction of diseases related to respiratory problems.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 28)*

28. Would you be willing to pay €2,500 to improve the thermal conditions in your house thanks to the existing heating replacement with a more efficient? This would result in a reduction of diseases related to colds and seasonal influences.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 36)*

29. Let us suppose that you live in an apartment of 90m^2 in a multifamily building of the ‘70s located in Turin, with standard natural gas heating system, in a bad/mediocre state of conservation. Let us assume that interventions on the property allow to improve efficiency and maintain a good level of indoor comfort apartment and improve the occupants’ health. Suppose you pay €600 every month as rent charge. In addition to this charge, would you be willing to pay €70 more every month to improve the thermal conditions in your house thanks to the external walls insulation and the windows replacement? This would result in a reduction of diseases related to colds and seasonal influences.

☐ Yes *(Continue with question 30)*
☐ No *(Continue with question 33)*

30. In addition to this charge, would you be willing to pay €100 more every month to improve the thermal conditions in your house thanks to the external walls insulation, the windows replacement, and the existing heating replacement with a more efficient? This would result in a reduction of diseases related to colds and seasonal influences.

☐ Yes *(Continue with question 31)*
☐ No *(Continue with question 32)*

31. In addition to this charge, would you be willing to pay €110 more every month to improve the thermal conditions in your house thanks to the external walls insulation, the windows replacement, and the existing heating replacement with a more efficient, and increase the indoor air quality installing a Mechanical Ventilation System? This would result in a reduction of diseases related to colds and seasonal influences, and to respiratory problems.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 36)*

32. In addition to this charge, would you be willing to pay €80 more every month to improve the thermal conditions in your house thanks to the external walls insulation, the windows replacement, and the existing heating replacement with a more efficient, and increase the indoor air quality installing a Mechanical Ventilation System? This would result in a reduction of diseases related to colds and seasonal influences, and to respiratory problems.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 33)*

33. In addition to this charge, would you be willing to pay €60 more every month to improve the thermal conditions in your house thanks to the existing heating replacement with a more efficient, and increase the indoor air quality installing

a Mechanical Ventilation System? This would result in a reduction of diseases related to colds and seasonal influences, and to respiratory problems.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 34)*

34. In addition to this charge, would you be willing to pay €30 to increase the indoor air quality installing a Mechanical Ventilation System? This would result in a reduction of diseases related to respiratory problems.

☐ Yes *(Continue with question 36)*
☐No *(Continue with question 35)*

35. In addition to this charge, would you be willing to pay €20 to improve the thermal conditions in your house thanks to the existing heating replacement with a more efficient? This would result in a reduction of diseases related to colds and seasonal influences.

☐ Yes *(Continue with question 36)*
☐ No *(Continue with question 36)*

Personal Information

Remember that the questionnaire is anonymous and the personal information will be processed solely for this academic research.

36. How old are you?

____

37. Gender

☐ Male
☐ Female

38. Nationality: ______________________
39. City of residence: ______________________
40. Are you married?

☐ Yes
☐ No

41. Do you have children?

☐ Yes
☐ No

42. How many people compose your family?

____

43. Educational level:

☐ Primary school
☐ Secondary school
☐ High school graduate

☐ University degree
☐ Postgraduate degree

44. Job:

☐ Student
☐ Entrepreneur
☐ Self-employed worker (artisan, merchant, farmer)
☐ Freelancer
☐ Executive, supervisory manager
☐ Employee/teacher
☐ Worker/foreman
☐ Housewife
☐ Retired
☐ Other: ____
(please, specify)

45. In which range can you insert your monthly gross income?

☐ Less than €1000
☐ €1000–2000
☐ €2000–3000
☐ €3000–4000
☐ More than €4000
☐ I'd prefer not to answer

Appendix 2—The Present and the Future Annuity Formulas for Aggregating Stated WTP

The formulas reported in Eqs. (1) and (2) were applied to aggregate the WTP affirmed by owners and tenants, respectively:

$$a_0 = A_0 \frac{iq^n}{q^n - 1} \tag{1}$$

where a represents the annual value of the health benefit perceived by owners, A_0 is the average estimated WTP, i is the annual interest rate, q is the interest binomial (1 + i), n is the economic life of the EEMs.

$$a_t = \frac{R \times (12 + q^n)}{q^n} \tag{2}$$

where a_t represents the annual value of the health benefit perceived by tenants, R the average monthly rent including the estimated WTP, i the annual interest rate, q is the interest binomial (1 + i), n the common duration of rental contract.

References

Banfi, S., Farsi, M., Filippini, M., & Jakob, M. (2008). Willingness to pay for energy-saving measures in residential buildings. *Energy Economics, 30*(2), 503–516. https://doi.org/10.1016/j.eneco.2006.06.001.

Barthelmes, V. M., Becchio, C., Bottero, M. C., & Corgnati, S. P. (2016). Cost-optimal analysis for the definition of energy design strategies: The case of a "nearly-Zero Energy Building". *Valori e Valutazioni, 16,* 61–76.

Bayoumi, A. M. (2004). The measurement of contingent valuation for health economics. *PharmacoEconomics*. https://doi.org/10.2165/00019053-200422110-00001.

Becchio, C., Bottero, M., Corgnati, S. P., & Dell'Anna, F. (2017). A MCDA-based approach for evaluating alternative requalification strategies for a Net-Zero Energy District (NZED). In *Multiple Criteria Decision Making* (pp. 189–211). Berlin: Springer International Publishing.

Bisello, A., Grilli, G., Balest, J., Stellin, G., & Ciolli, M. (2017). Co-benefits of smart and sustainable energy district projects: An overview of economic assessment methodologies. *Green Energy and Technologies* (pp. 127–164). https://doi.org/10.1007/978-3-319-44899-2_9.

Bonnefoy, X. (2007). Inadequate housing and health: An overview. *International Journal of Environment and Pollution, 30*(3/4), 411. https://doi.org/10.1504/IJEP.2007.014819.

Buso, T., Dell'Anna, F., Becchio, C., Bottero, M. C., & Corgnati, S. P. (2017). Of comfort and cost: Examining indoor comfort conditions and guests' valuations in Italian hotel rooms. *Energy Research & Social Science*. https://doi.org/10.1016/j.erss.2017.01.006.

Capolongo, S., Buffoli, M., Oppio, A., Nachiero, D., & Barletta, M. G. (2013). Healthy indoor environments: How to assess health performances of construction projects. *Environmental Engineering & Management Journal (EEMJ)*. Retrieved from http://search.ebscohost.com/login.aspx?direct=true&db=8gh&AN=95589101&site=ehost-live.

Carson, R. T. (2000). Contingent valuation: A user's guide †. *Environmental Science and Technology, 34*(8), 1413–1418. https://doi.org/10.1021/es990728j.

Cummings, R. G., Brookshire, D. S., & Schulze, W. D. (1986). Valuing environmental goods: A state of the arts assessment of the contingent method. *American Journal of Agricultural Economics, 69*.

Damigos, D., Menegaki, M., & Kaliampakos, D. (2016). Monetizing the social benefits of landfill mining: Evidence from a Contingent Valuation survey in a rural area in Greece. *Waste Management, 51,* 119–129. https://doi.org/10.1016/j.wasman.2015.12.012.

Damigos, D., Tourkolias, C., & Diakoulaki, D. (2009). Households' willingness to pay for safeguarding security of natural gas supply in electricity generation. *Energy Policy, 37*(5), 2008–2017. https://doi.org/10.1016/j.enpol.2009.01.042.

Deschenes, O. (2015). Green Jobs. In *International encyclopedia of the social & behavioral sciences*. Elsevier. http://dx.doi.org/10.1016/B978-0-08-097086-8.94025-X.

Devine-Wright, P., Batel, S., Aas, O., Sovacool, B., LaBelle, M. C., & Ruud, A. (2017). A conceptual framework for understanding the social acceptance of energy infrastructure: Insights from energy storage. *Energy Policy, 107,* 27–31. https://doi.org/10.1016/j.enpol.2017.04.020.

EC. (2013). Energy roadmap 2050. http://doi.org/10.2833/10759.

European Commission. (2003). External costs: Research results on socio environmental damages due to electricity and transport, Brussels.

European Commission. (2014). *Guide to cost-benefit analysis of investment projects: Economic appraisal tool for Cohesion Policy 2014–2020. Publications Office of the European Union*. http://doi.org/10.2776/97516.

Frew, E. J., Wolstenholme, J. L., & Whynes, D. K. (2004). Comparing willingness-to-pay: Bidding game format versus open-ended and payment scale formats. *Health Policy*. https://doi.org/10.1016/j.healthpol.2003.10.003.

Galvis, B., Bergin, M., Boylan, J., Huang, Y., Bergin, M., & Russell, A. G. (2015). Air quality impacts and health-benefit valuation of a low-emission technology for rail yard locomotives in

Atlanta Georgia. *Science of the Total Environment, 533,* 156–164. https://doi.org/10.1016/j.scitotenv.2015.06.064.

Giordano, V., Gangale, F., Jrc-ie, G. F., Sánchez, M., Dg, J., Onyeji, I. … Maschio, I. (2011). *Smart grid projects in Europe : Lessons learned and current developments*. *Europe. 2011*. http://doi.org/10.2790/32946.

Giuffrida, S., Napoli, G., & Trovato, M. R. (2016, July). Industrial areas and the city. equalization and compensation in a value-oriented allocation pattern. In *International Conference on Computational Science and Its Applications* (pp. 79–94). Berlin: Springer International Publishing.

Harlan, S. L., & Ruddell, D. M. (2011). Climate change and health in cities: Impacts of heat and air pollution and potential co-benefits from mitigation and adaptation. *Current Opinion in Environmental Sustainability, 3*(3), 126–134. https://doi.org/10.1016/j.cosust.2011.01.001.

Hervás Soriano, F., & Mulatero, F. (2011). EU Research and Innovation (R&I) in renewable energies: The role of the Strategic Energy Technology Plan (SET-Plan). *Energy Policy, 39*(6), 3582–3590. https://doi.org/10.1016/j.enpol.2011.03.059.

Hou, Z., Chang, J., Yue, D., Fang, H., Meng, Q., & Zhang, Y. (2014). Determinants of willingness to pay for self-paid vaccines in China. *Vaccine, 32*(35), 4471–4477. https://doi.org/10.1016/j.vaccine.2014.06.047.

Howden-Chapman, P., Crane, J., Matheson, A., Viggers, H., Cunningham, M., Blakely, T. … Waipara, N. (2005). Retrofitting houses with insulation to reduce health inequalities: Aims and methods of a clustered, randomised community-based trial. *Social Science & Medicine (1982)*, *61*(12), 2600–10. http://doi.org/10.1016/j.socscimed.2005.04.049.

International Energy Agency. (2014). Capturing the multiple benefits of energy efficiency: Executive summary. *Capturing the Multiple Benefits of Energy Efficiency*, 18–25. http://doi.org/10.1787/9789264220720-en.

Klose, T. (1999). The contingent valuation method in health care. *Health Policy*. https://doi.org/10.1016/S0168-8510(99)00010-X.

Kondili, E., & Kaldellis, J. K. (2012). Environmental-social benefits/impacts of wind power. In *Comprehensive Renewable Energy* (Vol. 2, pp. 503–539). http://doi.org/10.1016/B978-0-08-087872-0.00219-5.

Kroes, E. P., & Sheldon, R. J. (1988). Stated preference methods, an introduction. *Journal of Transport Economics and Policy*. Retrieved from http://www.jstor.org/stable/20052832.

Lee, C.-Y., & Heo, H. (2016). Estimating willingness to pay for renewable energy in South Korea using the contingent valuation method. *Energy Policy, 94,* 150–156. https://doi.org/10.1016/j.enpol.2016.03.051.

Liddell, C., & Guiney, C. (2015). Living in a cold and damp home: Frameworks for understanding impacts on mental well-being. *Public Health, 129*(3), 191–199.

Liddell, C., & Morris, C. (2010). Fuel poverty and human health: A review of recent evidence. *Energy Policy, 38*(6), 2987–2997. https://doi.org/10.1016/j.enpol.2010.01.037.

Loomis, J. B. (2014). Strategies for overcoming hypothetical bias in stated preference surveys. *Journal of Agricultural and Resource Economics, 39*(1), 34–46. https://doi.org/10.1111/j.1467-6419.2010.00675.x.

Lombardi, P., & Cooper, I. (2016). Inter-generational justice: Time to tackle our evaluation practices?. *Valori e Valutazioni*, *17*, 19-24.

Maxim, A. (2014). Sustainability assessment of electricity generation technologies using weighted multi-criteria decision analysis. *Energy Policy, 65,* 284–297. https://doi.org/10.1016/j.enpol.2013.09.059.

NAO. (2009, February). The warm front scheme. *Office*, 1–35.

Napoli, G., Gabrielli, L., & Barbaro, S. (2017). The efficiency of the incentives for the public buildings' energy retrofit. The case of the Italian Regions of the "Objective Convergence". *Valori e Valutazioni*, *18*(18), 25–39.

Nomura, N., & Akai, M. (2004). Willingness to pay for green electricity in Japan as estimated through contingent valuation method. *Applied Energy, 78*(4), 453–463. https://doi.org/10.1016/j.apenergy.2003.10.001.

O'Brien, B., & Viramontes, J. L. (1994). Willingness to pay: A valid and reliable measure of health state preference? *Medical Decision Making, 14*(March), 289–297. https://doi.org/10.1177/0272989X9401400311.
Oerlemans, L. A. G., Chan, K. Y., & Volschenk, J. (2016). Willingness to pay for green electricity: A review of the contingent valuation literature and its sources of error. *Renewable and Sustainable Energy Reviews*. https://doi.org/10.1016/j.rser.2016.08.054.
Oreszczyn, T., Hong, S. H., Ridley, I., & Wilkinson, P. (2006). Determinants of winter indoor temperatures in low income households in England. *Energy and Buildings*. https://doi.org/10.1016/j.enbuild.2005.06.006.
Poortinga, W., Steg, L., Vlek, C., & Wiersma, G. (2003). Household preferences for energy-saving measures: A conjoint analysis. *Journal of Economic Psychology, 24*(1), 49–64. https://doi.org/10.1016/S0167-4870(02)00154-X.
Scarpa, R., & Willis, K. (2010). Willingness-to-pay for renewable energy: Primary and discretionary choice of British households' for micro-generation technologies. *Energy Economics, 32*(1), 129–136. https://doi.org/10.1016/j.eneco.2009.06.004.
Schucht, S., Colette, A., Rao, S., Holland, M., Schöpp, W., Kolp, P. … Rouïl, L. (2015). Moving towards ambitious climate policies: Monetised health benefits from improved air quality could offset mitigation costs in Europe. *Environmental Science and Policy*. http://doi.org/10.1016/j.envsci.2015.03.001.
Silveira, C., Roebeling, P., Lopes, M., Ferreira, J., Costa, S., Teixeira, J. P. … Miranda, A. I. (2016). Assessment of health benefits related to air quality improvement strategies in urban areas: An impact pathway approach. *Journal of Environmental Management*, *183*, 694–702. http://doi.org/10.1016/j.jenvman.2016.08.079.
Simkhovich, B. Z., Kleinman, M. T., & Kloner, R. A. (2008). Air pollution and cardiovascular injury: Epidemiology, Toxicology, and Mechanisms. *Journal of the American College of Cardiology, 52*(9), 719–726. https://doi.org/10.1016/j.jacc.2008.05.029.
Stigka, E. K., Paravantis, J. A., & Mihalakakou, G. K. (2014). Social acceptance of renewable energy sources: A review of contingent valuation applications. *Renewable and Sustainable Energy Reviews, 32,* 100–106. https://doi.org/10.1016/j.rser.2013.12.026.
Strantzali, E., & Aravossis, K. (2016). Decision making in renewable energy investments: A review. *Renewable and Sustainable Energy Reviews, 55,* 885–898. https://doi.org/10.1016/j.rser.2015.11.021.
Sudman, S., Mitchell, R. C., & Carson, R. T. (1989). Using surveys to value public goods: the contingent valuation method. *Contemporary Sociology*, *20*. http://doi.org/10.2307/2072944.
Tang, D., Wang, C., Nie, J., Chen, R., Niu, Q., Kan, H. … Perera, F. (2014). Health benefits of improving air quality in Taiyuan, China. *Environment International*, *73*, 235–42. http://doi.org/10.1016/j.envint.2014.07.016.
Tourkolias, C., & Mirasgedis, S. (2011). Quantification and monetization of employment benefits associated with renewable energy technologies in Greece. *Renewable and Sustainable Energy Reviews, 15*(6), 2876–2886. https://doi.org/10.1016/j.rser.2011.02.027.
Turney, D., & Fthenakis, V. (2011). Environmental impacts from the installation and operation of large-scale solar power plants. *Renewable and Sustainable Energy Reviews, 15*(6), 3261–3270. https://doi.org/10.1016/j.rser.2011.04.023.
UNFCCC. Conference of the Parties (COP). (2015). *Paris climate change conference-November 2015, COP 21. Adoption of the Paris Agreement. Proposal by the President.* (Vol. 21932). Retrieved from http://unfccc.int/resource/docs/2015/cop21/eng/l09r01.pdf.
Ürge-Vorsatz, D., Herrero, S. T., Dubash, N. K., & Lecocq, F. (2014). Measuring the Co-Benefits of climate change mitigation. *Annual Review of Environment and Resources, 39*(October), 549–582. https://doi.org/10.1146/annurev-environ-031312-125456.
Venkatachalam, L. (2004). The contingent valuation method: A review. *Environmental Impact Assessment Review*. https://doi.org/10.1016/S0195-9255(03)00138-0.
Wang, J.-J., Jing, Y.-Y., Zhang, C.-F., & Zhao, J.-H. (2009). Review on multi-criteria decision analysis aid in sustainable energy decision-making. *Renewable and Sustainable Energy Reviews, 13*(9), 2263–2278. https://doi.org/10.1016/j.rser.2009.06.021.

Whitehead, J. C., & Blomquist, G. C. (2006). The use of Contingent Valuation in Benefit-Cost Analysis. *Handbook of Contingent Valuation*, 92–115.

WHO Regional Office for Europe. (2010). WHO guidelines for indoor air quality. *Nutrition Journal, 9,* 454. https://doi.org/10.1186/2041-1480-2-S2-I1.

Zaharna, M., & Guilleminault, C. (2010). Sleep, noise and health: review. *Noise Health*, *12*(47), 64–69. http://doi.org/NoiseHealth_2010_12_47_64_63205[pii]\r10.4103/1463-1741.63205.

Zahnd, A., & Kimber, H. M. (2009). Benefits from a renewable energy village electrification system. *Renewable Energy, 34*(2), 362–368. https://doi.org/10.1016/j.renene.2008.05.011.

Property Evaluation for Residential Structures: A Predictive Approach Using View and Spatial Attributes

Amro Abdelalim and Ayman Ismail

Abstract Computational simulation programs and analytical scientific methods are usually used to evaluate properties and structures in the city. Although such programs can help gather various information and analyze it better and more accurately than with manual methods, they usually require a huge amount of historical data on sale prices and also extensive property data. This may be somewhat complicated in developing countries where the history of sales may be hard to track for various reasons. This paper is an attempt to abstract that process by investigating the relationship between property value for residential structures and both building overlook (view) and its spatial attributes as two of the primary factors affecting property value. Property value is considered as a collective lump-sum indication of residential privileges. Spatial and view attributes are two of the main privileges which will be studied. The paper uses Space Syntax as an analytical tool for comparing the influence of each of these attributes using regression analysis.

Keywords Property value · Space syntax · Integration · Choice to depth
Spatial attributes

1 Introduction

Value, as an expression, has been generally used to describe how something can be translated to be seen in a tangible way. "Value itself is a balance between the satisfaction of needs (benefits) and the use of resources (expenditures) that consequently structures space (how we design) and defines place (urbanity)" (Narvaez et al. 2012a). Property value is a very important and broad term that is used

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frequently internationally in the domain of taxes. “In many countries in the developing world, land property accounts for about 50–75% of the national wealth” (Bell 2006). The price of something mostly expresses what it involves as a good and what it can give to the consumer as seen from his/her perspective. In the residential scope, this assumption is also applied but mostly in an indirect way. A customer will value what he/she pays for in relation to his/her needs and what he/she wants. That is, generally, how it works in the market. “The price that a property commands in the marketplace effectively is a payment for the right to rent and control the sensory experiences of utility, beauty and brand” (Roulac 2007). Establishing the relationships that exist between residential property values and these physical and locational housing attributes, amenities, etc., are very important to valuers, planning authorities and policymakers. “When these relationships are established, valuers will be aided accordingly when assigning premium of values to the various housing and locational characteristics” (Owusu-Ansah 2012). Understanding the relationships between aspects of cities as whole inter-connected systems is the key to sustainability. Analyzing the relationships could be more important than analyzing the components. It is the process in which it is assured that the components—even if they are not all present—are functioning together in an integrated, productive way. “In effect, they are means-ends systems in which the means are physical and the ends functional. The most critical area of ignorance is about the relation of means to ends, that is, of the physical city to the functional city. The fact that sustainability is about ends and the controls largely about means has exposed our ignorance in this critical area” (Hillier 1996).

2 Theoretical Background

One of the methods used for property evaluation is the Hedonic Pricing Method. It has been used to assess the impact of urban quality on property price based on the analysis of real estate prices (Del Giudice 2014). Hedonic Pricing Method is very accurate in generating an equation for factors affecting a main variable. By knowing all factors affecting a variable, the equation can be generated. It requires having data of all factors affecting property that are to be used. This research studies only the influence of factors of spatial configuration and view attributes. Space Syntax as a method used for urban-layout analysis for accessibility is much simpler and more convenient for cases of cities with limited data. And while many aspects of design such as street widths, building heights or construction materials are directly measurable and visible, others seem to be less tangible. Urban layout and especially its effect on social, cultural and economic aspects of community is one such intangible asset that is difficult to visualize and measure during the planning process (Chiaradia et al. 2008). This approach uses the configuration of urban layout (as a single tool) to predict and classify the values of various properties. Such an approach is very useful in cities with limited data. The only data needed is the city’s street layout (from Google Maps and Google Earth) and the selling meter-price of apartments in different locations of the city. This paper's objective is comparing the influence of both of view and spatial attributes on properties value.

Space syntax is commonly thought of as a set of techniques for analyzing architectural and urban space and foreseeing functional outcomes (Hillier 2014). It is a way to understand the complex effects—on the horizontally distributed social body of the city—of its physical infrastructural networks for movement (Read 2005). Space syntax uses graph theory to develop an index of the properties of neighborhoods layouts. This method has been implemented in architectural design studies of floor plans and pedestrian flows (Bafna 2003; Jo 1996; Unlu et al. 2001; Yi-Luen and Gross 1997). It has also been used as a significant independent variable to explore the extent to which neighborhood design affects neighborhood crime rates (Hillier 1999; Matthews and Turnbull 2007).`It is concerned about how connections and boundaries of spaces define the way people use and behave within them, and how they relate to one another. Within the study of how space impacts on society, the built space is to be understood as relational patterns of connections and interfaces (Narvaez et al. 2012b). Space syntax is often presented as a configurational theory of architecture, that is, it specifically deals with 'the relations of parts in architecture rather than the parts themselves' (Marcus 2010). In other words, buildings alone may not have a defining value. However, a network of buildings and streets will have a resultant value that is more accurate and more defining for the functioning of an urban layout. Selling price is an indication for the privileges of any property. Analyzing the relationship between street configuration and the square-meter selling prices of residential properties is the research interest.

3 Methodology

This paper uses Space Syntax to test the hypothesis that property value of residential buildings (summarized by purchase per m^2) is strongly correlated with the spatial layout (measured in terms of integration, choice-to-depth) and (street width). The urban structure is considered as a system of streets, individual spaces that are visible from one end to the other without obstruction. Each street is considered as a segment line that creates a street network map. Hillier (1996) states that, in every urban settlement, there are three factors to consider: origin, destination, and the series of spaces that pass through one another. The average depth of a space to all other spaces within an urban system is calculated by its degree of integration and segregation. Spatial integration is the measure for estimating the potential movement in a street network. As a form of analysis, integration measures spatial accessibility using the basic element as the segment of the street between junctions (Hillier and Hanson 1984).

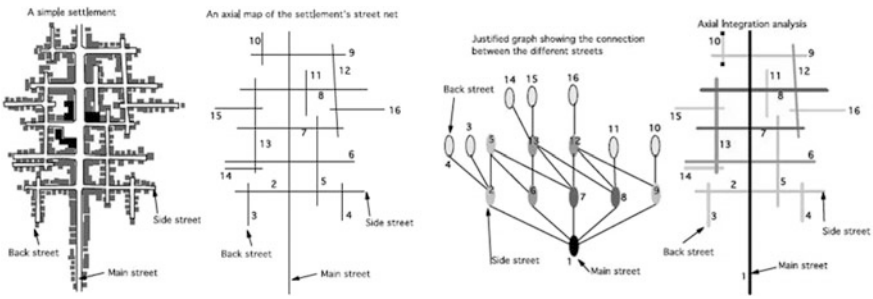


Fig. 1 Space syntax analyses of a simple settlement *Source* Van Nes A (2014)

The research applies the method of segment angular-integration analysis for the city pattern of streets. This involves breaking axial lines into segments at road intersections and measuring the angular depths within the whole physical structure of the urban network as shown in Fig. 1.

4 Case Study and Data Collection

Fayoum is a city located about 100 km south west of Cairo, Egypt. It has a semi-urbanized fabric surrounded by a ring road that passes through agricultural lands with a fairly paved network of a few main radial streets in addition to other local roads that connect various parts of the city as depicted in Fig. 2.

A sample of 55 apartments belonging to various different streets all over Fayoum, as shown in Fig. 2 was made over the month of December 2016 (to avoid any currency-exchange problem). Certain specifications have been taken into consideration for the selected apartments to neutralize other factors affecting property value (age, number of rooms, apartment floor area, apartment floor, access to basic services):

- Apartments should be constructed in new residential buildings (not before 2010).
- Apartment areas should range 150–220 m^2 and have similar compositions (Figs. 3 and 4).
- Apartments should overlook the street on which they are situated with a reasonable frontage.
- Selected apartments should have official building permits.
- None of the selected apartments should be in the ground floor or below the roof.

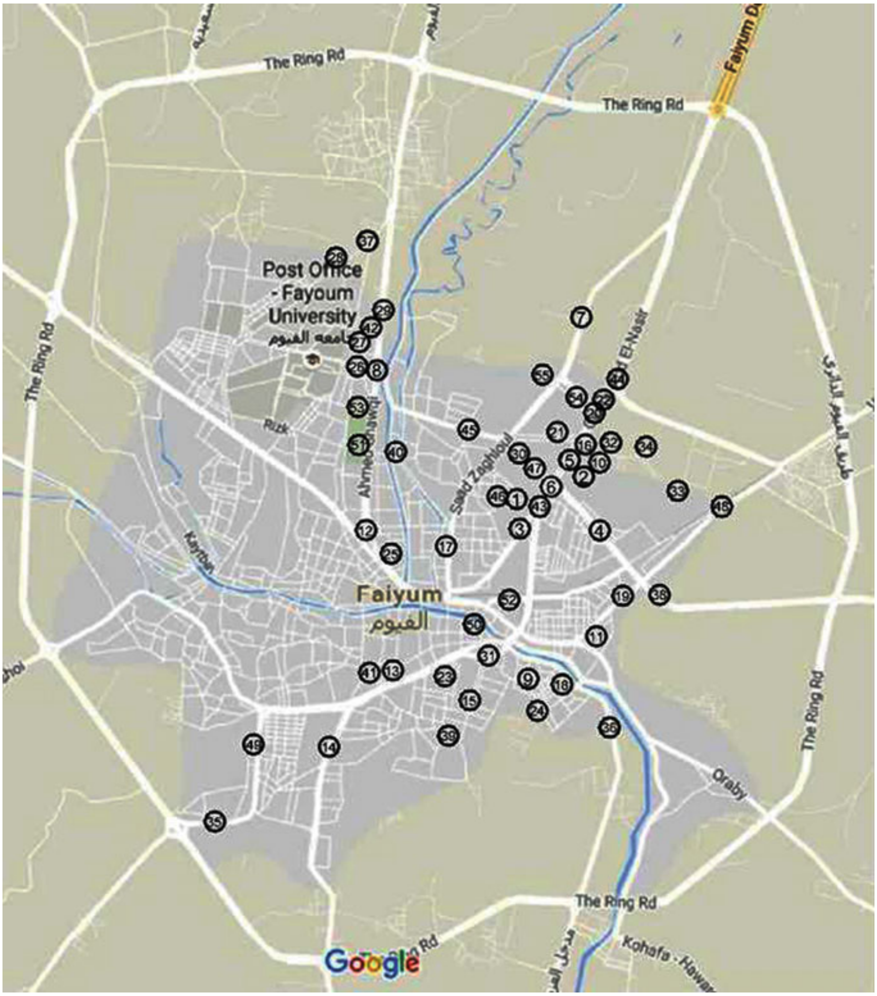


Fig. 2 Selected samples location *Source* Google maps (1/2017)

- Apartments' data collection performed through licensed engineering offices.
- Apartments should be actually sold not for sale.
- If one building had more than one apartment, the average square-meter price was used.
- All apartments are sold as semi-finished units.
- Selling date has to be before currency devaluation (before 8/2016).

Fig. 3 Integration map of Fayoum (white lines indicate routes with high integration value). Integration is a normalized measure of distance from any a space of origin to all others in a system. It calculates how close the origin space is to all other spaces (Hillier et al. 1987) *Source* Generated by DepthMap software

Integration and Choice-to-Depth values were generated with the DepthMap Application. Street width is measured from Google Earth (taking into consideration street width, pavement, and any other element to calculate the area from the front of the building to the opposite blocking-view obstacle). Meter prices were obtained from licensed realtors, property valuation offices and constructional engineers. Chosen samples attributes are gathered (as shown in Appendix 1), ranging in streets width 7–65 m, integration values of 0.83–1.43, choice-to-depth values 0.81–1.4 and square-meter prices ranging.

Fig. 4 Choice-to-depth map of Fayoum (white indicates high choice-to-depth value). Choice measures how likely an axial line or a street segment is to be passed through on all shortest routes from all spaces to all other spaces in the entire system (Hillier et al. 1987) *Source* Generated by DepthMap software

5 Results

The view from a building is measured across the area in front of the building. Locational attributes of a building are measured through accessibility and connectivity and square-meter selling prices. As shown in Figs. 5 and 6, information on integration, choice-to-depth values and square-meter selling prices obtained from the samples are charted together. Information on street width and square-meter selling price are shown in Fig. 7. Additional charts of polynomial regression are also constructed for both the integration values and street width with square-meter selling price in Figs. 5 and 7.

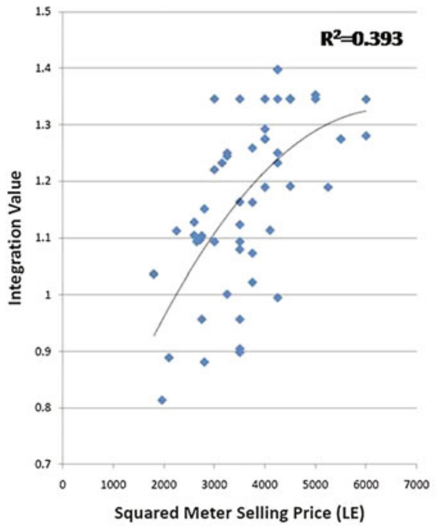
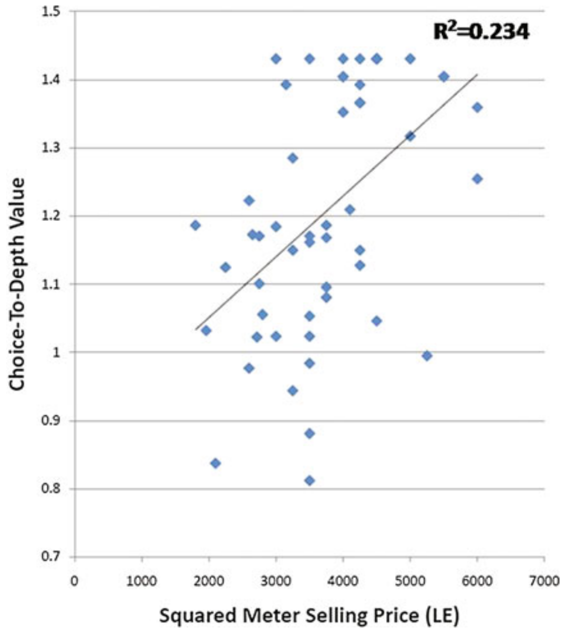


Fig. 5 Integration versus Meter selling price linear and polynomial regression charts linear correlation coefficient (r = 0.609) (r^2 = 0.371), polynomial correlation coefficient (r = 0.627) (r^2 = 0.393) *Source* Author

Fig. 6 Choice-to-depth versus meter selling price linear regression chart correlation coefficient (r = 0.484) (r^2 = 0.234) *Source* Author



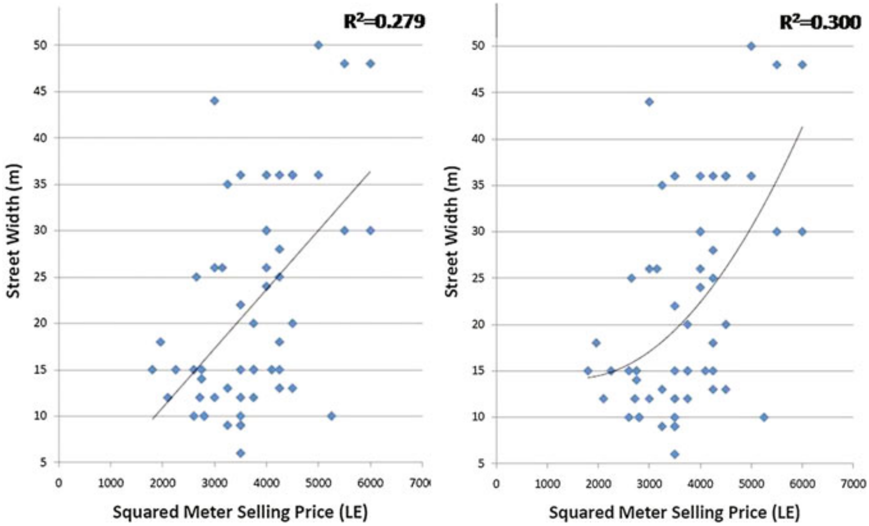


Fig. 7 Street width versus meter selling price linear & polynomial regression charts linear correlation coefficient (r = 0.528) (r^2 = 0.279), Polynomial correlation coefficient (r = 0.548) (r^2 = 0.3) *Source* Author

6 Discussion

The map generated with Depthmap shows that the obtained values for integration and choice are correlated with square-meter selling price. Correlation coefficients of street width, integration and choice-to-depth values are more than 0.5, which indicates that they have strong influence on the apartment's meter price. This indicates that, if the property value of some residential building consists of a number of variables, then the view and spatial attributes are considered to be the highest variables that affect it. Having correlation between square-meter selling price and street width lower than that of integration and choice-to-depth indicates that customers tend to pay more for apartments having accessibility and connectivity than those with view attributes. These results may also be relevant for the cultural and social aspects and needs driving for inhabitants in Fayoum city. These results also show that people tend to price properties located in the middle of the city more than those in the suburban areas. This approach can be very useful in fields of urban design and planning. It can be used to learn which streets, neighborhoods or even districts have higher value for purposes of urban expansion or demolition. It can be a very helpful tool in the tax calculation for structures using urban layout configuration only. This approach also gives accurate magnitudes of streets connectivity for traffic issues.

7 Conclusion

Analysis of spatial layout has proven to indicate many attributes that correlate well with the urban fabric of nearby streets. Spatial layout of any city will reveal the main attributes of its inhabitants' characteristics and the gradual increase and decrease in its properties due to various attributes. Attributes affecting properties values start from the cluster scale and end with district properties. As a result, each has its own weight in affecting the selling price of any property according to its magnitude of necessity and value from the point of view of the city's inhabitant. Streets, with their widths, lengths, activities and functions have been found to have a strong influence on the value of its properties. Accessibility and connectivity are two of the main factors affecting predilection of any street to be chosen for housing. Integration and street width can be indicators of property values. The relationship between integration and selling price is polynomial and an equation can be generated to calculate the selling price of properties based on integration and street-width values.

8 Application of Space Syntax

The DepthMap application was used for analysis. The following steps were done to obtain the resultant values for Integration, Connectivity and Choice-to-Depth representing Accessibility:

- After the AutoCAD Fayoum Map was drawn in lines and after extending the lines to ensure the true intersection between lines to be read by DepthMap, it was exported in .dxf file.
- After importing dxf file in DepthMap, it was converted to an Axial Map.
- Scale was checked from Line Depth to ensure that the lines correspond to reality.
- Connections less than one were checked so as to avoid any mistake in conversion from AutoCAD.
- Lines length were not permitted to be <0.1 to ensure that there are no mistakes in drawing.
- Bridge connections were considered to be unlinked (One main bridge in Fayoum called Higher Bridge connecting between Mesallah and Baghos District).
- Run Graph Analysis was performed with the following included options (Choice/Local Measure/According to Weighted Measures).
- A new column was added representing a value relating choice to total depth (as shown in Fig. 4) as follows: (Choice Normalized = (log(value("Choice") + 1))/(log(value("Total Depth") + 3))).

Appendix

See Table 1.

Table 1 Data of selected apartments in Fayoum

No.	Choice-to-depth	Integration	Street width (m)	Meter price (LE)
1	1.14983	1.25005	13	4250
2	1.02358	1.09283	12	3000
3	1.43036	1.3456	20	4500
4	1.39256	1.2324	28	4250
5	1.43036	1.3456	36	4000
6	1.43036	1.3456	36	4500
7	1.16139	1.16332	22	3500
8	1.40427	1.27462	30	4000
9	1.05298	0.904535	9	3500
10	0.919207	0.999932	9	4750
11	0.878008	1.00119	9	3250
12	1.35934	1.34504	7	6000
13	1.04591	1.19092	13	4500
14	1.35217	1.29232	26	4000
15	0.9841	1.07923	10	3500
16	1.43036	1.3456	36	3500
17	1.36589	1.39749	18	4250
18	1.12767	0.99497	65	4250
19	1.2093	1.11314	15	4100
20	1.43036	1.3456	36	4500
21	1.43036	1.3456	36	5000
22	1.43036	1.3456	36	4500
23	1.18625	1.25842	15	3750
24	0.811909	0.898197	9	3500
25	0.994943	1.18922	7	5250
26	0.880829	1.12325	30	3500
27	1.09545	1.02194	15	3750
28	1.17056	0.956747	15	3500
29	1.40427	1.27462	30	4000
30	1.18575	1.21596	25	4250
31	1.25423	1.28026	30	6000
32	1.02358	1.09283	12	3500
33	1.17265	1.09307	25	2650

(continued)

Table 1 (continued)

No.	Choice-to-depth	Integration	Street width (m)	Meter price (LE)
34	0.837257	0.888846	12	2100
35	1.18614	1.03629	15	1800
36	1.03214	0.813624	18	1960
37	1.17056	0.956747	15	2750
38	1.39256	1.2324	26	3150
39	1.05542	0.881114	10	2800
40	1.28501	1.24444	35	3250
41	0.97686	1.12736	10	2600
42	1.40427	1.27462	30	5500
43	1.43036	1.3456	36	4250
44	1.43036	1.3456	44	3000
45	1.10054	1.10328	14	2750
46	1.14983	1.25005	13	3250
47	1.18435	1.22036	26	3000
48	1.22244	1.10428	15	2600
49	1.124611	1.1121	15	2250
50	1.31704	1.35277	50	5000
51	1.40427	1.27462	48	5500
52	1.16812	1.07259	20	3750
53	1.08058	1.16242	12	3750
54	1.1669	1.18918	24	4000
55	1.07846	1.15106	10	2800

Source Author

References

Bafna, S. (2003). Space syntax: A brief introduction to its logic and analytical technique. *Environment and Behavior, 35*(1), 17–29.

Bell, K. (2006). *World bank support for land administration and management: Responding to the challenges of the millennium development goals*. Paper presented at the 23rd FIG Congress. Munich, Germany.

Chiaradia, Alain J., Schwander, C., Gil, J., & Friedrich, E. (2008). *Mapping the intangible value of urban layout (i-VALUL): Developing a tool kit for the socio-economic valuation of urban area, for designers and decision makers*. Presented at: 9th International Conference on Design & Decision Support Systems in Architecture and Urban Planning, Eindhoven, Netherlands, 2–5 July.

Del Giudice, V., Torrieri, F., & De Paola, P. (2014). Property value, urban quality and maintenance condition: A hedonic analysis in the city of Naples, Italy. *Advanced Engineering Forum* (Vol. 11, pp. 560–565). Switzerland: Trans Tech Publications.

Hillier, B., & Hanson, J. (1984). *The Social Logic of Space*. Cambridge: Cambridge University Press.

Hillier, B., Burdett, R., Peponis, J., & Penn, A. (1987), Creating life: Or, does architecture determine anything? *Architecture et Comportement/Architecture and Behavior, 3*(3), 233–250.
Hillier, B. (1996). *Space is the machine*. Cambridge: Cambridge University Press.
Hillier, B. (1999). The hidden geometry of deformed grids: Or why space syntax works when it looks as though it shouldn't. *Environment and Planning B: Planning and Design, 26,* 169–191.
Hillier, B, (2014). Space syntax as a theory as well as a method, space syntax laboratory, University College London. Retrieved fromhttp://isuf2014.fe.up.pt/Hillier.pdf
Jo, S. (1996). *A balance between pedestrian and vehicular movement in relation to street configuration* (Unpublished doctoral dissertation). Georgia Institute of Technology, Atlanta.
Marcus, L. (2010). Spatial capital: A proposal for an extension of space syntax into a more general urban morphology. *Journal of Space Syntax, 1*(1), 30–40.
Matthews, J., & Turnbull, G. (2007). Neighborhood street layout and property value: The interaction of accessibility and land use mix. *Real Estate Finance and Economics, 35*(2), 111–141.
Narvaez, L., Penn, A., & Griffiths, S. (2012a). Configurational economies: The value of accessibility in urban development, *International Transaction Journal of Engineering, Management & Applied Sciences & Technologies*, *3*(3).
Narvaez, L., Penn, A., & Griffiths, S. (2012b). Creating urban place: Re-thinking the value of residential and commercial use in urban street networks. In *Space and Flows: International Conference on Urban and Extraurban Studies*. Illinois: Common Ground Publishing.
Owusu-Ansah, A. (2012). *Examination of the determinants of housing values in urban ghana and implications for policy makers*. Paper presented at the African Real Estate Society Conference, Accra, Ghana.
Read, S. (2005). Flat city; A space syntax derived urban movement network model. In A. van Nes (Ed.), *5th international space syntax symposium proceedings* (pp. 341–357). Amsterdam: Techne Press.
Roulac, S. (2007). Brand + Beauty + Utility = Property Value. *Property Management, 25*(5), 428–446.
Unlu, A., Ozener, O., Ozden, T., & Edgu, E. (2001). An evaluation of social interactive spaces in a university building, In *3rd International Space Syntax Symposium*, Atlanta: Georgia Institute of Technology.
Van Nes, A. (2014). Integrating street vitality in excavated towns: Spatial configurative analyses applied to pompeii, *Spatial analysis and social spaces. Interdisciplinary approaches to the interpretation of prehistoric and historic built environments* (pp. 277–296). Berlin.
Yi-Luen, D., & Gross, M. (1997). *Tools for visual and spatial analysis of CAD models*. Computer Assisted Architectural Design Futures: Kluwer Academic Publishers.

Biogas and Biomethane Technologies: An AHP Model to Support the Policy Maker in Incentive Design in Italy

Donatella Banzato, Rubina Canesi and Chiara D'Alpaos

Abstract Over the past six years, biogas production in Italy has experienced an economic boom: investments of more than 4.5 billion euros and production of about 2 billion normal m^2 of natural gas equivalent. By contrast, biomethane production in Italy is not widespread. This limited spread substantially results from the lack of effective government incentives for biomethane production. In the near future, the Italian government is expected to fix new feed-in tariff (FIT) schemes for energy production from renewable energy sources (RES). In this context, it is fundamental for the policy maker to determine whether it will be preferable to introduce more generous FITs to support biogas production for electric-power generation or biomethane production through biogas upgrading. In this paper, we propose a multicriteria decision model to support the policy maker in the definition of sustainable development policies for biogas and biomethane production. Specifically we provide an Analytic Hierarchy Process (AHP) model to multicriteria prioritization of incentives paid to biogas versus biomethane. In accord with group decision-making approaches, we selected a pool of experts that structured the decision problem and disaggregated it into a hierarchy by identifying quantitative and qualitative criteria and subcriteria to evaluate each technology. The model results reveal that biomethane production plants are preferred to biogas production plants, independently of their size, whereas larger biomethane installations are ranked higher than smaller ones. Under stringent public budget constraints, it might be de facto inefficient and not cost-effective to introduce incentive mechanisms for biogas-production plants.

Keywords Biogas · Biomethane · RES support policy · Incentive design AHP

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1 Introduction

Over the last decades, increased environmental awareness and growing concern about greenhouse gas (GHG) emissions have motivated many governments to adopt incentive schemes to encourage green-energy production through renewable energy sources (RES). In order to meet the EU's long-term 2050 greenhouse gas reduction target, in 2014 EU countries agreed on a new 2030 Framework for climate and energy, which includes EU targets and policy objectives for the period of 2020–2030. These targets consist of a 40% reduction in greenhouse-gas emissions compared to 1990 levels, a minimum 27% share of renewable gross energy consumption, and at least a 27% improvement in energy efficiency.

In this respect, compared to other energy sources, biogas (and, in turn, biomethane) can play a key role because of its versatile technology to produce electricity, heat and biofuels and its potential in environmental improvements related to greenhouse-gas reduction, carbon sequestration, and fertilizer production.

Over the past six years, biogas production in Italy has experienced an economic boom: investments of more than 4.5 billion euros and production of about 2 billion normal cubic meters of natural gas equivalent (i.e., 20% of the national natural gas production) and 12,000 new job openings (CIB 2016; EBA 2016). Currently there are about 1900 plants in operation (with more than 1000 MW installed capacity), and electricity production is about 7400 GWh (CIB 2016; Energy & Strategy Group 2016; GSE 2017). Biogas production has been one of the most dynamic sectors in Italy, attracting many investors from the agro-industrial sector, that have been encouraged in their investment decisions by the generous incentive (feed-in-tariff) scheme established by the Italian government.

By contrast, biomethane production in Italy is not widespread. Regardless, biomethane technology is mature, and biomethane has a high market potential and is a well-known energy carrier in the transport sector and for stationary applications (heat and power), but, to date only seven upgrading plants are operating (CIB 2016; Energy & Strategy Group 2016; GSE 2017). This limited spread is partially due to the Italian legislation that is still vague with respect to norms and standards concerning the injection of biomethane into the natural gas system, but it substantially results from the lack of rewarding government incentives for biomethane production. Incentives are currently contingent on natural gas prices for biomethane injected in the natural gas system or are based on tradable certificates for biomethane used as a fuel (Banzato 2015, 2016).

In the near future, the Italian government is expected to setup new feed-in tariff (FIT) schemes for energy production by RES and specifically for biogas and biomethane. In this context, the policy maker is at a turning point and it becomes of paramount importance to identify the "best" technology that will receive the highest feed-in tariffs. In other words, it is fundamental to identify whether it will be preferable to introduce more generous FITs to favor biogas production for electric power generation versus biomethane production through biogas upgrading.

In this paper, we propose a multicriteria decision model to support the policy maker in the definition of sustainable development policies for biogas and biomethane production.

Specifically we implemented an Analytic Hierarchy Process (AHP) model for multiple-criteria prioritization of biogas and biomethane technologies in order to address public incentives to, and in turn favor, private investments. In accordance with group decision-making approaches, we selected a pool of experts that structured the decision problem and disaggregated it into a hierarchy by identifying quantitative and qualitative criteria and subcriteria to evaluate each technology. We then organized focus groups, with experts and stakeholders involved in the energy sector, to develop and validate the hierarchy and fill the judgments matrixes through an open group process and majority-rule ordering.

The remainder of the paper is organized as follows. In Sect. 2, RES support policies are reviewed and discussed, and driving forces for FIT schemes implementation are identified with respect to biogas and biomethane; Sect. 3 presents the hierarchical approach to support the policy maker in the design of sustainable development policies; Sect. 4 provides the decision model and discusses the results. In Sect. 5, conclusions are derived.

2 Incentive Policy for RES

In the past decade, the European Union adopted targets for the use of RES as a mean to increase energy security, reduce GHG emissions and improve competitiveness of EU Member States economies. In 2007, the European Council adopted a binding target for RES at 20% of total energy for end-user consumption by 2020. As part of the RES target, biofuels are to increase to a minimum of 10% out of the total fuel consumption of petrol and diesel for transportation by 2020.

To favor RES expansion, renewable energy policies have been implemented worldwide. Among EU Member States, the most prevailing support mechanisms are represented by FITs and quota obligations or tradable green certificates (TGCs). It is commonly agreed that well, designed FIT systems are effective policy instruments, promoting a faster shift towards distributed energies and access parity for a large number of players and, in turn, industry development (Fouquet and Johansson 2008; Couture and Gagnon 2010), whereas TGCs aim at promoting price competition among RES generators to pursue targets set by the government at the minimum cost. Starting from the early 2000s, there was a sharp debate in the literature on the successes and failures of policy effectiveness and efficiency in the support of RES. This debate aimed at investigating comparative costs and benefits of various policy options and identifying potential barriers to the development of RES, both related to the correlation between oil prices and RES deployment, and the interaction between TCGs trading and RES support schemes (Ragwitz et al. 2007; Auer et al. 2009; Klessman et al. 2011; Haas et al. 2011). The theory of incentives (Maskin et al. 1982; Laffont and Martimort 2002) distinguishes basically between direct and indirect policy instruments: the former aim to stimulate the immediate installation of RES technologies, whereas the latter focus on long-term conditions. In turn, both policy instruments can be classified into either regulatory or voluntary approaches. Furthermore, policy instruments can address price versus quantity or support investments versus power generation. Under regulatory price-driven schemes, producers receive financial support in terms of a subsidy per kW of capacity installed, or a payment (price) per kWh produced and sold. In this respect, when referring to investment-focused strategies, financial support is given by investment subsidies, loans or taxes; whereas, when generation-based strategies are implemented, financial support takes the form of a fixed regulated FIT (or sometimes a fixed premium), that is paid to eligible energy generators. As far as regulatory-driven strategies are concerned, the target on RE generation (and, in turn, its market penetration) is set by governments, and it is reached through bidding systems or TCGs (Reiche and Bechberger 2004; Rickerson and Grace 2007; Fouquet and Johansson 2008; IEA 2008; Toke 2008; Jacobsson et al. 2009; Couture et al. 2010). The EU has experience with both FITs and TGCs, but, contrary to TGCs, FITs have proved to favor rapid renewable energy expansion and their success has made FITs the world's most widespread policy (REN21 2006; Rickerson and Grace 2007).

If properly designed, support mechanisms for the expansion of RES may unquestionably contribute, on the one hand, to GHG emissions reduction and climate-change effects mitigation, and, on the other hand, to the limitation of conflicts that can arise from changing patterns of land use and its potential effects on agriculture, tourism, water production or biodiversity (Faúndez 2008).

In Italy, RES expansion was driven by generous FITs schemes that started in 2003 with the so-called "Primo Conto Energia" that introduced the first FITs system for photovoltaic-energy production at a fixed price over a 20-year period (see Dlgs 387/2003). The RES expansion was so rapid that in 2014 Italy exceeded the 2020 target for RES, i.e., 17% of total energy consumption from renewable sources. Although the minimum share of consumption covered by RES has largely been achieved in the electricity and in the thermal sector, Italy is far behind in reaching the 2020 target for renewable fuels (including biofuels), i.e., at least 10% of transport fuels deriving from RES (Ministero dello Sviluppo Economico 2013). In 2014, the biofuel quota was equal to 4.5%, lower by 0.5% than the target set for 2015 (i.e., 5%) and lower by 5.5% than the target set for 2020 (i.e., 10%).

In this context, compared to other energy sources, biogas and biomethane can play a key role in Europe and obviously in Italy, due to a versatile technology that enables production of electricity, heat and biofuels. Anaerobic digestion of energy crops, residues and wastes is of increasing interest among RES because it can be promising in accelerating accomplishment of EU 2020 (and 2030) targets. According to the latest data, 17,376 biogas and 459 biomethane plants were operating in Europe as of late 2015 (EBA 2016; Energy & Strategy Group 2016; REN21 2016). The number of biogas plants in Europe increased by 3% in 2015.

Some EU countries achieved significant increases, such as the UK that registered 17% growth, Belgium 11% growth and the Netherlands 6% growth. National associations and third-party observers quantified the total amount of electricity produced from biogas at 60.6 TWh, corresponding to the annual consumption of 13.9 million European households (EBA 2016; REN21 2016). Although the share of biomethane in the RES market is still small, in 2015 there were 92 new biogas-upgrading units installed in Europe (+25%). Few countries achieved significant growth, such as the UK (43 new plants), France (12 new plants), Switzerland (11 new plants), Germany (7 new plants) and Denmark (6 new plants). Germany remains the leader in the sector (EBA 2016; Energy & Strategy Group 2016), though Sweden is a pioneer in the use of biomethane for transport as 93% of total production of biomethane is used as a (bio) fuel by 50,000 vehicles (EBA 2016).

In Italy, the total amount of existing biogas plants is 1924, and they produce 20% of the national natural gas production (CIB 2016; GSE 2017). Over the past six years, biogas production in Italy has experienced an economic boom: investments of more than 4.5 billion euros, and about 12,000 new job openings (CIB 2016; GSE 2017). Regardless, biomethane technology is mature, and biomethane has a high market potential as an energy carrier in the transport sector and for heat and power applications, by August 2016, only 7 upgrading plants were operating (CIB 2016). This limited spread is partially due to the Italian legislation that is still vague, and it substantially results from the lack of proper government incentives for biomethane production.

In the very near future, the Italian government is expected to setup new FITs schemes for biogas and biomethane. The policy maker is at a turning point and needs to prioritize incentive policies designed to be effective to quickly stimulate the deployment of large amounts of renewable-energy generation and/or biofuels production at the least cost. In the past, Italian incentives paid to electric power generation through RES were among the most expensive in Europe and had a high impact on electricity bills: 20% of the amount paid (net of taxes and levies) covers FITs costs (Ministero dello Sviluppo Economico 2013). The minimization of incentive costs for each renewable energy technology is de facto a fundamental issue in policy design. FITs drive market growth by providing long-term purchase agreements that are required to be both efficient and cost-effective. In order to adapt FITs to various policy goals, the payment level can be differentiated by technology type, project size and resource quality. Nonetheless, in the presence of stringent public budget constraints, it is primarily important to determine whether it will be preferable to introduce more generous FITs to favor biogas production for electric-power generation or biomethane production through biogas upgrading.

In the following section, we propose a multicriteria decision model to support the policy maker in the definition of sustainable and cost-effective incentive policies for biogas and biomethane production.

3 The Method

National energy policies are designed to pursue multiple objectives, which include long-term targets, increased economic growth and market opportunities, sustainable job creation and the development of innovative RES technologies. Specifically, successful FIT schemes should primarily encourage rapid, sustained and widespread RES development at minimum cost.

There are various options to structure a FIT policy aimed at increasing energy security and improving emissions reductions. Decisions related to RES ought to be addressed as decision-making problems where multiple criteria, usually mutually conflicting, must be taken into account, as well as different and contradictory interest groups (Jankowski et al. 2015; Mardani et al. 2015; Wątróbski et al. 2016; Wątróbski and Sałabun 2016a, b). Furthermore, effective incentive-policy implementation involves complex relationships between technological, economic, environmental, ecological and social (and political) conditions and factors. In this respect, multiple-criteria analyses appear to be the most appropriate tool to structure the decision problem, identify all the different perspectives involved and support the decision maker in the evaluation and selection of current RES-support policies (Cavallaro and Ciraolo 2005; Georgiu et al. 2015; Guerrero-Liquet et al. 2016). Multiple-criteria decision making has proven over the years to be extremely effective in transparently incorporating multiple considerations into a decision-making framework and coping with trade-offs and priorities among evaluation criteria (Belton and Stewart 2002; Bana e Costa and Vansnick 2008; D'Alpaos and Canesi 2014; Canesi et al. 2016a, b).

In order to support the policy maker in the design of FITs, we implement an AHP-relative model for multiple-criteria prioritization of the incentives paid to biogas versus biomethane production plants.

The AHP proposed by Saaty in the 1980s (Saaty 1980) is a well-established technique, which has been applied to systematize a wide range of decision problems in various contexts, and it has also proven to be useful when there is little quantitative information on the effects of the actions to be evaluated (De Felice and Petrillo 2013; Ferreira et al. 2014). The AHP allows for measurement of tangible and/or intangible criteria and factors and assumes that the decision maker is always able to express a preference and judge the relative importance of (or preference for) the evaluation parameters. Through the AHP, it is possible to structure and decompose a complex decision problem into a simple hierarchy and to evaluate a large number of quantitative and qualitative factors under conflicting multiple criteria. The hierarchical structure represents the relationship between goals, criteria and alternatives involved in the decision process. The main goal of the decision problem is placed at the top of the hierarchy, whereas criteria and subcriteria that contribute to the goal are at lower levels. The bottom level is composed of the alternatives/actions to be evaluated. It is then possible to rank a finite number of alternatives/actions by evaluating them with respect to a finite number of attributes (criteria, subcriteria, etc.) whose relative importance is determined through pairwise comparisons that allow for constructing ratio scales (Saaty 2000). The pairwise comparisons expressed in semantic judgments are converted into numerical values, according to Saaty's fundamental scale (Saaty 1980), i.e., a scale of absolute numbers from one to nine. The pairwise-comparison procedure results in square matrices of preferences where the dominance coefficient a_{ij} represents the relative importance of the component on row i over the component on column j, i.e., a "judgement is made on a pair of elements with respect to the property they have in common" (Saaty and Peniwati 2012, p. 25). The weights/priorities are determined according to the eigenvalue approach to pairwise comparisons and pairwise comparisons of the elements in each level are conducted with respect to their relative importance towards their control/parent criterion (Saaty 2000; De Felice and Petrillo 2013). Once the priority vectors are determined, the consistency of the pairwise comparison matrices has to be verified by determining the inconsistency index IC, where $IC < 0.10$ is usually considered as acceptable (Saaty 1980). Finally, the global ranking of alternatives/actions is obtained via a weighted-sum, bottom-up, aggregation procedure throughout the hierarchical levels.

4 Model and Results

In order to define the hierarchy, experience and knowledge of the key factors under investigation are required. Therefore, we conducted an extensive literature review (see, among others, Nigim et al. 2004; Dinca et al. 2007; Rao et al. 2014; Scannapieco et al. 2014; Georgiou et al. 2015; Grafakos et al. 2015; Väisänen et al. 2016; Billig and Thrän 2016; Spyridaki et al. 2016; Sindhu et al. 2017), and we selected a pool of experts in an attempt to capture as much diversity of thinking as possible (Peniwati 2006; Saaty and Peniwati 2012). We involved 18 Italian experts with a consolidated expertise in the energy sector and in incentive design at the national and international levels. We involved academics and practitioners in order to capture as much diversity of thinking and preference structures as possible and to take advantage of the plurality of the group members in reaching consensus for both the hierarchy and judgments (Senge 2006). In order to ensure the greatest representation, we interviewed: six academics from the most prestigious Italian universities and research centers; one member of the board of the Italian Biogas Consortium (CIB); one member of the European Biogas Association (EBA); and eight professionals selected from—agronomists expert in sustainable agriculture and Environmental Impact Assessment; economic and financial advisors of Italian Consulting Companies; production plant technical managers; project development managers; and asset managers of energy investment funds working for national private and public-private companies. Subsequently, we organized focus groups to develop the set of criteria and subcriteria and validate the hierarchy by dynamic discussion. The panel of experts structured the decision problem and disaggregated it into sub-problems by identifying three hierarchical levels (goal, criteria and subcriteria) and five decision nodes (see Fig. 1).

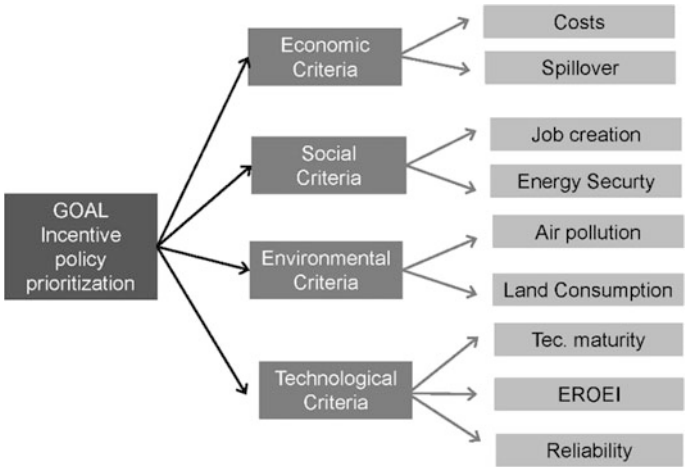

Fig. 1 AHP model–hierarchy

Table 1 Descriptions of criteria and subcriteria

Goal	Criteria	Subcriteria	Description
Incentive policy prioritization	Economic	Costs	Investment, operating and maintenance costs
		Spillover	Generation of benefits and positive externalities
	Social	Job creation	Net hiring of workers from RES deployment
		Energy security	Dependence on imported energy
	Environmental	Air pollution	CH_4 emissions
		Land consumption	Extent of land subject to (direct and indirect) exploitation
	Technological	Technology maturity	Technology readiness level and technology market share
		EROEI	Energy returned on energy invested
		Reliability	Frequency of failures and system safety

At the end of the group decision process, four criteria (Economic, Social, Environmental and Technological) and nine subcriteria (Costs, Spillover, Job Creation, Energy Security, Air Pollution, Land Consumption, Technology Maturity, EROEI, Reliability) were identified. Table 1 summarizes description of the criteria and subcriteria.

The alternatives to be evaluated were discussed and selected by the focus groups. The panel of experts identified four alternatives involving the two technologies under investigation (biogas vs. biomethane) and various installed capacities (but same feedstock): we considered two biogas production plants of installed capacity equal to 1000 and 300 kW, respectively, and 2 biomethane production plants of installed capacity equal to 1000 and 500 kW, respectively.

We then proceeded with the pairwise-comparison step, and asked each expert to compile the 14 pairwise-comparison matrices and verify them for inconsistency, by calculating ICs that were within the acceptability threshold. We aggregated individual judgments (see Table 2) by calculating the geometrical mean. The geometrical mean represents an appropriate method for the aggregation of individual judgments by synthesizing individual judgments, given in response to a single pairwise comparison, as the representative judgment for the entire group (Xu 2000; Grošelj and Zadnik Stirn 2012). In the final phase of the group decision process, we obtained the final priority vector and the prioritization of the alternatives with respect to the goal (see Table 3).

According to priority vectors displayed in Table 2, Social Criteria play a major role in the achievement of the goal because their relative importance is the greatest, as well as Environmental Criteria which are ranked as second in terms of relative importance. Although RES policy was largely motivated by environmental considerations in the 1990s, today energy security and job creation are again principal considerations for public decision makers. RES policies that prioritize incentive for biomethane production may establish attractive conditions for developers and generate employment and income in economically depressed regions. Furthermore,

Table 2 Criteria and subcriteria aggregation of experts' judgments (priority vectors)

Criteria	Priority vector	Subcriteria	Priority vector
Economic	0.198	Costs	0.25
		Spillover	0.75
Social	0.359	Job creation	0.66
		Energy security	0.33
Environmental	0.284	Air pollution	0.80
		Land Consumption	0.20
Technological	0.157	Technical maturity	0.21
		EROEI	0.55
		Reliability	0.24

Table 3 Ranking of alternatives and final priority vectors (ideals and normal)

Alternatives (kW)	Ideals	Normal
BG 1000	0.402	0.151
BG 300	0.441	0.165
BM 1000	1.000	0.375
BM 500	0.827	0.310

results show that biomethane production plants are preferred to biogas production plants, independently from their size, whereas larger-sized biomethane installations are ranked higher than smaller ones.

5 Conclusions

RES development has taken different paths in various countries, due to different support policy frameworks. Although in EU Member States the prevailing support mechanisms are represented by FITs and TGCs, much debate surrounds their effectiveness. Evaluation of RES-incentive policies is a multidimensional and complex problem that incorporates multiple, often conflicting, actors and objectives, in order to address the complexity of the decision problem. In this paper, we proposed a transparent tool to support the policy maker in the design of FITs by considering multiple-criteria policy priorities and goals. Specifically, we provided an AHP model for multiple-criteria prioritization of incentives paid to biogas versus biomethane production plants. The model results have interesting effects in terms of policy implications. According to experts' judgments, the policy maker should design incentive schemes that reward biomethane production rather than biogas and electricity production from cogeneration. Furthermore energy policies should primarily larger-sized biomethane plants rather than smaller ones. Under stringent public-budget constraints, it might be de facto inefficient and not cost-effective to introduce incentives for biogas production plants. Biomethane production has become a key issue for Italy to achieve the 2020 target on transport fuels, i.e., minimum 10% share of biofuels in transport petrol and diesel consumption by 2020.

If efficiently designed, FIT schemes can therefore represent a powerful policy tool to drive RES deployment, favor local development and contextually achieve the 2020 (and 2030) targets on energy security, emissions reductions and innovation.

References

Auer, J., Resch, G., Haas, R., Held, A., & Ragwitz, M. (2009). Regulatory instruments to deliver the full potential of renewable energy sources of efficiently. *European Review of Energy Markets, 3*(2), 91–124.

Bana e Costa, C., & Vansnick, J. (2008). A critical analysis of the eigenvalue method used to derive priorities in AHP. *European Journal of Operational Research, 187*(3), 1422–1428.

Banzato, D. (2015). The incentive system for the production of electricity and thermal energy from anaerobic digestion in Italy and Europe: A comparison. *Valori e Valutazioni, 15,* 43–53.

Banzato, D. (2016). The use of the digestate from anaerobic digestion: A comparison with the EU countries. *Valori e Valutazioni, 17,* 73–80.

Belton, V., & Stewart, T. (2002). *Multiple criteria decision analysis: An integrated approach*. Dordrecht: Kluwer Academic Publisher.
Billig, E., & Thrän, D. (2016). Evaluation of biomethane technologies in Europe—Technical concepts under the scope of a delphi-survey embedded in a multi-criteria analysis. *Energy, 114,* 1176–1186.
Canesi, R., D'Alpaos, C., & Marella, G. (2016a). Forced sale values vs. market values in Italy. *Journal of Real Estate Literature, 24*(2), 377–401.
Canesi, R., D'Alpaos, C., & Marella, G. (2016b). Foreclosed homes market in Italy: Bases of value. *International Journal for Housing Science and Its Applications, 40*(3), 201–209.
Cavallaro, F., & Ciraolo, L. (2005). A multicriteria approach to evaluate wind energy plants on an Italian island. *Energy Policy, 33*(2), 235–244.
CIB. (2016). *Piattaforma Biometano. Documento programmatico.* Accessed at April 18, 2017, from http://www.snam.it/export/sites/snam-rp/repository/media/energy-morning/allegati_energy_morning/20161110_1.pdf.
Couture, T. D., Cory, K., Kreycik, C., & Williams, E. (2010). *Policymaker's guide to feed-in tariff policy design* (No. NREL/TP-6A2-44849). Golden, CO: National Renewable Energy Laboratory (NREL).
Couture, T., & Gagnon, Y. (2010). An analysis of feed-in tariff remuneration models: Implications for renewable energy investment. *Energy Policy, 38*(2), 955–965.
D'Alpaos C., & Canesi R. (2014). MCDM approaches in property investments: An AHP model for risk assessment. In *Proceedings of the International Symposium of the Analytic Hierarchy Process (ISAHP)*, *June 29–July 2, 2014*. Washington DC, USA.
De Felice, F., & Petrillo, A. (2013). Absolute measurement with analytic hierarchy process: A case study for Italian racecourse. *International Journal of Applied Decision Sciences, 6*(3), 209–227.
Dinca, C., Badea, A., Rousseaux, P., & Apostol, T. (2007). A multi-criteria approach to evaluate the natural gas energy systems. *Energy Policy, 35*(11), 5754–5765.
EBA. (2016). *Statistical report 2016: Annual statistical report of the European biogas association*. Brussels: EBA. Accessed at: April 18, 2017, from http://www.european-biogas.eu.
Energy & Strategy Group. (2016). *Renewable energy report.* Politecnico di Milano, Milano. Accessed at: April 18, 2017, from http://www.energystrategy.it/report.html.
Faúndez, P. (2008). Renewable energy in a market-based economy: How to estimate its potential and choose the right incentives. *Renewable Energy, 33*(8), 1768–1774.
Ferreira, F. A., Santos, S. P., & Dias, V. M. (2014). An AHP-based approach to credit risk evaluation of mortgage loans. *International Journal of Strategic Property Management, 18*(1), 38–55.
Fouquet, D., & Johansson, T. B. (2008). European renewable energy policy at crossroads: Focus on electricity support mechanisms. *Energy Policy, 36*(11), 4079–4092.
Georgiou, D., Mohammed, E. S., & Rozakis, S. (2015). Multi-criteria decision making on the energy supply configuration of autonomous desalination units. *Renewable Energy, 75,* 459–467.
Grafakos, S., Flamos, A., & Enseñado, E. M. (2015). Preferences matter: A constructive approach to incorporating local stakeholders' preferences in the sustainability evaluation of energy technologies. *Sustainability, 7*(8), 10922–10960.
Grošelj, P., & Zadnik Stirn, L. (2012). Acceptable consistency of aggregated comparison matrices in analytic hierarchy process. *European Journal of Operational Research, 223*(2), 417–4201.
GSE. (2017). *Rapporto statistico, Energia e fonti rinnovabili in Italia Anno 2015*. Accessed at: April 18, 2017, from http://www.gse.it/it/Statistiche/RapportiStatistici/Pagine/default.aspx.
Guerrero-Liquet, G. C., Sánchez-Lozano, J. M., García-Cascales, M. S., Lamata, M. T., & Verdegay, J. L. (2016). Decision-making for risk management in sustainable renewable energy facilities: A case study in the Dominican Republic. *Sustainability, 8*(5), 455.

Haas, R., Resch, G., Panzer, C., Busch, S., Ragwitz, M., & Held, A. (2011). Efficiency and effectiveness of promotion systems for electricity generation from renewable energy sources—Lessons from EU countries. *Energy, 36*(4), 2186–2193.

IEA. (2008). *Deploying renewables: Principles for effective policies*. Paris: IEA Publications. ISBN 978-92-64-04220-9. Accessed at: April 18, 2017, from https://www.iea.org/publications/freepublications/publication/DeployingRenewables2008.pdf.

Jacobsson, S., Bergek, A., Finon, D., Lauber, V., Mitchell, C., Toke, D., et al. (2009). EU renewable energy support policy: Faith or facts? *Energy policy, 37*(6), 2143–2146.

Jankowski, J., Michalski, R., Bródka, P., Kazienko, P., & Utz, S. (2015). Knowledge acquisition from social platforms based on network distributions fitting. *Computers in Human Behavior, 51,* 685–693.

Klessmann, C., Held, A., Rathman, M., & Ragwitz, M. (2011). Status and perspectives of renewable energy policy and deployment in the European Union—What is needed to reach the 2020 targets? *Energy Policy, 39*(12), 7637–7657.

Laffont, J. J., & Martimort, D. (2002). *The theory of incentives: The principal-agent model*. Princeton NJ: Princeton University Press.

Mardani, A., Jusoh, A., Zavadskas, E. K., Cavallaro, F., & Khalifah, Z. (2015). Sustainable and renewable energy: An overview of the application of multiple criteria decision making techniques and approaches. *Sustainability, 7*(10), 13947–13984.

Maskin, E., Laffont, J. J., & Hildenbrand, W. (1982). The theory of incentives: An overview. In: *Advances in economic theory* (invited lectures from the 4th World Congress of the Econometric Society) (pp. 31–94). Cambridge: Cambridge University Press.

Ministero dello Sviluppo Economico. (2013). *Strategia Energetica Nazionale: per un'energia più competitiva e sostenibile.* Accessed at: April 18, 2017, from http://www.sviluppoeconomico.gov.it/images/stories/normativa/20130314_Strategia_Energetica_Nazionale.pdf.

Nigim, K., Munier, N., & Green, J. (2004). Pre-feasibility MCDM tools to aid communities in prioritizing local viable renewable energy sources. *Renewable Energy, 29*(11), 1775–1791.

Peniwati, K. (2006). Criteria for evaluating group decision-making methods. *International Series in Operations Research and Management Science, 95,* 251–273.

Ragwitz, M., Held, A., Resch, G., Faber, T., Haas, R., Huber, C., et al. (2007). *Assessment and optimisation of renewable energy support schemes in the European electricity market*. Germany: Fraunhofer IRB Verlag.

Rao, B., Mane, A., Rao, A. B., & Sardeshpande, V. (2014). Multi-criteria analysis of alternative biogas technologies. *Energy Procedia, 54,* 292–301.

Reiche, D., & Bechberger, M. (2004). Policy differences in the promotion of renewable energies in the EU member states. *Energy policy, 32*(7), 843–849.

REN21. (2006). *Renewables global status report: 2006 update*. Paris, Washington, DC: REN21 Secretariat and Worldwatch Institute. Accessed at: April 18, 2017, from http://www.ren21.net/Portals/0/documents/activities/gsr/RE2007_Global_Status_Report.pdf.

REN21. (2016). *Renewables global status report: 2016*. Paris, Washington, DC: REN21 Secretariat and Worldwatch Institute. Accessed at: April 18, 2017, from http://www.ren21.net/wp-content/uploads/2016/10/REN21_GSR2016_FullReport_en_11.pdf.

Rickerson, W., & Grace, R. C. (2007). *The debate over fixed price incentives for renewable electricity in Europe and the United States: Fallout and future directions.* A white paper prepared for the Heinrich Böll Foundation. Accessed at: April 18, 2017, from http://www.folkecenter.net/mediafiles/folkecenter/pdf/the_debate_over_fixed.pdf.

Saaty, T. (1980). *The analytic hierarchy process: Planning, priority setting, resource allocation*. New York: McGraw-Hill.

Saaty, T. L. (2000). *Fundamentals of decision making and priority theory with the analytic hierarchy process* (Vol. 6). Pittsburgh: RWS Publications.

Saaty, T. L., & Peniwati, K. (2012). *Group decision making: Drawing out and reconciling differences*. Pittsburgh: RWS Publications.

Scannapieco, D., Naddeo, V., & Belgiorno, V. (2014). Sustainable power plants: A support tool for the analysis of alternatives. *Land Use Policy, 36,* 478–484.

Senge, P. M. (2006). *The fifth discipline: The art & practice of the learning organization*. New York: Currency Doubleday.

Sindhu, S., Nehra, V., & Luthra, S. (2017). Investigation of feasibility study of solar farms deployment using hybrid AHP-TOPSIS analysis: Case study of India. *Renewable and Sustainable Energy Reviews, 73,* 496–511.

Spyridaki, N., Banaka, S., & Flamos, A. (2016). Evaluating public policy instruments in the greek building sector. *Energy Policy, 88,* 528–543.

Toke, D. (2008). The EU Renewables Directive—What is the fuss about trading? *Energy Policy, 36*(8), 3001–3008.

Väisänen, S., Mikkilä, M., Havukainen, J., Sokka, L., Luoranen, M., & Horttanainen, M. (2016). Using a multi-method approach for decision-making about a sustainable local distributed energy system: A case study from Finland. *Journal of Cleaner Production, 137,* 1330–1338.

Wątróbski, J., & Sałabun, W. (2016a). Green supplier selection framework based on multi-criteria decision-analysis approach. In R. Setchi, R. Howlett, Y. Liu, & P. Theobald (Eds.), *Sustainable design and manufacturing 2016* (pp. 361–371). Cham: Springer.

Wątróbski, J., & Sałabun, W. (2016b). The characteristic objects method: A new intelligent decision support tool for sustainable manufacturing. In R. Setchi, R. Howlett, Y. Liu, & P. Theobald (Eds.), *Sustainable design and manufacturing 2016* (pp. 349–359). Cham: Springer.

Wątróbski, J., Ziemba, P., Jankowski, J., & Zioło, M. (2016). Green energy for a green city—A multi-perspective model approach. *Sustainability, 8*(8), 702.

Xu, Z. (2000). On consistency of the weighted geometric mean complex judgement matrix in AHP. *European Journal of Operational Research, 126*(3), 683–687.

Rethinking the Construction Industry Under the Circular Economy: Principles and Case Studies

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Abstract The research on new ways to make our existing city more sustainable in economic and environmental terms has become a central theme at the national and international levels, with important implications for city management. The collective agenda is focused on retaining, refurbishing and recycling the existing elements by transforming wastes into new resources. This continuous cycle represented by the extension of the product life cycle and the enhancement of the discarded parts in the built environment is changing the economic system used for many centuries. The current linear economy model is going progressively to be converted into a more circular economy. Many sectors—like infrastructure, foods, enterprises, design etc.—are improving their efficiency by adopting a more circular pattern, but construction companies seem to be very far from this purpose. As one of the main sectors responsible of global energy consumption and waste production, the construction industry has to undergo a radical change in perspective on urban development, along with a new social, cultural, and economic interest in rebuilding the existing city in a sustainable way. The aim of this research is to highlight how to transform the construction industry through the circular economy to make urban reuse strategies more sustainable in social, economic and especially environmental terms. The paper considers not only the theoretical implications of the economic paradigm of circularity, but also case studies through which it is possible to evaluate its relevance in terms of design, production and management of such a new perspective. Through a critical analysis of the more relevant circular interventions in Europe to upcycle obsolete buildings, the research highlights the new fundamental rules for the construction industry to regenerate the existing cities. In particular, the cases studies show how the economic and environmental benefits apply to a circular

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model in the construction industry and how this system is able to generate new social and economic value in existing buildings. The second element is to show how to combine the circular economy with costs via technologies able to match circularity and environmental efficiency.

Keywords Circular economy · Construction industry · Sustainable urban regeneration · Pre-fab components · Modular construction components

1 Introduction

In recent years in Europe, since the advent of the crisis still existing in the real-estate sector, the demand for conservation of the built environment has assumed a key role in city regeneration. The reuse of the existing city has become a central issue internationally, with important implications for city management.

The European Union (European Commission 2016, 2017) promotes policies to reuse the existing city in a sustainable way, limiting the extraction of natural resources and trying to enhance and regenerate the existing ones. The new policies to organize the city support the creation of a more circular organization that starts to reuse, recycle and regenerate the built environment, in order to reproduce an ecosystem typical of nature (Fusco Girard 2015).

This is the reason why, in recent years, with the significant slowdown in the Italian construction industry and in new urban-expansion investments, there has been a remarkable change in urban development, along with a new social, cultural, and economic interest in recovering the existing city. A new demand has emerged, based on upgrading and renovating the built environment, to which experts, professionals, and construction companies must respond (Campeol et al. 2017; Coscia and Curto 2017; De Filippi et al. 2016; Power 2008; Mangialardo and Micelli 2017; Micelli and Mangialardo 2017).

The paper aims to illustrate how to conceive of urban reuse strategies through a more circular- economy approach.

As one of the leading Italian economic industries and one of those mainly responsible for the production of waste and environmental pollution, construction companies must find strategies for innovation, thus recovering from the crisis and providing simultaneously more sustainable, economic and durable interventions.

The construction industry must overturn its mode of action, drastically reducing the construction of new buildings and increasing interventions to recover the existing city, through retrofitting or demolition and reconstruction operations. In addition, the construction industry must reconfigure itself to make the upgrading of the existing buildings more sustainable in social, economic and especially environmental terms.

The paper is divided into four parts. The first one compares the differences between the linear and the circular economy in the built environment. The second one focus on the circularity principles applied in the construction industry. The third one shows the circular model in practice through some European case studies. Finally, the last part interprets the main elements that emerged in the case studies.

2 Linear Economy Versus Circular Economy: Two Different Approaches in the Built Environment

The construction industry traditionally presents a linear economic model, based on "take, make dispose of" (Ellen MacArthur Foundation 2015). This is due to its great capacity to produce and to dispose of fast-moving consumer goods. In particular, considering the built environment, the phases that characterize the linear economy start from the extraction of virgin materials; then they are processed to create new products—often the finished product can't be disassembled—the elements are assembled on site, generating wastes; once they become obsolete, they are discarded, often before the real end of their useful life (Cheshire 2017; Ellen MacArthur Foundation 2015).

Today, almost the 80% of resources at the end of their lives become waste. The negative externalities and the collective costs related to this linear approach are evident. In the future, the availability and price of commodities, resources and material will be increasingly scarce and costly. Moreover, one must also consider the considerable costs of disposing of the waste and the environmental and economic damage deriving from the high value of the materials that are squandered because they not being able to be disassembled. This traditional business model has become ever more unsustainable (Bisello et al. 2017; Andersen 2007; Arup 2016; Braungart and McDonough 2009; Cheshire 2017; Ellen MacArthur Foundation 2015).

On the contrary, the circular economy is more sustainable, because, on the basis of this model, there is the goal of improving the efficiency of the elements. Urban policies are evolving to organize a more ecological transition of the built environment. This innovative economic approach started with the recycling of high-value components in products that were consumed and thrown away once they ceased to function. This circular model has now been strongly developed in the automotive sector or high-tech technologies, which contain in their products increasingly rare and precious components, and the extraction of which is highly polluting (McDonough et al. 2013; Sauvè et al. 2016).

As in the linear economy, the circular model entails the extraction of the raw materials, and then these resources are used to manufacture new products which are consumed. The difference with the traditional business model is that wastes are transformed into another resource. They are kept in use, retaining their value and contributing to a substantial reduction in the extraction of virgin materials.

The circular economy can be summarized by "six R"[1] words, namely, *savings, reuse, recover, recycle, regeneration and renewable energy* (Fusco Girard 2015).

[1]In Italian words they are: risparmio, riuso, recupero, riciclo, rigenerazione, rinnovabili.

Restoring natural capital by the use of renewable energy, avoiding soil consumption and recovering existing resources are the keywords for redeveloping the built environment. Generating a continuous cycle by remanufacturing and refurbishing products and components in order to save and recover materials are the necessary elements to create a circular loop. Optimization at the end-of-life of buildings, such as by maintaining and reusing durable components, 'constitutes the key to guaranteeing more flexibility' (Addis and Schouten 2004; Kohler and Yang 2007).

The feasibility conditions of the circular model are linked to the economic efficiency of the processes. To achieve this purpose, competitive jump is required, only possible thanks to the new 4.0 manufacturing.

The use of intelligent and higher-performance materials and technologies such as Bim or automated maintenance systems, 3D printing or specific management systems are examples of essential new services and products to improve the quality and reduce the costs connected to the design and management of buildings and infrastructures. The circular thinking changes also the way to design and to conceive of the built environment: professionals focus on the optimization of the system performance by prolonging the lifespan of components, the design of modular systems and the off-site production of the elements to facilitate the reuse of the existing resources (Nasir et al. 2017).

3 Principles and Methods of the Circular Economy in the Construction Industry

The circular economy applied in the construction industry, according to Cheshire (2017) and inspired by the principles advocated by the Ellen MacArthur Foundation about the circular economy in the built environment (2015), can be summarized in a nested circle (see Fig. 1).

The dimension of the circles shows the hierarchy, with the three inner circle being the most desirable.

The first element is retaining a building. This intervention is the least invasive, representing the most resource-efficient/intensive option. It is followed by refitting and then refurbishing the building, requiring more demanding interventions.

After these circles, the more difficult operations involve reclaiming or remanufacturing components, with the last circle—that represents the more difficult operation—to recycle or compost buildings in order to create new products or return materials to the biosphere.

Common to these circles, there are five segments that represent the design principles to follow in each type of intervention.

The first one is the concept of *building in layers*, which differentiates the various elements that constitute a building and their different lifespans. In order to recycle and replace them, it is important that each component presents different rules that are independent of the others. In this way, layers make it possible to easily identify

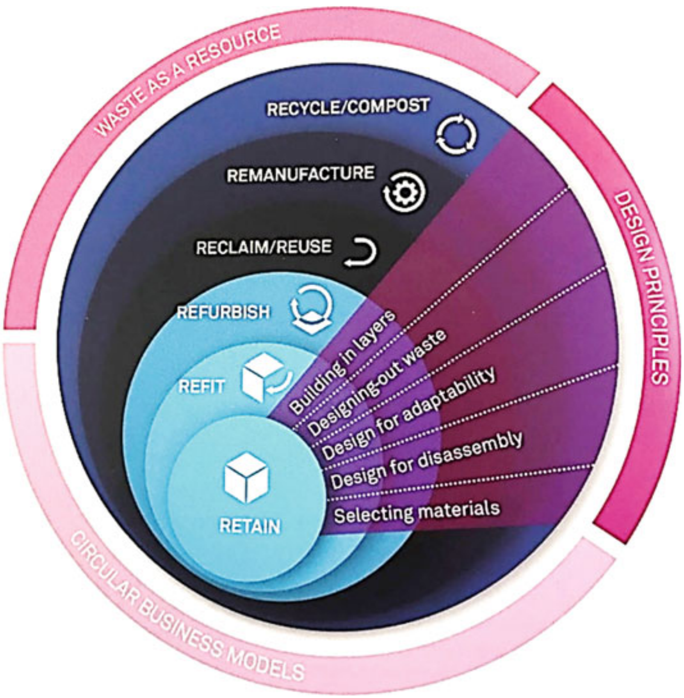

Fig. 1 Principles of circular economy applied in the construction industry. *Source* Cheshire (2017)

and replace something damaged, without changing the adjacent layers. All the layers that compose the building make it more flexible and adaptable than a building without this differentiation. It also helps to quickly reclaim the components once they are broken.

Secondly, *designing-out waste* is represented by a new concept to consider the entire lifespan of a building, starting by consideration of wastes as opportunities to be transformed into a new resource. It means that repairing elements—and all the operations linked to this like refitting and refurbishment— are preferable to interventions such as demolition and reconstruction. The use of reclaimed or remanufactured elements has to be encouraged to limit demand for raw resources. Finally, the modern construction techniques—off-site technologies—can contribute to significantly reducing on-site wastes.

The third element is *design for adaptability*. Buildings are a great resource, and they must be retained as long as possible for future generations. Design activities have to consider how the building can be easily converted to other uses and how to easily adapt the internal disposition.

The fourth principle is *design for disassembly*. Considering the great uncertainty that characterizes current society and the development of cities in the future,

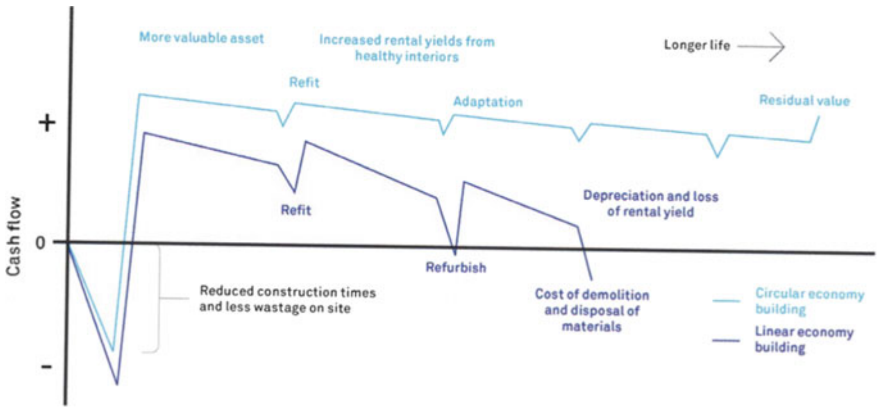

Fig. 2 Economic benefits of linear and circular-economy buildings. *Source* Cheshire (2017, p. 112)

buildings must be designed so that flexible structures are easily removable and transferable to other locations. Once a building has been abandoned, elements can be disassembled and transferred elsewhere, retaining their value for a longer time and becoming independent of the value of the original site.

Finally, to design through a circular model, it is important to select the correct *materials*. It is necessary to split the constituent elements that compose a building into biological—the eco materials—and technical—the elements that are more difficult to recycle—materials. In this way, it is easier to distinguish those who are destined for the biosphere, for an industrial loop or to be recycled. For the construction industry, this means to produce a new market for salvaged products and materials by using them for other operations. The correct selection of the materials is possible throughout a detailed inventory of the constitute elements of the building, making it easier to find new markets for these materials.

The economic benefits of the circular model applied to the construction industry are shown in the graph conceptualized by Cheshire (Fig. 2). The linear and the circular economic approach to build and to upgrade a building are compared in terms of the revenues and the costs, in a long-term view, starting from the design to the end-of-life of the building.

The costs and time associated with construction operations are almost the same in the two models. The difference starts when the building needs to be refitted, increasing the lifespan of the assets. In the linear economy, when the building becomes obsolete, it needs relevant refurbishment operations to become efficient again. Nevertheless, the building continues to lose its economic value and, consequently, decrease the percentage of the rental yield associated with the cost of the investment, until it is totally demolished. The demolition also involves the costs of remediation of the site and, in economic terms, the value of the site corresponds to the value of transformation.

In the circular model, the costs of refitting and adapting spaces are lower, and they require less time.

The approach of designing to disassemble and to adapt the building to new uses can provide a longer lifespan for the building, conferring more residual value on the asset with the potential lower the depreciation rate.

The potential of the circular economy applied in the construction industry totally changes the value chain linked to all stages of intervention in existing buildings. This approach is focused on a long-term view of the building, and it requires that the construction industry, the designers and the developers, all the professional involved in all stages of the intervention, to center their attention on the entire lifecycle of the components that compose a building, making the operations sustainable in social, environmental and economic terms, thus contributing to an increase in the residual value of the assets.

4 The Circular Approach in Three European Case Studies

Although circular experiences in the construction industry are not yet widespread, there are some cases in Europe that demonstrate the great efficiency in environmental, economic, and social terms of similar practices. In order to illustrate the main types of constructive interventions through the circular-economy principles, this section summarizes three famous cases studies in Europe. The first one is 55 Baker Street in London, which is representative of recycling operations in big abandoned buildings. The second one is the town hall in Brummen, which shows how to transform and build up an old building. Finally, the third one illustrates how to upgrade a cultural asset listed among UNESCO Cultural Heritage sites (see Table 1).

The 55 Baker Street in London[2] is a typical office building of considerable dimension built after the Second World War. Once it had fallen into disuse, the developer, London and Regional Properties Limited, planned to demolish the structure and to transform it into a new urban center. The professionals responsible for the design of the project proposed retaining the existing buildings to limit as far as possible demolition operations. According to this, in order to adapt the existing buildings to new uses, it was necessary to radically change the internal conformation, making interiors ampler than the current offices.

To create a large shopping center, engineering retained all external structures, totally demolishing the internal part, creating open floor plates for the shops. Instead of twelve concrete columns, a steel transfer structure was installed. Furthermore, the empty areas that gave the structure the typical "H- block" shape

[2]To see more detail of the project, please refer to the following website: http://www.archdaily.com/200378/55-baker-street-make-architects.

Table 1 Circular principles applied to the three case studies

Case study	Circular principles	Before the transformation	After the transformation
55 Baker Street in London	Reuse	Obsolete buildings slated for demolishing	Reuse of the existing buildings + new structures (>30% of the volume)
	Design for adaptability	Old offices	Shopping mall
	Design out waste	Demolition of obsolete parts of the buildings	Recycle of wastes
Town Hall in Brummen	New sustainable construction	The current town hall had to be expanded	A new building alongside the existing one
	Design for disassembly		The new structure is made up of modules easily to disassembly and to re-build in other places
	Building in layers		The components of the new structure are easy to replace
Historical residential building un France	Refurbish	Residential building	Offices
	Design for adaptability	The UNESCO restriction required adapting the refurbishment to the characteristics of the building	Internal insulation. The external façade wasn't damaged
	Selecting materials	There was no insulation	The materials for the thermal insulation depends on the position of the walls

Source Elaboration by the authors

were transformed in three atria to add commercial space and to better connect the buildings.

This intervention makes possible highlighting two circular elements. The first one is represented by the circular loop that was realized by the demolition of the obsolete parts of the buildings, redeploying them to the new transformation. Almost 70% of the original building was reused, and 50% of the existing fabric was retained. In addition to the benefits related to recycling the existing materials without consuming virgin resources, the operations to upgrade the area took a year less than a rebuild solution, making this intervention less expensive. The innovative technologies employed in the renovation of the buildings make the structure more sustainable: the use of bespoke chilled beams with holes enables controlling individually the internal climate of all the shops, maximizing energy efficiency and reducing energy bills and carbon emissions.

The second case study is the town hall in Brummen.[3] The municipality of Brummen needed to increase its surface, and it chose to expand the existing building instead of building a new one.

The municipality commissioned an expansion of the current structure (a historical building of the beginning of 19th century that remained intact) with a lifespan of 20 years because today whether there is a future use for a new building is uncertain.

The project was designed on the basis of circular principles. The new fabric was built with modules, 90% of which can be dismantled and transferred and the components adapted for use in other places. In this way, after the expected lifespan of the project, the value of the structure is retained, and it can be adapted reviving in other locations. This innovative constructive system is made possible by the use of pre-fab—in this case, the material is wooden—components that make construction easier and faster. The use of pre-fab structures, in fact, is characterized by an industrial process that replaces the on-site activities (Lieber and Rashid 2016).

Off-site interventions offer many advantages, for example, to undertake skilled work, the production process takes place in a closed and controlled place without being influenced by the climate and so ensuring greater accuracy and durability of materials, and waste materials are minimized, guaranteeing better quality and a performance typical of the industrial process. Considering ancient existing buildings, the new components adhere to the old ones without affecting the supporting structures. The optimization of the building components in pre-fab and modular elements involves a number of advantages that make faster and cheaper the entire supply chain of the construction industry. Finally, the components used to construct the new building were documented in detail in a file intended to be used in the future, e.g., when structure might be dismantled and transferred to other locations.

The final case study is a historical residential building in France; listed by UNESCO, it was transformed into offices.[4] The upgrade operations for this building presented great complexity due to its architectural typology and the restrictions caused by the ban on affecting the external façade.[5] Retrofitting operations only involved only interior parts, with delicate interventions guaranteeing, at the same time, meeting high energy-efficiency standards.

The most significant intervention on this building regards the thermal insulation. In order to achieve as high an impact as possible, a insulating panels made for sustainable intervention have been internally attached. Eight different eco-materials were used for the insulation; they were chosen according to the position of the wall—and its need to have more or less insulation—like sheep's wool, recycled cellular

[3]To read more about this project, please refer to the following website: https://www.brakel.com/brakel/en/reference/167_Brummen-Town-Hall.

[4]To study in detail this project, please refer to the official website of the designer involved into the project: http://www.rehafutur.fr/le-projet-2/lot1-maison-de-lingenieur/.

[5]This case study raise the current international debate on Façadism, that means the total demolition of internal parts of the building leaving only unaltered the external facade. To learn more about this topic please refer to Benhamou (2003).

glass, flax fiber etc. The totally natural elements employed were assembled in the internal walls, producing minimal environmental and health impacts. Although these materials are totally sustainable, they are also very high performance. In fact, the surface of the building is almost 400 m^2, but it consumes the annual heating of a 100 m^2 apartment.

5 Conclusions

The circular economy has becoming more and more important at the global level in many economic sectors. The construction industry, which is one of the major sectors responsible for the production of global wastes, has a great potential to ensure a more ecological and circular approach, although, compared to other sectors, it is very far removed from a circular approach.

Good regeneration practices are already achieving much in various countries around the world, and transforming these innovative practices into ordinary ones constitutes the challenge for the future (Mosannenzadeh et al. 2017).

The circular economy can change the fundamental rules of the construction industry to transform our existing city. Making a few incremental steps toward a more circular approach that considers the entire supply chain of the elements and designing for the whole life of the building to transform it to whatever forms the future demands represents a big improvement for the regeneration of cities and the environment.

Nevertheless, there are still many open issues. It is important to understand if the circular economy is able to generate new value and in which way this value is created. As demonstrated by the European experiences, the use of high-performance technologies opens new perspectives for the construction industry.

Off-site industrialization increases the energy efficiency of buildings, generating better returns in terms of economic and environmental sustainability, becoming also an enormous opportunity in the construction value chain. The construction sector is changing into an industrial area where the component systems are made with advanced technologies able to make the building energetically self-sustainable, converting the economic impact of energy savings into resource for building renovation.

Nevertheless, it is important to understand how to apply these new technologies and a circular approach to the large real-estate complexes that characterize the majority of Italian cities. The Italian housing stock, in fact, is characterized by a large number of owners, which makes the transactional costs linked to the owner composition particularly expensive. Future research might concern how to combine the circular economy with costs throughout technologies able to combine circularity and environmental efficiency.

References

Addis, W., & Schouten, J. (2004). *Design for deconstruction: Principles of design to facilitate reuse and recycling*. London: CIRIA.

Andersen, M. S. (2007). An introductory note on the environmental economics of the circular economy. *Sustainable Science, 2*(1), e133–e140.

Arup. (2016). The circular economy in the built environment. Accessed at: http://publications.arup.com/publications/c/circular_economy_in_the_built_environment.

Benhamou, F. (2003). Who owns cultural goods? The case of the built heritage. In V. Ginsburg (Ed.), *Economics of the arts and culture* (pp. 2–20). Amsterdam: Elsevier.

Bisello, A., Grilli, G., Balest, J., Stellin, G., & Ciolli, M. (2017). Co-benefits of smart and sustainable energy district projects: An overview on economic assessment methodologies. In *Green Energy and Technology*, 127–164. https://doi.org/10.1007/978-3-319-44899-2_9.

Braungart, M., & McDonough, W. (2009). *Cradle to cradle: Patterns of the planet*. London: Vintage books.

Campeol, G., Carollo, S., & Masotto, N. (2017). Development theories and infrastructural planning: The Belluno province. *Green Energy and Technology*, 299–315.

Cheshire, D. (2017). *Building revolutions—Applying the circular economy to the built environment* (1st ed.). London: Riba Publishing.

Coscia, C., & Curto, R. (2017). Valorising in the absence of public resources and weak markets: The case of "Ivrea, the 20th century industrial city". In: S. Stanghellini et al. (Eds.) *Appraisal: From theory to practice. Results of SIEV 2015* (pp. 79–99). Berlino: Springer.

de Filippi, F., Coscia, C., Boella, G., Antonini, A., Calafiore, A., Cantini, A., et al. (2016). MiraMap: A we-government tool for smart peripheries in smart cities. *IEEE Access, 4,* 3824–3843.

Ellen MacArthur Foundation, Stiftungsfonds für Umweltökonomie und Nachhaltigkeit, Deutsche Post Foundation, McKinsey Center for Business and Environment (2015). *Growth within: A circular economy vision for a competitive Europe.* New York: McKinsey & Company.

European Commission. (2016). Construction and demolition waste. Accessed at: http://ec.europa.eu/environment/waste/construction_demolition.htm.

European Commission. (2017). Circular economy strategy. Accessed at: http://ec.europa.eu/environment/circular-economy/index_en.htm.

Fusco Girard L. (2015). Nuovo umanesimo e rigenerazione urbana: quali strumenti per una crescita economica inclusiva? In L. Mazzinghi & A. Spini (Eds.), *Per una nuova visione della città*. Polistampa: Firenze.

Kohler, N., & Yang, W. (2007). Long-term management of building stocks. *Building Research and Information, 34*(3), 287–294.

Lieder, M., & Rashid, A. (2016). Towards circular economy implementation: A comprehensive review in the context of manufacturing industry. *Journal of Cleaner Production, 115,* 36–51.

Mangialardo, A., & Micelli, E. (2017). New bottom-up approaches to enhance public real estate property. In S. Stanghellini et al. (Eds.), *Appraisal: From theory to practice* (pp. 53–62). Cham: Springer International Publishing AG, Green Energy and Technology.

McDonough, W., Braungart, M., & Clinton, B. (2013). *The upcycle: Beyond sustainability*. London: Macmillan.

Micelli, E., & Mangialardo, A. (2017). Recycling the city—New perspective on the real-estate market and construction industry. *Green Energy and Technology*, 115–125.

Mosannenzadeh, F., Bisello, A., Diamantini, C., Stellin, G., & Vettorato, D. (2017). A case-based learning methodology to predict barriers to implementation of smart and sustainable urban energy projects. *Cities*, *60*, 28–36. https://doi.org/10.1016/j.cities.2016.07.007.

Nasir, M. H. A., Genovese, A., Acquaye, A. A., Koh, S. C. L., & Yamoah, F. (2017). Comparing linear and circular supply chains: A case study from the construction industry. *International Journal of Production Economics, 183,* 443–457.

Power, A. (2008). Does demolition or refurbishment of old and inefficient homes help to increase our environmental, social and economic viability? *Energy Policy, 36,* 4487–4501.

Sauvé, S., Bernard, S., & Sloan, P. (2016). Environmental sciences, sustainable development and circular economy: Alternative concepts for trans-disciplinary research. *Environmental Development, 17,* 48–56.

Public and Private Benefits in Urban Development Agreements

Alessandra Oppio and Francesca Torrieri

Abstract The paper is aimed at exploring the advantages of public authorities within the context of negotiating Public Private Partnership (PPP). During recent years, many European cities have developed complex urban interventions through innovative forms of cooperation between the public and private sector. Given the limited public funds to cover investments and the need to increase the quality and efficiency of public services, this kind of PPP enables public and private sectors to define agreements with respect to future urban development interventions. Starting from an analysis of the urban developments under PPP carried out in Lombardy region over the last 15 years, the paper provides an overview of surplus values that result from land-use changes and development with the aim of pointing out the allocation between public and private parties. Despite the difficulty of performing an ex-post evaluation of surplus values, meaning the difference between the asset values before and after transformation, mainly for the limited and incomplete economic data recorded by the agreement, some preliminary insights are drawn, and a first operational framework is suggested to evaluate the sustainability of the urban development interventions from a public perspective.

Keywords Urban Development Agreements · Value capture · Ex-post evaluation Lombardy Region

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1 Introduction

During recent years, many European cities have developed complex urban interventions through innovative forms of cooperation between the public and private sectors. Given the scarcity of public funds to cover investments and the need to improve urban quality, various kind of agreements under the notion of Public Private Partnership (PPP) have been defined in order to share resources, advantages and risks of urban development interventions. Public authorities increase land values by planning and regulatory tools, infrastructures and the provision of utilities, as well as environmental improvement, thus they are entitled to allocate the distribution of the returns from private investments generated by subsequent increases in urban rents (Bowers 1992; Curti 2006; Camagni 2008; Micelli 2011).

Many types of value-capture mechanisms exist, based on various arguments (Healey et al. 1992, 1995): impact fees, joint developments, property and land-value taxes, betterments and development agreements. The latter value-capture instrument is exemplified by agreements through which developers undertake infrastructure construction, the provision of public services and areas for public uses or financial contributions to obtain the planning/building permissions. Planning gains assume a negotiated flexibility that is defined case-by-case with a limited knowledge of the degree to which they contribute to public budgets (OECD 2017). The high flexibility is one the main advantages of development agreements, due to their light regulation, being at the same time at the root of criticisms of process management (Codecasa and Ponzini 2011).

According to regional urban-planning laws and regulations, the Italian municipalities normally base their negotiation processes with the private sector on planning fees and obligations, relying on the definition of an additional public benefit on a case-by-case approach. In particular, public benefit is meant as an extra contribution that developers give to the local authority in exchange for planning permission, without any evaluation of economic fairness and environmental and social externalities.

Given these premises, the paper explores how much local governments are able to capture from negotiations with the private sector by Urban Development Agreements. The analysis is focused on the last 15-years of experience of the Lombardy region, one of the most active Italian regions in the field of Urban Development Agreements. After the introduction, the paper is divided into three main sections: the first illustrates the methodological background for providing a rough measure of the benefits gained by public administrations through urban development agreements; the second describes the application of the abovementioned synthetic methodology to a sample of Urban Development Agreements in the Lombardy Region (Italy) and discusses the results; the last one proposes future research lines.

2 Evaluation Perspectives in Urban Development Agreements

In the context of Urban Development Agreements, two main evaluation perspectives are generally considered: (i) the economic and financial sustainability of the urban development from the private developer's point of view; (ii) the value capture incidence on the capital gain obtained by the transformation for the public authorities. The first evaluation instance mostly deals with the entrepreneurial capability of the private developer; the second is related both to the surplus values generated by urban developments and to the negotiation process between public and private parties (Stanghellini and Copiello 2011). Since 2014 in Italy, the minimum incidence of value capture has been defined by a national law as a percentage of the capital gains obtained from the urban development (DL. 133 del 12/9/2014). More precisely, it is defined as a percentage of the difference between the final value of the properties resulting from the urban development, transformation costs and expenses included, and their initial value (Micelli 2004, 2011; Camagni 2008; Alterman 2012; Morano and Manganelli 2014). This evaluation perspective seems to be the most critical one, given the difficulty for the public authorities to estimate the adequacy of the value capture with respect to the overall surplus values generated by transformation and to sustainable growth objectives when they enter into negotiation with private parties.

From the analytical point of view, the surplus value variation determined by planning choices can be expressed by the following formulas (Micelli 2004):

$$\mathrm{PrB} + \mathrm{PB} = \mathrm{LV_f} - \mathrm{LV_i} \tag{1}$$

where:

- PrB Private benefit
- PB Public benefit
- LV_f Value of the area after transformation
- LV_i Value of the area before transformation

The value of the area after transformation can be estimate on the basis of the *transformation value*, considering the following inputs:

$$\mathrm{LV_f} = \mathrm{MV} - \mathrm{Ct}/\mathrm{q}^\wedge\mathrm{n} \tag{2}$$

where:

- MV Assets' market value after transformation process
- Ct Transformation costs
- Ct CcF + PO + EC + TE + GE + P
- CcF Fees paid by private developers on construction costs
- PO Planning obligations

EC Extra contribution as additional fees, areas and/or property rights transferred to public administrations, areas preserved for public uses, on- and off-site infrastructures and payments, negotiated within the urban development agreement
TE Technical expenses
GE General expenses
P Developer's profit
q Discount coefficient
n Time required to complete the transformation process

Therefore, the additional contribution (EC) represents the Public Benefit (PB) that public authorities are entitled to seek from the private developer within the negotiation process, in addition to the obligations due by law. In the Italian urban planning practice, these extra contributions are additional fees, areas and/or property rights transferred to public administrations, areas preserved for public uses, on- and off-site infrastructure and payments. Given this theoretical framework, the next section aims at exploring the incidence of PB in a sample of urban development agreements carried out in Lombardy Region in the northern part of Italy.

3 Case Study

3.1 Urban Development Agreements in the Lombardy Region

Negotiated planning was first introduced in the Lombardy region in 1986.[1] Differently from the existing regional urban-planning law, focused on new residential and industrial interventions, the laws issued in the 1990s were addressed towards the renewal of large and disused urban brownfields. The urban planning agreements have enhanced urban transformations according to the following main features: (i) institutional cooperation between various government levels; (ii) subsidiarity; (iii) stakeholders' involvement in strategies and actions' definition; (iv) local private-public partnerships; (v) public investments' efficiency and effectiveness; (vi) functional mix; and (vii) the achievement of environmental and social objectives.

Among the large number of Urban Development Agreements carried out across the last 70 years, a sample of 15 case studies has been selected. They represent successful experiences in the sense that they have been completed. For the most part, the case studies are located in the province of Milano (Fig. 1 and Table 1), with private and functions, respectively the 88% and the 12% of the total gross floor

[1]LR. 22/86, LR. 23/1990.

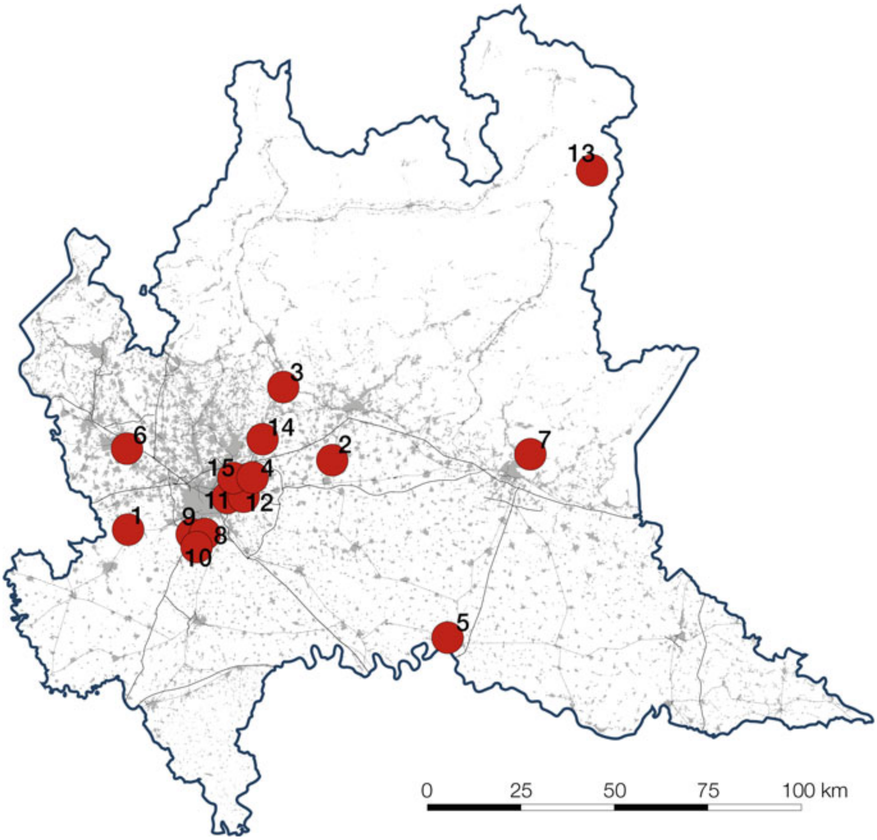

Fig. 1 The urban development agreements under evaluation: location

area. Among the private functions, the greater part is represented by residential buildings (69%), followed by retail (17%) and offices (7%).

As Fig. 2 shows, most of the cases under investigation took a long time to develop, from the subscription of the agreement by all the involved parties and the closing, when its completion is verified by the regional authority, passing through the approval step.

3.2 Ex-post Evaluation

The ex-post analysis of the case studies has been performed with the aim of evaluating the BP generated by the Urban Development Agreements under investigation. Starting from the available data, the PB has been calculated as a difference

Table 1 The urban Development agreements under evaluation: provinces and sizes

	Urban development agreement	Province size	m^2	Volume (m^3)
1	Abbiategrasso: *Area dismessa Ex Nestlè*	MI	17,527	40,000
2	Arcene: *Via Leopardi e Immobili Masciardi*	BG	95,100	53,000
3	Brivio: *Recupero area dismessa*	LC	9955	22,000
4	Cernusco sul Naviglio: *Ex area Arcofalc*	MI	32,035	54,000
5	Cremona: *Ex Feltrinelli*	CR	283,440	124,431
6	Legnano: *Ex Opificio Cantoni*	MI	128,345	180,000
7	Nave: *Comparto Nave Centro P.A. 8/1*	BS	25,436	37,600
8	Rozzano: *Quinto de Stampi Ex Cartiera*	MI	97,600	93,262
9	Rozzano: *Valleambrosia*	MI	86,204	78,762
10	Rozzano: *Rozzano vecchia*	MI	88,539	53,200
11	Segrate: *Cascina Ovi*	MI	44,290	57,222
12	Segrate: *Causa Pia*	MI	138,878	85,815
13	Temù: *Comparto 19, Lotto 71*	BG	11,493	11,176
14	Vimercate: *Via Mazzini n. 34*	MI	2090	8158
15	Vimodrone: *Comparto Nord/Ovest*	Mi	225,403	329,080

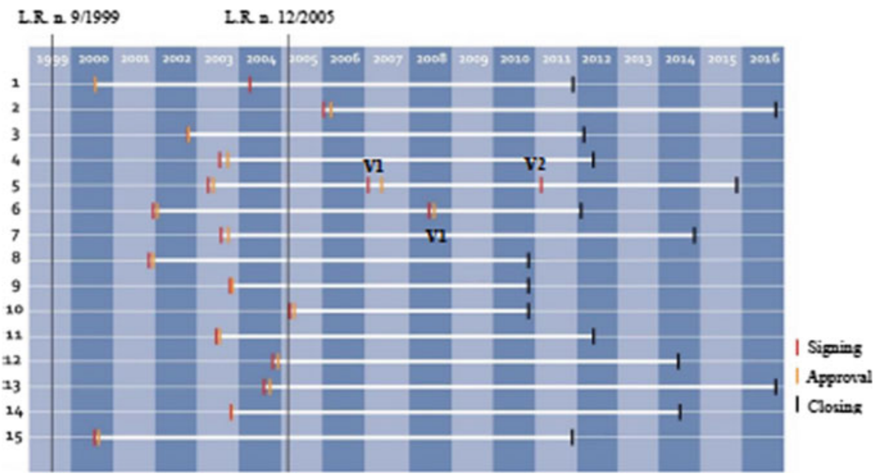

Fig. 2 The duration of the urban development agreements under investigation, with reference to the administrative procedure introduced by the regional laws L.R. 9/1999 and L.R. 12/2005

between planning fees negotiated within the urban development agreements (EC), planning obligations (PO) due by law and the resources (PC) of the public administration. Thus, the PB results from the following formula:

$$PB = EC - PO - PC \quad (3)$$

where:

Planning fees by agreement (EC) are the extra contributions negotiated within the agreement;

Planning fees by law (PO) are the obligations the private developer must pay to the municipality according to the regional law and local regulations (L.R. 12/2005 art. 44).

Resources of the public administration (PC) are resources provided by the public administration for supporting the costs of public functions.

Table 2 and Fig. 3 show the BP for each of the analyzed Urban Development Agreements.

Table 2 Public benefit for each of the analyzed Urban Development Agreements

	Urban Development Agreement	Planning fees by agreement (EC) (€)	Planning fees due by law (PO) (€)	Public resources (PC) (€)	Public benefit (PB) (€)
1	Abbiategrasso_*Area dismessa Ex Nestlè*	1,662,851.80	1,417,999.00	–	244,852.80
2	Arcene_*Via Leopardi e Immobili Masciardi*	5,865,116.25	1,065,060.00	–	4,800,056.25
3	Brivio_*Recupero area dismessa*	813,961.14	207,955.00	–	606,006.14
4	Cernusco sul Naviglio_*Ex area Arcofalc*	3,796,021.50	2,874,174.00	452,999.90	468,847.60
5	Cremona_*Ex Feltrinelli*	12,770,556.33	5,336,512.00	–	7,434,044.33
6	Legnano_*Ex Opificio Cantoni*	13,789,556.45	4,870,620.00	–	8,918,936.45
7	Nave_*Comparto Nave Centro P.A. 8/1*	3,344,052.43	598,919.00	–	2,745,133.43
8	Rozzano_*Quinto de Stampi Ex Cartiera*	4,389,733.45	2,616,731.00	454,865.84	1,318,136.61
9	Rozzano_*Valleambrosia*	7,238,041.28	4,871,268.00	–	2,366,773.28
10	Rozzano_*Rozzano vecchia*	6,526,035.02	4,548,665.00	–	1,977,370.02
11	Segrate_*Cascina Ovi*	3,554,755.61	984,715.00	–	2,570,040.61
12	Segrate_*Causa Pia*	7,447,068.27	7,414,901.00	–	32,167.27
13	Temù_*Comparto 19, Lotto 71*	187,922.07	62,780.00	154,936.98	-29,794.91
14	Vimercate_*Via Mazzini n. 34*	611,000.00	389,104.00	150,000.40	71,895.60
15	Vimodrone_*Comparto Nord/Ovest*	15,049,080.04	9,079,348.00	–	5,969,732.04

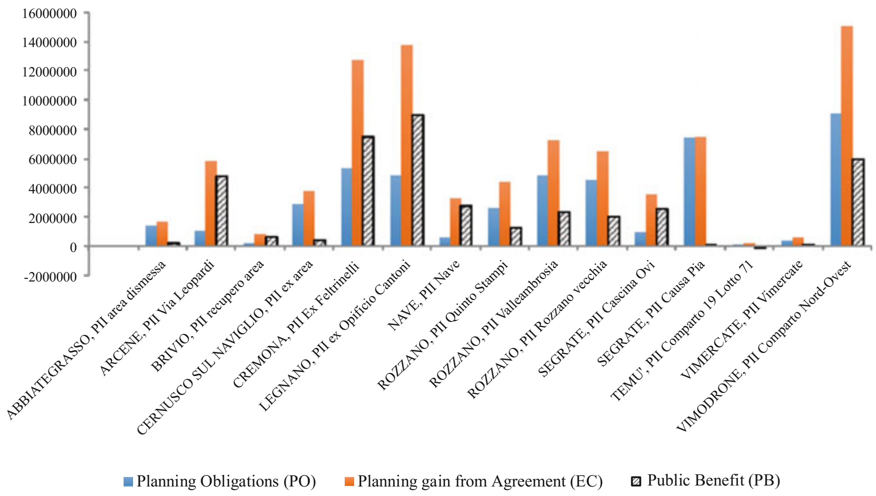

Fig. 3 Public benefit (PB), planning fees by agreement (EC) and planning fees by law (PO)

As is evident from Table 2 and Fig. 3, the difference between EC negotiated and PO due by law is generally positive, but extremely variable. In order to understand the relations between the amount of public benefit and the various peculiarities of each Urban Development Agreement, namely the size and functional mix, a linear regression analysis has been carried out. The results are reported in next section.

4 Results and Discussion

The relationships between public benefit, planning fees by law, planning fees by agreement and the various features of each case study have been explored by the use of linear regression. More in depth, the following correlations has been extracted:

(1) Between the size of the program (i.e., total volume) and planning fees defined by law (PO). As expected, planning fees by law are proportional to the size of the intervention, since they are calculated on the basis of indexes established by municipal regulations. Actually, the R^2 index, which reflects the goodness of the model estimated by the trend line, has a significant value near 0.65 (Fig. 4).
(2) Between dimension of the program and planning fees defined by the agreement (EC). In this case, the correlation is strengthened ($R^2 \approx 0.76$), suggesting that the fees' increase depends on the fairness of planning obligations as they have been defined by public authorities. Figure 4 shows that when planning fees by law are considered fair, they increase only slightly; while, when they are

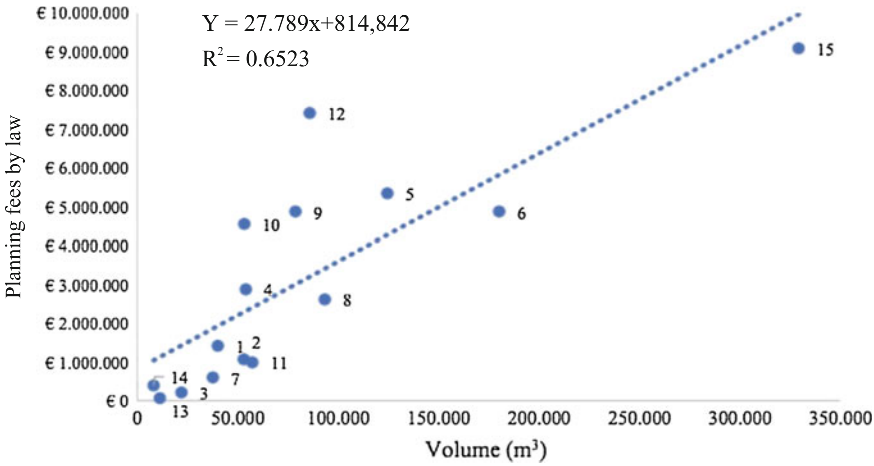

Fig. 4 Correlation between dimension of the program and planning fees by law

considered low, there is a more significant increase (Fig. 5). Therefore, the data are more concentrated around the trend line.

(3) Between public benefit (PB) and the dimension of the urban development. The correlation is less significant when public benefit is set as the dependent variable of the linear regression (Fig. 6). Data are more scattered, suggesting that a dimensional variation of the intervention does not always cause a proportional variation of the absolute PB. In this case, the R^2 is near 0.46.

(4) Between the functional mix and public benefit. The following chart (Fig. 7) points out that the public benefit is higher when private functions are

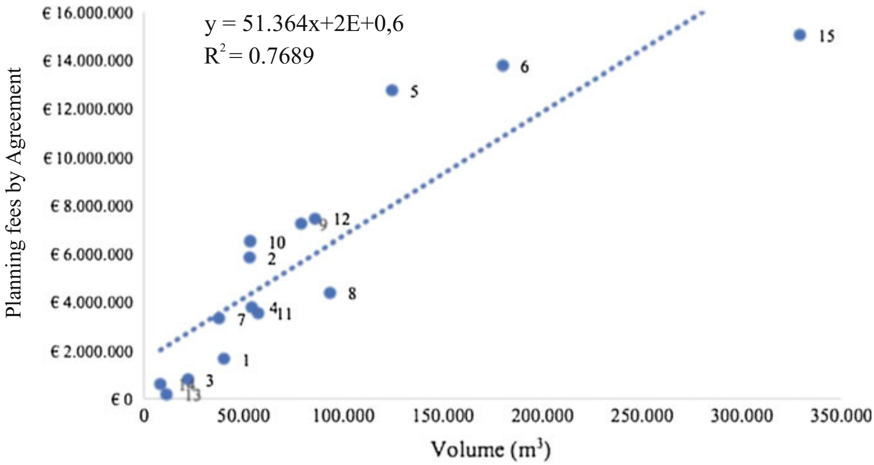

Fig. 5 Correlation between dimension of the program and planning fees by agreement

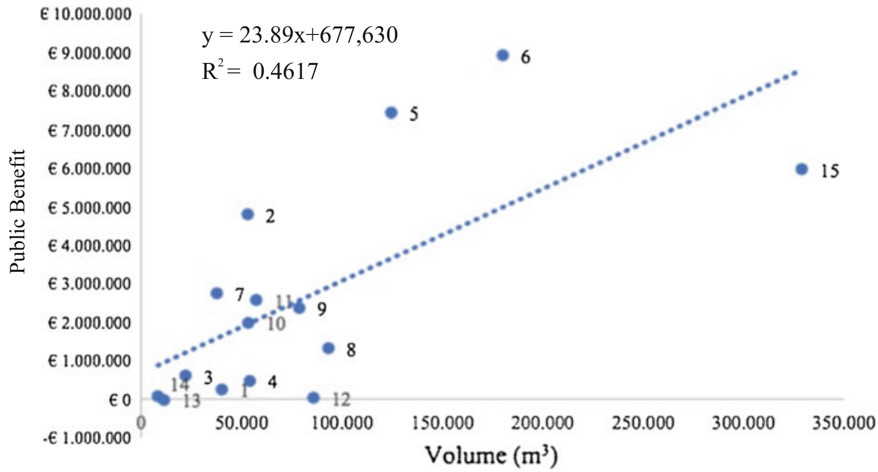

Fig. 6 Correlation between public benefit and dimension of the program

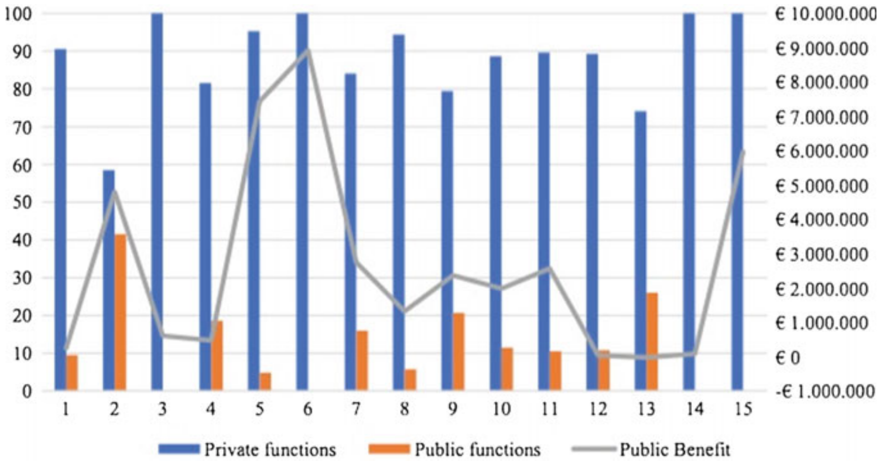

Fig. 7 Correlation between functional mix and public benefit

predominant, and this can be explained as the major expected profit for the private developer. Nevertheless, a more accurate analysis of the agreements has revealed that, generally, the expected profits for the private partners are not considered, so that the negotiation seems to be done on a case-by-case basis.

The results emerging from the analysis of public benefit with respect to the 15 selected case studies highlights a strong heterogeneity of value capture. Moreover, the review of the economic and financial reports has demonstrated that the only data available in the majority of cases are those concerning planning fees due by law.

Such lack of information does not allow any light to be shed on the fairness of the exchange, but rather suggests that the decisions are made case-by-case with respect to contingent conditions and to the negotiation process. Furthermore, the regression analysis shows the absence of a meaningful correlation between the public benefit gained and the specific characteristics of the interventions.

Finally, the asymmetric information between private developers and public parties about the expected revenue of the investment does not allow an effective evaluation of the public's advantage. To this end, it would be desirable to introduce guidelines for addressing the submission of the economic-financial feasibility reports to support the negotiation process with exhaustive information related to the private developers' costs and incomes.

5 Conclusions

Starting from the analysis of the Urban Development Agreement under PPP carried out in the Lombardy Region over the past 15 years, the paper provides an overview of the public advantages defined within the negotiations. The analysis encourages reconsideration of the outcomes of the urban developments under investigation to understand the basis of negotiations between public and private parties with respect to the final allocation of land surplus values. Despite the difficulty of performing an ex-post evaluation of the land surplus values and their allocation, mainly for the limited and incomplete information about costs, incomes and profits, some preliminary insights have been drawn. First of all, the analysis has revealed the scarce transparency of the negotiation processes, due to the lack of methodologies able to evaluate the sustainability of the proposed interventions under a public perspective. The percentages of surplus values captured by public administrations seem to be not dependent from the private developers' profit, not even from the presence of income-producing functions. Thus, there is a high degree of diversity of value capture among the municipalities, regardless of how much the urban development has increased the initial values, thus excluding social and environmental costs from the analysis. Another criticality of assessing the capital gain allocation is the ambiguous identification and classification of the urbanization works, meaning both as betterment for the city and as directly essential to the intervention fulfillment. In the first case, they should be considered as a value-capture mechanism, thus increasing the public benefit, while, in the latter, as a part of private investment.

Moreover, the epistemic and ontological uncertainty (Salling and Leleur 2006) that typically characterizes the evaluation of the expected private returns over long horizon times and according to rapid change of the market conditions, prompts us to consider the opportunity to define a decision-aiding system for supporting more flexible negotiation processes rather than deterministic ones (Oppio and Torrieri 2016). Actually, in many of the cases under analysis, the time horizon of the project is very long and many variations have been implemented according to external conditions and changes, especially due to the real-estate market crisis.

Some investments that were considered as profitable are now suffering from the lower revenues. From this perspective, a more flexible evaluation approach, supported by quantitative risk analysis, can better reflect the uncertainty related to the future developments. Finally, the time value of money should be introduced into the negotiations, since delayed payments of the public benefit by the private investor might represent a way to share the risk between the private and public sectors.

References

Alterman, R. (2012). Land use regulations and property values: The 'windfalls capture' idea revisited. In N. Brooks, K. Donanghy, & G. Knapp (Eds.), *Oxford handbook on urban economics and planning* (pp. 755–786). Oxford: Oxford University Press.

Bowers, J. (1992). The economics of planning gain: A re-appraisal. *Urban Studies, 29*(8), 1329–1339.

Camagni, R. (2008). Il finanziamento della città pubblica. In M. Baioni (Ed.), *La costruzione della città pubblica* (pp. 39–56). Firenze: Alinea.

Codecasa, G., & Ponzini, D. (2011). Public-private partnership: A delusion for urban regeneration? Evidence from Italy. *European Planning Studies, 19*(4), 647–667.

Curti, F. (2006). *Lo scambio leale*. Roma: Officina.

Healey, P., Purdue, M., & Ennis, F. (1992). Rationales for planning gain. *Policy Studies, 13*(2), 18–30.

Healey, P., Ennis, F., & Purdue, M. (1995). *Negotiating development*. London: Spon Press.

Micelli, E. (2004). *Perequazione urbanistica. Pubblico e privato per la trasformazione della città*. Venezia: Marsilio.

Micelli, E. (2011). *La gestione dei piani urbanistici. Perequazione, accordi, incentivi*. Venezia: Marsilio.

Morano, P., & Manganelli, B. (2014). La stima delle aree fabbricabili a fini imu. Proposte per il superamento delle inadeguatezze nelle procedure messe a punto dai Comuni. *Valori e Valutazioni, 12,* 119–138.

OECD. (2017). *The governance of land use in OECD countries policy analysis and recommendations*.

Oppio, A., & Torrieri, F. (2016). Supporting private public partnership for economic and financial feasibility. *Social and Behavioural Science, 223,* 62–68.

Salling, K. B., & Leleur, S. (2006). Assessment of transport appraisal by the use of Monte Carlo simulation: The CBA-DK model. In *Proceedings of WSC' 06*, Monterey, CA.

Stanghellini, S., & Copiello, S. (2011). Urban models in Italy: Partnership forms, territorial contexts, tools, and results. In R. Dalla Longa (Ed.), *Urban models and public-private partnership*. Berlin: Springer.

What Interpretations for 'Smart Specialization Strategies' in European Urban Regions? Lessons from Boston

Bruno Monardo

Abstract This paper aims to highlight the crucial challenges faced by the regions of the European Union (EU) when applying the EU's 'Research and Innovation Strategies for Smart Specialisation' (RIS3) policy to implement its 'Cohesion Policy' and 'Europe 2020' agendas. The author maintains that policymakers, planners, entrepreneurs, local communities and the other stakeholders involved in the future of urban regions should adopt a fresh view of the current innovation strategies at the forefront of the European debate, informed in particular by lessons from US experiences. With reference to the current literature on the subject, the author argues that it is possible to draw insights from international best practice—such as the clusters present in the Boston area and the 'innovation districts' that have been growing across the US over the past few years—and assumes that some similarities exist between 'innovation clusters' and 'smart specialisation'. Following the in-depth discussion of the main disciplinary schools of thought about the key features of the RIS3 and the ways in which it resembles and diverges from cluster policy, the paper proposes a critical interpretation of what may be deemed an 'innovation strategy' at the urban level. Lessons drawn from the Boston innovation strategy may be considered significant with respect to the RIS3 path to be implemented in European Union regions and urban areas. The paper concludes that, in order to pursue a genuinely place-based and entrepreneurial innovation process, it is necessary to support grassroots projects—both business and social—rather than to prioritize only top-down, economic and 'real-estate' driven planning initiatives.

Keywords Smart specialisation strategies · Cluster policies · Innovation districts Place-based approach

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1 Introduction

Since the start of the 2000s, and in particular during the past decade, the debate in the European Union (EU) concerning the concept of 'innovation' has been to see it as a fundamental issue to cope with the persisting global economic crisis (Madelin and Ringrose 2016). In this respect, there is no doubt that the EU has been facing its largest challenge since World War II, as it strives to pursue a new season of prosperity and sustainable urban and territorial development.

The EU's ambitious Cohesion Policy was conceived to tackle a persistent research and innovation gap in EU regions. The strategy favored for pursuing the EU's '2020 Vision' is the beneficial integration of three fundamental factors: the 'Smart Specialisation' concept enhanced by the 'cluster' policy, the high technology emphasis and the 'place-based' approach (Barca 2009).

The main aim of these reflections is not to develop the comparison between EU 'smart specialisation strategies' and US 'cluster policies', but to highlight the expanding role of the 'innovation district' phenomenon as the emerging interpretation model of an implicit 'smart strategy' at the local scale. In recent years across US, a new generation of redevelopment projects has been conceived in order to represent 'excellence poles' for rethinking the physical and social, as well as economic identity of blighted, strategically-located areas or deprived neighborhoods, with the ambition of creating new thriving urban ecosystems. Since it is natural and informative for the EU to look at the American 'smart strategy' model, the key example of the Boston urban area is explored here, highlighting the significant differences that its diverse 'cultural styles' can suggest for Europe.

Indeed, the idea of studying US policies to rethink effective strategies in a European context seems particularly appropriate, since the 'Smart Specialisation' concept is embedded in the 'transatlantic productivity gap' issue (McCann and Ortega-Argilés 2015), due to the weak state of 'Old Europe' in using new technologies to support strategic economic sectors.

In Sect. 2, a brief reconstruction of the pivotal EU requirement to tackle this gap is developed, which goes back to the roots of the 'Research and Innovation Strategy for Smart Specialisation' (RIS3) policy, which was conceived of by an expert group coordinated by Dominique Foray (EC 2009) and was incorporated into the Europe 2020 agenda as part of its tripartite goals of 'smart, sustainable and inclusive growth'.

The next section discusses how RIS3 may be linked to US entrepreneurship and innovation policies, which in turn are strongly connected to the widespread application of the 'cluster theory'. This theory was re-conceived by Michael Porter in the early 1990s following the original interpretation of Alfred Marshall's 'industrial districts' of the 1920s, via a notable use of the concept with regard to the milestone of Italian industrial districts in the 1970s. Recent best practices in the US have shown how the benefits derived from such clusters have evolved, particularly in terms of economies of scale for urban agglomerations, stakeholder networks and an increase in the exchange of local knowledge.

The article then explores a significant fragment of policy and planning initiatives to implement the principles of research and innovation strategies in the Boston municipality, by analyzing two case studies related to a complex-cluster entanglement. The last part develops some preliminary findings, discussing the positive and negative issues to be highlighted from the experience of Boston, and reflecting on lessons that emerge from it with regard to the ongoing implementation of the RIS3 framework in EU regions and specific territorial and urban domains.

2 Smart Specialization: From Idea to Policy

The ‘smart specialization’ concept originally appears in the literature examining the ‘productivity gap’ between Europe and North America. A preliminary analysis reveals that the information and communications technology sector (ICT) has boosted US productivity growth more than in the EU, where support for new technologies for innovation had been scarce. The EU’s poorer performance has been explained by multiple factors, such as a lower level of R&D investment (Falk 2006), differences in industrial structure and the relatively slow pace of dissemination of new technologies across European economies (O’Mahony and Vecchi 2005).

In its ‘Europe 2020’ agenda, the EU incorporated a policy specifically aimed at tackling the productivity gap and launching a knowledge-intensive growth model (Camagni and Capello 2013): ‘Research and Innovation Strategies for Smart Specialisation’ (RIS3) (EC 2010). This is designed to promote local innovation processes in particular sectors and technological domains through a bottom-up identification of specific ‘innovation patterns’ (Capello et al. 2012).

Ultimately, ‘smart specialization’ is based on four principles. First, that economic development is driven by knowledge and innovation, and in the long run is about ‘true’ economic regeneration that is not possible to plan *ex ante*; for this reason, it refuses to use the ‘picking-the-winner’ policy. Second, ‘history matters’, meaning that various EU regions have different potentials, institutional effectiveness, industrial specialization and levels of knowledge; thus an analysis of each region’s environment is vital. Third, the perspective of economic growth embraces a bottom-up approach. Fourth, the policy is demand-driven since it is derived from local potentials and local needs.

The RIS3 policy has thus embraced a ‘place-based’ approach (Barca 2009) in order to identify the specifics that each region can utilize for successful innovation. This approach implies collaboration and sharing of information between local actors and all levels of government to enhance the ‘grassroots’ factors that create knowledge and transform it into sustainable innovation.

In this context, local policy makers, universities and private entrepreneurs are key actors for promoting knowledge and innovation as the principal features for regional growth (Capello 2014), whereas governments perform a strategic role in the production sphere, assigning greater importance to the involvement of local stakeholders and public/private coordination (Iacobucci 2014).

On one hand, these public policies are based on the concept that each region has its particular industrial and institutional history and that the local stakeholders—entrepreneurs, policy makers, and civil society—should be involved in implementing regional development (Coffano and Foray 2014). In this approach, local stakeholders play a large part in identifying the main strengths, weaknesses, potentials and bottlenecks of a region, and it is their duty to analyze technological and market opportunities, to focus on possible strategies and to articulate a reliable pattern of economic growth. The policy process must therefore be inclusive and allow a large number of stakeholders to participate, in order to identify specific needs by using available resources.

On the other hand, the process of 'entrepreneurial discovery' (Foray et al. 2011) is also being pursued; this consists of selecting and prioritizing fields and sectors where a cluster should be developed and where entrepreneurial activity unveils new domains for future specialization. In the self-discovery process (Hausmann and Rodrik 2003), both public and private sectors have to collaborate strategically, evaluating costs and opportunities and reducing the impact of necessarily imperfect information. Governments therefore have a prominent role—more important than merely the safeguarding of property rights—in avoiding corruption and guaranteeing economic stability.

3 Clusters and Smart Strategies

The 'cluster' concept has been enjoying a surge in popularity over the past two decades, largely thanks to the work of Michael Porter (1990, 1996), although early cluster theories date back to the last century (Marshall 1920). In so-called 'Marshallian' economies, a company would be able to remain small yet still capable of being highly specialized and competitive, thus challenging the dominant narrative of internal economies of scale as the main advantage of such clusters, at least as far as such small companies would have the ability to create extensive networks of direct and indirect intra-industry relationships.

Despite the potential they offer, Marshall's speculations have long struggled to find their way into mainstream economic theory. A resurgence of the idea of the industrial district only began to become pervasive decades later when scholars started taking a renewed interest in the dynamics occurring within regional agglomerations of small and medium enterprises (SMEs). Indeed, many regions in central-northern Italy, dubbed the 'Third Italy' (Bagnasco 1977), were traditionally home to a large variety of local socioeconomic systems characterized by "the active presence of both a community of people and a population of firms in one naturally and historically bounded area" (Becattini 1990: 39).

Eventually, cluster theory went through a more structured systematization in Porter's conception (Porter 1990, 1996), where clusters were defined as "geographic concentrations of interconnected companies, specialized suppliers, service producers, firms in related industries, and associated institutions (for example, universities, standard agencies, and trade associations) in particular fields that compete but also cooperate”.

Among the many qualities in Porter’s theory, three are well worth mentioning here. The first is the virtuous collision between collaboration and rivalry, which concurrently creates pressure to innovate, and to improve competitiveness in the productive system. Secondly, Porter’s general definition of cluster as the encompassing of a broader range of regional agglomeration goes beyond the traditional Marshallian industrial district. Finally, and most notably, Porter “not only promoted the idea of ‘clusters’ as an analytical concept, but also as a key policy tool” (Martin and Sunley 2003: 6) by explicitly including policy makers as key actors in fostering local economies.

Indeed, ever since Porter’s work, policy makers have exploited the notion of the ‘cluster’ as a tool for promoting regional growth and competitiveness; this has led to “a proliferation of policies that seek to nurture and support cooperative relationships among firms and with other production-related agents” (Aranguren and Wilson 2013: 7).

EU regions have long-established cluster policies within their regional systems, in order to facilitate cooperative relationships between firms and institutions, emulating the US policy framework, which is largely built upon the concept of ‘cluster’ as a specific target and a strategic tool to enhance sub-national economic systems.

These policies aim to build a territorial network—a ‘platform’ of local stakeholders, firms, institutions, public and private organizations, universities, technology transfer offices and civil society, which are encouraged to interact in formal and informal relationships in order to create, use and disseminate knowledge, enhance social trust and develop a harmonized vision for the future of the region. They operate below ‘macro-level’ polices—with the intention of improving the ecosystem for all firms through ‘setting the table’ activities (Lerner 2009)—but above ‘micro-level’ policies, tailored to the need of individual firms (Porter 2007).

In these ways, it should be obvious that cluster policies share much common ground with the underlying principles of RIS3 and thus require an overarching consideration in terms of their synergies and contradictions. Foray himself acknowledges that “vibrant innovation clusters” should be considered as a “classic outcome” or an “emergent priority” of a RIS3 strategy; however, he also warns that ‘smart specialization’ is not really the same thing as a cluster policy (Foray et al. 2011). Indeed, two main differences between the two concepts can be drawn, both in terms of target and focus (Aranguren and Wilson 2013). Cluster policies are in fact tailored to the specific needs of cluster agents and do not deal with the broader scope of gaining competitive advantages for the regional economy as a whole. Moreover, they seek to promote the competitiveness of the cluster across a broad range of areas (internationalization, quality standards, training, R&D, innovation etc.), while RIS3 strategies specifically target the allocation of regional investments to enhance innovation processes and human capital. Nevertheless, cluster policies and RIS3 may both be considered to be ‘systemic policies’ (Sugden et al. 2006), insofar as they set up new forms of governance and institutions in order to promote cooperation between a wide range of industrial and non-industrial actors within a specific sub-national economic system. Moreover, both policies are considerably place-dependent, since they have their roots in the collection of assets and capabilities that are already present in the territory, in terms of limitations as well as opportunities.

Two specific elements of the smart specialization strategies are largely shared by cluster-oriented policies: the process of entrepreneurial discovery and the engagement of stakeholders in the evaluation of RIS3 potential. These can both be interpreted as being within the first two of the six steps selected by Foray (EC 2012) for RIS3 design: "Analysis of the regional context and potential for innovation: a wide view of innovation" and "Governance: ensuring participation and ownership". While the scope and the boundaries of the public actor are rather well-stated in both policies, very little is known in terms of effective diagnostic processes of regional contexts, which should be capable of fully recognizing the role of local entrepreneurs and their grassroots organizations. Moreover, the way the market and civil society should be included in order to foster 'collaborative leadership' (EC 2012:17) is not well-specified in the RIS3 guidelines; by contrast, a long-standing tradition of successful public-private partnerships (PPPs) and territory-oriented initiatives is seen in the US cluster policy framework.

While RIS3 policies have been conceived privileging the geographic and political reach of EU regional governments, cluster policies—or in more general terms, public initiatives aimed at fostering entrepreneurship in specific contexts—have shown their multi-scalarity in the passage from theory to practice, acquiring sense and significance not only at the regional level but also at the urban scale. Across the US, it is not unusual to discover cluster policies that are often narrowly place-specific (Chatterji et al. 2014), favoring a particular local area. This is shown particularly in the experience of the 'Boston Innovation District' (Sect. 4.1). The rationale for such a geographic concentration can be ascribed to the broad objective of generating positive results in a designated area, which usually occur on a micro scale (Rauch 1993) and can be fostered by the coordination of a government entity that connects various companies. Cities provide a natural testing ground for these policies, thanks to a vast array of favorable conditions that can be found in urban areas: among them the presence of an educated and 'creative' workforce (Florida 2002), a 'local supply' of entrepreneurs (Glaeser et al. 2010), a high concentration of private venture capital (Samila and Sorenson 2011), a diversified business environment (Glaeser and Kerr 2009) and the provision of public infrastructure (Chatterji et al. 2014) are undoubtedly the most important. This is also why, for the purpose of this study, the analysis of US industrial and entrepreneurship policies is anchored to a specific urban context.

4 The Innovation District Phenomenon: Lessons from the Boston Area

The Greater Boston area is currently one of the most innovative locations in the US local-development landscape. This is thanks to its high agglomeration of educational institutions and industries, as well as its geography and infrastructure. As a result, the entire urban region is increasingly able to attract the interest of major investors and venture capitalists. The flourishing economic environment has positively impacted the economic growth of the metropolitan area, which is recording the highest rate of growth anywhere in the US (Kahn et al. 2012). Specifically, over the past thirty years, the cities of Boston and Cambridge—followed more recently by adjacent municipalities, such as Somerville and Charlestown—have implemented economic and urban policies that have turned the area into one of the most prosperous and vibrant zones in the nation. Public and private investments have therefore been made to boost sectors, such as education, financial services, life sciences and the high-tech industries, which today represent the main clusters that sustain the urban economy by creating jobs, as well as sustaining many other sectors.

The effects of these economic policies are felt in the territory via the spread of new development and renewal projects, which are changing the urban geography of the city by supporting the placement of innovation hubs within various neighborhoods. The idea of creating an innovative urban ecosystem is embodied in the 'innovation-district' concept: a "geographic area where leading-edge anchor institutions and companies cluster and connect with start-ups, business incubators, and accelerators" (Katz and Wagner 2014).

Innovation districts are conceived as dense enclaves that merge the poietic and job potential of research-oriented anchor institutions and the high-tech start-ups in well-designed, amenity-rich residential, commercial and consuming environments. Creation, circulation and commercialization of new ideas are facilitated within these thriving atmospheres that leverage the intrinsic qualities of the virtuous urban context: physical proximity, relational density and dynamic identity.

The city of Boston represents a paradigmatic case of original and compelling integration between innovation policies and city redevelopment, thanks to the ongoing implementation of an explicit strategy whose core is the alignment between urban regeneration initiatives and exploitation of the potential of innovation-related, growing ecosystems. As is concisely highlighted in the two following subsections, the strategy of spurring innovation within the city can be interpreted either for promoting economic and real estate 'excellence poles' (Seaport) or for connecting disadvantaged populations to employment and educational opportunities (Roxbury).

4.1 Boston Innovation District

In 2004, the Boston Planning Development Agency (BPDA), then known as the Boston Redevelopment Authority (BRA), launched the ‘LifeTech Boston’ policy initiative, which can be seen as a significant incubatory step towards the eventual creation of a new redevelopment model, the first Innovation District in Boston. Its original mission was to foster the growth of Boston’s life sciences and high-technology sectors by nurturing incumbent companies in the city and by attracting national and international business. It targeted three domains: biopharmaceutical, ICT and medical devices.

Its strategic goal was to attract new companies that were looking for favorable locations, by providing city services and identifying financial resources. In this activity, a network was created between trade and investment organizations, consulates, non-profits and public agencies. In particular, it worked with two stable partners: MassBio, a non-profit organization that represents and provides services and support for the life-science sector, and the Massachusetts Life Science Center (MLSC), a quasi-public agency tasked with implementing the Massachusetts State Life Sciences Act.

The most significant strand of the original strategy was later identified in the ‘Boston Innovation District’ (BID), a planning initiative launched in 2010 by the Menino administration and still in progress; the project aims to create a complex neighborhood able to attract financers, resources and talent that mimics the success of 22@Barcelona, the most significant forerunning experience of all ‘innovation district’ models (Fig. 1).

The BID project was conceived to redevelop the South Boston Waterfront, an underutilized area of 1000 acres that previously hosted industrial activities and parking, and transform it into a thriving hub of innovation and entrepreneurship together with new residential, commercial and retail spaces (about 7.7 million ft^2) with a mixed-use configuration (Fig. 2).

The BRA managed the project and provided partial funding for constructing new public spaces, building a network of private companies and using financial and planning tools within a PPP ‘architecture’ both to guarantee progressive implementation and to ease the cost burden of the project on the city’s budget.

The public initiative has been actively involved in attracting both start-ups and more established companies, such as Vertex Pharmaceutical and more recently General Electric, both of which received significant tax breaks in return for setting up their new headquarters within the BID boundaries. Unique assets are concentrated in the dense redevelopment area, such as the world’s largest start-up accelerator—‘MassChallenge’—and ‘Factory 63’, a significant experiment in innovative housing, providing private micro-apartments and public areas for working, gathering and organizing events.

The BID vision has four main features, setting out general guidelines for how developments should be approached:

Fig. 1 The BID redevelopment plan
Source www.seaportinnovationdistrict.com

Fig. 2 The Boston Innovation District. Residential, business and cultural facilities
Source www.archdaily.com, www.districthallboston.org, author’s own photos

- *Industry-Agnostic*: the initiative is open to industries of every kind; this should allow for broad inclusivity of established companies and small enterprises, providing a framework for community engagement;
- *Clusters*: the BID's motto is "Work, Live, Play", which shows that the municipality hopes to attract amenities that would encourage entrepreneurs to spend more time in the district networking and socializing. This would bring entrepreneurs together into clusters to increase their proximity and density, making it easier for creative people in such a cluster environment to share technologies and knowledge. The city needs to retain talent through a working and living environment favorable to creativity and exchange; the creation of physical spaces that enable entrepreneurs to convene during and after work hours is an imperative for this municipal initiative, which leads to the recruitment of accelerators such as MassChallenge and the development of public meeting spaces such as District Hall;
- *Experimental*: the public administration is adopting an experimental framework characterized by expedited decision making and planning flexibility. The city's choice, reconfirmed by the present administration after Mayor Menino's original idea, aroused interest throughout the business community and created momentum for the public sector's efforts to attract developers, the creative industries, CEOs, entrepreneurs and non-profit organizations and to engage them in building a new community;
- *The City as Host*: differing from the 'university-as-host' scenario, as seen at MIT in Cambridge (Kendall Square), in the BID the city embodies the role of host institution. The identification of the innovation district as the flagship project in Boston means that the neighborhood will be free to develop organically, create momentum and allow innovation to spread throughout the city and its surroundings.

The centerpiece of BID is the District Hall, a large public space where innovators can meet, exchange ideas, explore potential synergies, finalize their creativity and come to concrete agreements. The building, opened in 2013, offers 12,000 ft^2 of meeting space, and it is the result of a PPP between the BRA and private investors. The city also plans to add 1.2 million ft^2 to the Massachusetts Convention Center, a major focal point in the district, with a \$1bn project to implement the construction of new private housing units.

4.2 'Neighborhood Innovation District'

The '*Neighborhood Innovation District'* (NID) is an on-going public strategy launched in 2014 by the government of Boston City Council. The main goal of this initiative is to encourage and spread innovation and technology within low-income neighborhoods to improve small business growth and local economic development. However, rather than supporting a specific industrial sector in advance, the NID strategy has adopted a more consistent territory-based approach, which is able to empower existing business activities, as well as adapt to the physical and geographical requirements of the areas. The initiative's most innovative aspect has therefore been to shift the focus from the mere *idea* of entrepreneurship towards a more inclusive and community-oriented point of view, taking into account the requirement for overall economic empowerment of the neighborhood.

This represents the first time an explicit innovation policy has sought to prevent the inevitable displacement of the existing community that is generated by the development of innovation districts, the creation of which inevitably leads to 'gentrification' in the form of a dramatic rise in real-estate values and related exclusory factors for original low-income residents and small businesses. This is the reason that the 'Neighborhood Innovation District Committee' (NIDC)—a body created by the current administration to identify policies, practices and infrastructure improvements to support the development of innovation districts throughout Boston—strongly suggested the use of a district- housing plan to ensure a consistent provision of new, affordable housing and business spaces within the neighborhood (NIDC 2015).

The NIDC comprises local leaders, business experts, representatives of community-based organizations and city officers, jointly in charge of piloting the process. It encourages a participatory approach, working with residents and local stakeholders to ensure a shared and affordable vision of economic development in the city. The results achieved by the NIDC were collected in a document that defines the guidelines to implement an innovation district in an existing distressed neighborhood. Four specific recommendations are highlighted in the document: ensuring adequate entrepreneurial education programs, promoting a streamlined regulatory framework for new entrepreneurs, providing enough space for both retail activities and new affordable housing and finally delivering publicly-accessible business spaces and infrastructure that support interaction between private entrepreneurs.

Following specific criteria cited in the innovation-district literature (transit access, affordable office space, arts and cultural amenities and involvement of non-profit organizations) and considering the particular features of the area (e.g., the presence of higher-education institutions, vacant lots, transportation nodes), the location for the first experiment was chosen to be the 'Dudley Square-Upham's Corner Corridor', a vibrant zone within the Roxbury neighborhood. The area contains all the necessary physical and structural characteristics to become a successful pilot project, with the ability to spur on local entrepreneurship. Since the beginning of the initiative, the area has attracted investment from a few local stakeholders, such as the non-profit 'Initiative for a Competitive Inner City' (ICIC) founded by Michael Porter in 1994, which proposes several state and federal research programs aimed at boosting market opportunities and investment in inner-city areas as a whole. After almost two years' activity, however, the Roxbury Innovation Center (Fig. 3) has mainly been involved in providing vocational training programs for local residents; the local administration, due to the lack of a thriving socioeconomic environment, is struggling to find entrepreneurs ready to invest in the corridor.

Fig. 3 The Roxbury Innovation Center in Boston (author's own photos)

5 Preliminary Findings and Final Remarks

In a first attempt to draw some insights from these preliminary findings, some core questions arise: looking at the policy initiatives in the Boston Area, can we identify an original US interpretation of 'smart specialization strategies'? What role do clusters take in this experience? Is there a specific interpretation of the 'place-based' approach useful for the EU 2020 vision?

Finding a single answer to these questions is not an easy task. Despite the limited number of examples presented in the previous section, the huge distance between the cultural approaches on the two sides of the Atlantic is undeniable. Boston policy initiatives show that the way in which 'innovation strategies' are interpreted is linked to a 'flexible geometry' model that emphasizes the metamorphic synergies between the main actors of the classic 'quadruple helix model'. In particular, the municipal administration has proven to be sensitive to the 'institutional innovation' approach, playing a sophisticated role in tailoring adaptive partnerships among anchor institutions, investors, knowledge subjects and local communities. The Boston model represents the 'virtuous hybridization' of the various dimensions wisely mixed in the planning initiatives: from local inclusion to real-estate development and from governance profiles to socioeconomic quality. The dialectics generated by such contrasting approaches as the BID and the NID demonstrate that locations, proximity and *ex ante* conditions still matter (Lorenzen 2007), and that governance plays a crucial role in the potential success or failure of such initiatives.

Given the considerable commitment and direct involvement of public institutions in the case of the BID, it is possible to interpret the evolution of the redevelopment strategy as the product of long-term planning and shared investment on the part of taxpayers, anchor institutions and private-sector partners. In a public-private/non-profit partnership, the cooperation between actors has been able to manage risk, mostly emphasizing the potential for private profit together with a recognized public benefit. Nevertheless, it is impossible to overlook the overwhelmingly business-driven philosophy of its policy and planning initiative.

The first lesson to be derived from the Boston model concerns flexibility in the stakeholder management, with an adaptive strategy based on entrepreneurial discovery/self-creation rather than on pre-conceived plans. One factor determining the success of these US initiatives, which at the same time coincides with some of the standard features of the RIS3 theory (entrepreneurial discovery, flexible strategy, elastic implementation) is versatility in the appropriate blending of 'stakeholders' from the urban zone, specifically public governmental institutions and local communities. In other words, it has a 'flexible geometry' approach in which roles can occasionally assume different identities and in which the boundaries between public and private initiatives are often blurred. By contrast, in the case of EU policy, these 'geometries' are likely to be shaped by a dominant, hierarchical, regional approach, in which the regions themselves catalyze and address the roles of the public and private actors that could potentially be involved in implementing and fostering innovation policies. And the first assessments about bottlenecks and weaknesses in the RIS3 implementation process (Capello and Kroll 2016) seem to confirm those features.

A second factor is the clear interconnection between clusters and the urban scale. Referring to Porter's theory, it would be inappropriate and substantially incorrect to investigate, follow and identify 'complete' clusters at a neighborhood or municipal level since the assessment method adopted by Porter's team at Harvard Business School has been validated at state and county scales. Nevertheless, the team's investigation of clusters on a regional scale does deliver intriguing interpretations at an urban level, as well. The Boston redevelopment initiatives show strong ties with a specific urban area, and the willingness to frame policy interventions within a wider spatial strategy of overall regeneration appears almost explicit. Physically dense concentrations of fragments and their ability to gain critical mass represent hotspots in the urban fabric, which 'topologically materialize' cluster fractals belonging to more complex and extended network systems.

The BID, for instance, doesn't just push a 'real-estate' philosophy in the context of a huge range of other economic activities, but instead tries to pursue new thriving patterns of integrated models with smaller and newer actors naturally being drawn to a nucleus of potential and opportunity. In general, in the 'innovation-district' phenomenon, the ideal objective of the regeneration strategy is the synergy between increased creative production and a high level of 'urbanity' associated with cross fertilization between actors.

Finally, innovation does not happen just because support is provided: the urban ecosystem as a whole has to be successfully reorganized and reinforced, including its physical and socioeconomic features. This is the biggest challenge faced by the current Boston administration after situating an 'innovation center' in a distressed neighborhood such as Roxbury. It must discard traditional strategies in favor of doing something truly innovative: disrupting the patterns of inequality.

From a wider, EU-based point of view, the major challenge for an effective implementation of an RIS3 is to virtuously 'downsize' the role of industrial clusters, emphasizing the spatial and social sensitiveness to the redevelopment vision. A "consciousness of places" (Becattini 2015) is still crucial: a 'place-based' approach allows the creation of beneficial regeneration projects that are woven into the territorial 'DNA' of local communities in order to identify, recover and increase the value of local cultural specifics.

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References

Aranguren, M. J., & Wilson, J. R. (2013). What can experience with clusters teach us about fostering regional smart specialisation. *Ekonomiaz, 83*(2), 126–145.

Bagnasco, A. (1977). *Tre Italie. La problematica territoriale dello sviluppo italiano*. Bologna: Il Mulino.

Becattini, G. (1990). The Marshallian ID as a Socio-economic Notion. In F. Pyke, G. Becattini, & W. Sengenberger (Eds.), *IDs and inter-firm co-operation in Italy* (pp. 37–51). Geneva: International Institute for Labor Studies.

Becattini, G. (2015). *La coscienza dei luoghi. Il territorio come soggetto corale*. Roma: Donzelli Editore.

Barca, F. (2009). *An agenda for a reformed cohesion policy. A 'place-based' approach to meeting European Union challenges and expectations*. Accessed as April 28, 2017 www.europarl.europa.eu/meetdocs/2009_2014/documents/regi/dv/barca_report_/barca_report_en.pdf.

Capello, R., & Kroll, H. (2016). From theory to practice in smart specialisation strategy: Emerging limits and possible future trajectories. *European Planning Studies, 24*(8), 1393–1406.

Capello, R. (2014). Smart specialisation strategy and the new EU Cohesion Policy reform: Introductory remarks. *Scienze Regionali, 13*(1), 5–14.

Camagni, R., & Capello, R. (2013). Regional innovation patterns and the EU regional policy reform: Toward smart innovation policies. *Growth and Change, 44*(2), 355–389.

Capello, R., Cappellin, R., Ferlaino, F., & Rizzi, P. (2012). *Territorial patterns of innovation*. Milano: Franco Angeli.

Chatterji, A., Glaeser, E., & Kerr, W. (2014). Cluster of Entrepreneurship and Innovation. *Innovation Policy and Economy, 14*(1), 129–166.

Coffano, M., & Foray, D. (2014). The centrality of entrepreneurial discovery in building and implementing a smart specialisation strategy. *Scienze Regionali, 13*(1), 33–50.

Falk, M. (2006). What drives business R&D intensity across OECD countries? *Applied Economics, 38*(5), 533–547.

Foray, D., David, P. A., & Hall, B. H. (2011). *Smart specialisation. From academic idea to political instrument, the surprising career of a concept and the difficulties involved in its implementation*. Ecole Polytechnique Féderale Lausanne: working paper 170252. Accessed at April 28, 2017 from https://pdfs.semanticscholar.org/29ad/6773ef30f362d7d3937c483003d974bc91c5.pdf.

European Commission. (2009). *Knowledge for growth. Prospects for science technology and innovation*. Selected papers from Research Commissioner Janez Potočnik's Expert Group, Accessed at: http://www.ec.europa.eu/invest-in-research/monitoring/knowledge_en.htm.

European Commission. (2010). *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Regional Policy contributing to smart growth in Europe 2020*. Brussels: COM (2010) 553 final.

European Commission. (2012). *Guide to research and innovation strategies for smart specialisation (RIS3)*. Brussels: CEC.

Florida, R. (2002). *The rise of the creative class*. New York: Basic Books.

Glaeser, E., & Kerr, W. (2009). Local industrial conditions and entrepreneurship: How much of the spatial distribution can we explain? *Journal of Economics and Management Strategy, 18*(3), 623–663.

Glaeser, E., Kerr, W., & Ponzetto, G. (2010). Clusters of Entrepreneurship. *Journal of Urban Economics, 67*(1), 150–168.

Hausmann, R., & Rodrik, D. (2003). Economic development as self-discovery. *Journal of Development Economics, 72*(2), 603–633.

Iacobucci, D. (2014). Designing and implementing a smart specialisation strategy at a regional level: Some open question. *Scienze Regionali, 13*(1), 107–126.

Kahn, C. B., Martin, J. K., & Mehta, A. (2012). *City of ideas: Reinventing Boston's innovation economy: The Boston indicators report 2012*. Boston, MA: The Boston Foundation.

Katz, B., & Wagner, J. (2014). *The rise of innovation district: A new geography of innovation in America*. Washington: Brookings Institution.

Lerner, J. (2009). *Boulevard of Broken dreams*. Princeton, NJ: Princeton University Press.

Lorenzen, M. (2007). Social capital and localised learning: Proximity and place in technological and institutional dynamics. *Urban Studies, 44*(4), 799–817.

Madelin, R., & Ringrose, D. (Eds.) (2016). Opportunity now: Europe's mission to innovate. *European Commission, Directorate General for Communication Networks, Content and Technology, Brussels*.

Marshall, A. (1920). *Principles of economics*. London: Macmillan.

Martin, R., & Sunley, P. (2003). Deconstructing clusters: Chaotic concept or policy panacea? *Journal of Economic Geography, 3*(1), 5–35.

McCann, P., & Ortega-Argilés, R. (2015). Smart specialisation regional growth and applications to European Union Cohesion policy. *Regional Studies, 49*(8), 1291–1302.

NIDC. (2015). *Neighborhood Innovation District Committee Report & Recommendations*. Boston, MA.

O'Mahony, M., & Vecchi, M. (2005). Quantifying the impact of ICT capital on output growth: A heterogeneous dynamic panel approach. *Economica, 72*(288), 615–633.

Porter, M. E. (1990). The competitive advantage of notions. *Harvard Business Review, 68*(2), 73–93.

Porter, M. E. (1996). Competitive advantage, agglomeration economies, and regional policy. *International Regional Science Review, 19*(1–2), 85–90.

Porter, M. E. (2007). *Clusters and economic policy: Aligning public policy with the new economics of competition.* Harvard Business School Paper.

Rauch, J. (1993). Productivity gains from geographic concentration of human capital: Evidence from the cities. *Journal of Urban Economics, 34*(3), 380–400.

Samila, S., & Sorenson, O. (2011). Venture Capital, Entrepreneurship and Economic Growth. *Review of Economics and Statistics, 93*(1), 338–349.

Sugden, R., Wei, P., & Wilson, J. R. (2006). Clusters, governance and the development of local economies: A framework for case studies. In C. Pitelis, R. Sugden, & J. R. Wilson (Eds.), *Clusters and globalisation: The development of Urban and Regional Economies* (pp. 63–83). Cheltenham: Edward Elgar.

Part IV
Strategies and Actions for Good Governance

Integrated Green Cities: Urban Meets Forest—A Case Study of the Town of Trento

Maria Giulia Cantiani, Alessandro Betta, Isabella De Meo, Alessandro Paletto, Sara Tamanini and Federica Maino

Abstract A smart city is one which is liveable both from the natural and human-environment points of view and is also one where citizens are involved in the realization and management of an attractive urban environment of high quality. This requires an effective dialogue between citizens and institutions, which means, among other issues, that the planners' conception of urban, peri-urban and rural spaces is coupled with the inhabitants' perception of them and their sense of place. In light of the process of urbanization occurring in many towns of the Alpine Region, managers and planners need to know the new order of priorities in values expressed by the population with regard to forests. This paper illustrates a case

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study of the town of Trento, in the north-eastern Italian Alps, a typical medium-sized alpine town which, despite recent urbanization, is still in close proximity to forested areas. The research, carried out by means of a self-reporting questionnaire, was aimed at investigating the relationship between citizens and their forests. The data collected were analyzed statistically with special regard to sociodemographic characteristics. In particular, the Principal Component Analysis (PCA), applied to some questions investigating people's perception, made it possible to highlight visitors' preferences for forest features and the main functions attributed to the forests. The results show that urbanization and socioeconomic changes, with the introduction of an urban lifestyle, are producing a radical transformation in people's behavior and attitudes in relation to forests. A survey of this type may be a useful tool in helping future management and planning.

Keywords Urban agenda · Urban forestry · Citizens' perceptions
Social inclusion · Trento municipality

1 Introduction

In a world where, by 2050, 70% of the population will be living in cities, a "New Urban Agenda" is considered crucial in order to shape more sustainable, inclusive and resilient cities. Indeed, this was recently proclaimed at the UN Conference on Housing and Sustainable Urban Development, held in Quito (Ecuador) in October 2016 (United Nations 2016).

Rethinking the urban agenda means, among other issues, the necessity of building bridges across physical spaces, that is urban, peri-urban and rural areas. Special attention should be paid to public space, in particular, open and green zones, which directly affect the well-being of people (Nielsen and Hansen 2007; Nutsford et al. 2013; Sangster 2010) and the conservation about their cultural heritage. The process of urbanization that has occurred in many cities all over the world has involved a radical change in the relationship between citizens and the natural environment. Urban sprawl has generally caused natural-habitat fragmentation and soil degradation, entailing a progressive loss of the ecosystem beneficial to residents. Rethinking the urban agenda therefore implies the need for combining social and ecological perspectives, considering cities and towns as integrated socio-ecological systems (Artmann et al. 2017).

Of all the various meanings that the term "smart city" assumes (European Parliament 2014), the one adopted in this work describes it as the one resulting from actions that have been coordinated in order to strengthen and to connect socio-cultural and socio-spatial features of the community, which have the goal of generating sustainable economic development and a higher quality of life, through new forms of governance (Manfredi 2015). In this framework, a key concern is giving people the opportunity to participate in shaping the kind of city they want to live in. For this reason decision makers (planners and managers) need to know what kind of relationship binds the residents to their environment (Cantiani et al. 2016; Rametsteiner et al. 2009; Schmithüsen and Wild-Eck 2000). Actually, the governance for smart and sustainable development of cities has to be based on a bottom-up approach and requires an inclusive and effective dialogue among local authorities, stakeholders and people (Hansen and Pauleit 2014). The planners' conception of urban spaces should definitely be coupled with citizens' perceptions and their sense of place. Taking this into consideration, a long-term research project is being carried out by means of case studies, at the Ecology Lab of the University of Trento.

In this paper, we refer to some results concerning a case study of the town of Trento. The municipality of Trento, in the northeastern Italian Alps, fully reflects the situation of other towns in mountainous and forested European regions. All around the town, forests and farmlands extend over expansive lands that are strictly interconnected with the urban area. As in many other urban centers of the same size, the ecological links and the socioeconomic interdependence between urban and rural areas have always been guaranteed. However, urban development and recent socioeconomic changes have altered the traditional structure, making boundaries between "inside" and "outside" the town flexible and intricate. The relationship itself between humans and forests has been profoundly modified, entailing a different order of priority in values expressed by the population. The aim of this research is to investigate the connection between people and territory, their cultural identity, knowledge of their own forests and the priority of needs and values recognized. Our paper focuses in particular on the main functions attributed to forests and on visitors' favorite forest features. Knowledge of peoples' perceptions is in fact an important prerequisite for the involvement of local communities in decisions concerning environmental issues and may provide valuable support for administrators and policy makers when trying to adapt local mechanisms of governance to current and future changes (Cantiani et al. 2016; Dudek 2016; Hunziker et al. 2013; Šišák 2011).

2 Materials and Methods

2.1 Study Area

Trento, chief town of the autonomous Province of Trentino, is a typical town of the Alpine Region, being surrounded by mountains that reach heights of about 2000 m a.s.l. Extending over a surface of 157 km^2, it is organized into twelve administrative districts, six located on the valley floor and six on the mountain slopes (Fig. 1). With a resident population of 117,418 inhabitants (Comune di Trento 2016), Trento has experienced three successive waves of migration. The first wave consisted of villagers migrating away from the valleys of Trentino towards the chief town, the second one was characterized by people moving from the southern to the northern regions of Italy and the third, more recent one, features migrants arriving from various

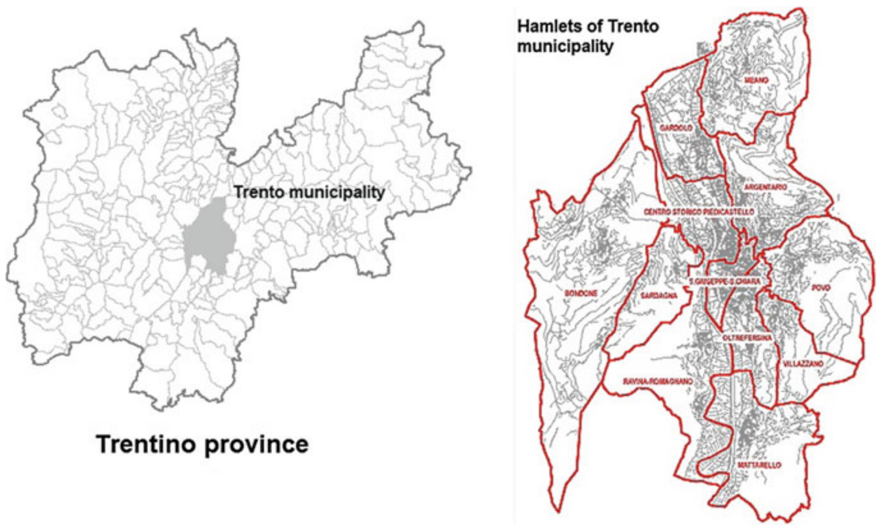

Fig. 1 Study area (Trento municipality in Trentino Province)

foreign countries. Despite a slowing down of the foreign migratory flow and a stabilizing of the population, there are still many problems associated with the rapid demographic growth and the development of various economic activities that characterized the town after World War II. Today, Trento has to cope with issues such as soil consumption, an urgent need for brownfield regeneration, problems of commuting and transport and the poor quality of life in some urban and suburban areas.

Public green areas (parks, gardens, riverbanks) cover a surface of 158 ha (about 13.5 m^2/inh.). These areas, together with forests within the town limits, covering 68 ha, are managed by the Parks and Gardens Department of the town. Overall, this is a small surface, but forestland outside town limits covers a huge area, 5397 ha belonging to the community, which is managed by a special Forest Agency on the basis of forest management plans with multifunctional objectives and particular attention paid to recreation. Despite recent urbanization, urban areas are still in close connection to forested areas, which are easily reached from the town center (De Meo et al. 2015).

2.2 Sampling and Survey

The 47,615 households in the town were the object of the survey. The sampling was proportionally stratified for administrative districts and identified 1000 households, randomly-selected from the local Registry Office. The survey was conducted from November 2005 to June 2006 by means of a self-reporting questionnaire that investigated several topics.

Table 1 Questions investigating the attractiveness and functions of forests

Question	Options		
What goods and services do you look for from a forest?	Culture Landscape Picnics Walks	Hunting Mushrooms Relaxation Work	Firewood Nature Sports
In your opinion, what is important to find in a forest?	Benches Meadows/ open areas Refreshment areas	Car parks Panoramas Vita parcours	Footpaths Peace and quite Wildlife

The questionnaire was composed of 56 mainly closed-ended questions organized in four thematic sections. This article focuses on the questions concerning perceptions of forest, in particular two questions (Table 1) investigating the features that best characterize the forests' attractiveness for visitors and the most important functions (corresponding to various activities).

In this case, people's preferences were investigated by asking the respondents to assess the level of importance assigned to the various kinds of features they look for and activities they carry out in the forest they go to, using a ten-point Likert-scale response format (from 1 = very low importance to 10 = very high importance). The data collected were analyzed statistically with special regard to sociodemographic characteristics (age, gender, origin, level of education).

2.3 Data Analysis

The Principal Component Analysis (PCA) was used to identify the main groups of people based on individual preferences regarding forest features and human activities in forests. With regard to forest features, two main categories were considered (Van Raaij 1986; Laws 1995): innate features (e.g., wildlife, panoramas, meadows/open areas, peace and quiet) and man-made features (e.g., footpaths, benches, vita parcours, refreshments areas, car parks). Concerning human activities in forests, eleven potential assets were considered and described in the questionnaire (Pavlikakis and Tsihrintzis 2006): walks in the forest, hunting activities, sports (i.e., hiking), cultural heritage, picnics, relaxation, landscape contemplation, nature contemplation, workplace, collecting firewood and picking mushrooms.

From the theoretical point of view, PCA is a mathematical procedure that transforms a number of correlated variables (e.g., forest features or human activities in forests) into a number of uncorrelated variables called principal components (e.g., groups of people). In this study, PCA was used in order to understand the relationship between people and forests, identifying various types of human behavior.

3 Results and Discussion

3.1 Sociodemographic Characteristics

At the end of the data collection, 242 completed questionnaires (a response rate of 24.2%) were statistically processed. With regard to the sociodemographic characteristics of respondents, 61.9% of them are male and the remaining 38.1% are female. The majority of respondents are persons who were born in Trento municipality (53.3%) or in other municipalities of Trentino province (25.6%), while the remaining 21.1% are persons from other Italian regions or other countries.

The average age of respondents is 55 years, with the following distribution by age groups: 7.9% are less than 30 years old, 14.1% 30–39 years old, 16.4% 40–49 years old, 24.4% 50–59 years old, 14.5% 60–69 years old, while the remaining 22.7% are 70 or more years old.

Concerning the level of education, 0.8% of total respondents have no degree, 28.1% have an elementary school certificate, 47.5% have a middle-high school certificate, and 21.9% have a university or post-university degree.

3.2 Forest Features

The results show that the perceived most important forest features are (see Appendix 1, where mean and standard deviation are listed): peace and quiet and wildlife (median = 10), followed by footpaths and panoramas (median = 8).

With regard to the sociodemographic characteristics of respondents, the results show that females prefer two forest features—footpaths (median females = 9, median males = 8), and meadows (median females = 7, median males = 6)—compared to males. Conversely, more males prefer car parks (median males = 4, median females = 3) than females.

Concerning the age of respondents, we have identified three age-related trends: the preferences for footpaths (median for the first four classes is 7, while the last classes median is 8) and for benches (median values: $2 \rightarrow 3 \rightarrow 3 \rightarrow 3 \rightarrow 3 \rightarrow 5$) increase with advancing age, while the preferences for open areas/meadows decrease with increasing age (median values: $8 \rightarrow 7 \rightarrow 7 \rightarrow 6 \rightarrow 6 \rightarrow 5$).

Regarding the level of education of respondents, the perceived importance of some forest features decreases with higher levels of education. This is the case for footpaths (the median for the first two classes is 9, while for the last two classes it is 9), refreshment areas (median $7 \rightarrow 5 \rightarrow 5 \rightarrow 4$) and car parks (median $6 \rightarrow 4 \rightarrow 3 \rightarrow 4$).

Finally, people who were born in Trento assign a higher importance to peace and quiet and car parks than people of other parts of Trentino province or other Italian regions. Probably, these two aspects are related to the urban lifestyle: on the one hand, the forest is seen as a place to find peace and quiet, but on the other hand, people want to find car parks close to the forest.

The PCA made it possible to identify two components that together explain 48% of the variability. Such components correspond to two main groups of respondents (Fig. 2): people who consider the forest in terms of "contemplation"; and people who consider the forest in terms of "usage". People belonging to the first group prefer the innate forest features (peace and quiet, wildlife, panoramas and meadows), while people in the second group prefer the man-made forest features (footpaths, vita parcours, refreshment areas, car parks and benches). The second group of people is mainly composed of elderly persons and those with a sedentary lifestyle.

Results show that the respondents like the feeling of being in a forest with a deep sense of peace, but without sacrificing the basic facilities such as car parks and footpaths. This phenomenon is typical of post-modern societies (Inglehart 1997), where people look for easy ways to be in contact with nature, without sacrificing their comforts. The local managers and decision makers need to consider these aspects in order to meet this community's demand. In particular, in the last few years, the Province of Trento has developed important changes in forest legislation and planning, aimed at a multifunctional forest management. The Forest Service of the province drafted guidelines for the management of public and private forests aimed at ensuring both soil protection and biodiversity conservation and also at meeting the recreational demands of residents: some outdoor activities—such as walking, picnicking, landscape viewing, and mushroom and berry picking—have become an increasingly important issue (Paletto et al. 2012).

Furthermore, the forests of the Province of Trento are important not only for the local residents but also for people coming from other regions of the country and from abroad. Tourism is an important element of the economy of the province. So, it is crucial to look for management strategies resulting in meeting residents' demands and tourists' requests (Paletto et al. 2013).

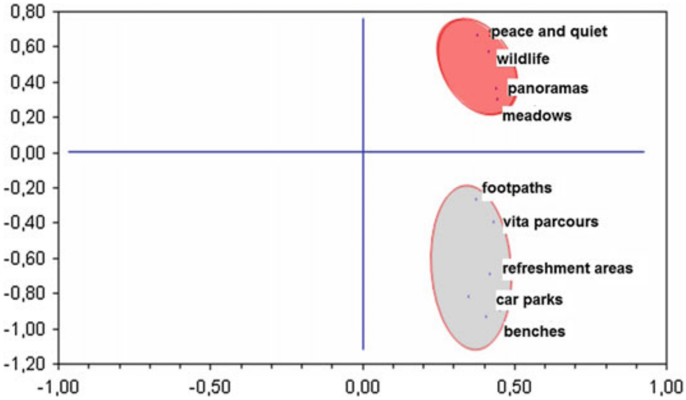

Fig. 2 Forest features—results of the Principal Component Analysis (PCA)

3.3 Human Activities in Forests

The results show that for respondents the most important human activities in forests are (see Appendix 2, where mean and standard deviation are listed): contact with nature and sports (both with a median of 10), followed by walks in forest and picnics (both with a median of 8). Conversely, the human activities considered less important by respondents are hunting (median = 3), cultural heritage and workplace (both with median = 4).

With regard to gender, males prefer activities that make direct use of the forest such as hunting, firewood gathering and mushroom picking, while females prefer more contemplative activities such as relaxation, contact with nature and forest walks.

Concerning the age of respondents, it is interesting to emphasize that older people prefer picking mushrooms more than younger people (median from 7 to 4), while older people and younger people have a more marked preference for the forest's cultural values than people between 30- and 59-year old.

With regard to the level of education, the results show that people with a lower level of education assign higher values to almost all human activities. Conversely, the level of education seems not to affect two human activities: walks in the forest and nature contemplation.

Finally, the origin of respondents is not a key variable to explain the differences in their preferences for human activities.

In this case, the PCA enabled us to identify three components that together explain 50% of the variability (Fig. 3). Each component is characterized by a particular function: production, recreation and nature conservation. In particular, people who chose answers concerning production, mainly males, were only a few, but they assigned a particularly high score. This group of people conceive of the forest as a place to supply the local society with goods.

The second group includes people—composed mainly of young people—who consider the forest as a place for sports activities and picnicking.

The third group includes people—composed mainly of older people and females—who perceive the forest as a place for relaxation and landscape and nature contemplation.

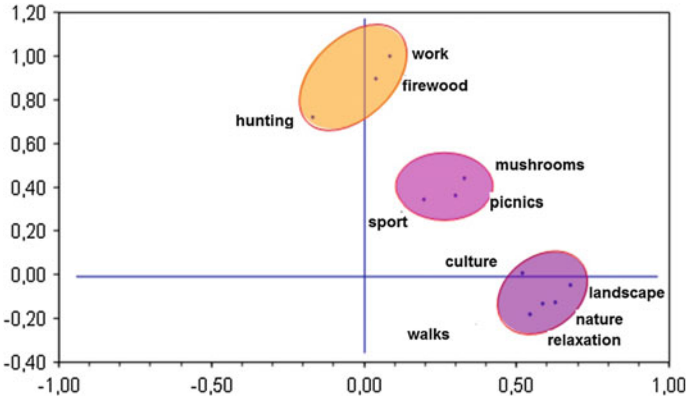

Fig. 3 Human activities in forests—results of the Principal Component Analysis (PCA)

Results clearly show that different activities are considered important by different groups of people, confirming that attitudes towards forests are influenced by diverse factors such as age, gender and reasons for forest frequentation, especially when considering people belonging to an alpine community who are familiar with forests. Possible conflicts between users can arise from different attitudes and interests, so it is advisable to provide appropriate and timely information regarding the aim of various management strategies. Actually, in 2007 the Forest Law was revised in Trentino, and the forest planning structure changed, introducing a regional-level of planning in order to take into account long-term interests and, by means of a single planning drive, to address the various problems and possible conflicts related to the various forest functions (Paletto et al. 2013). In this framework, the results of the present case study may prove a useful point of departure in the participatory planning process required by the law.

4 Conclusion

The research proved to be effective in highlighting people's needs and values attributed to the forests. It is clear that the town is undergoing a delicate time of transition from a traditional way of life, characterized by an economy in which the activities of the primary sector still retain a certain degree of importance, to a distinctly urban lifestyle. The relationship itself of citizens with the forests surrounding the town is dramatically changing. Actually, these forests were not "urban forests", according to the classical meaning, but part of the forested territory, and they have always been managed as commons, in order to supply provisioning and supporting services for the community. The different order in priority that is emerging in the population is posing a real challenge for future management.

Taking all this into consideration, a second survey has been planned and is expected to show differences in perceptions, reflecting the social evolution of the last decade. Surveys of this type may help in opening up dialogue between the community and public administrators and may be useful tools in the hands of planners and decision makers in order to focus attention on the evolution of society's demands. This is particularly important in a long-term perspective in a period of rapid change, such as the one we are experiencing now.

Appendix 1

See Table 2.

Appendix 2

See Table 3.

Table 2 Perceived importance for the forest features by gender, age, level of education and origin (mean and st.dev.)

	Footpaths	Benches	Wildlife	Vita parcours	Refreshment areas	Meadows/open areas	Panoramas	Peace and quite	Car parks
Gender									
Male (n = 150)	7.5 (2.5)	3.7 (3.0)	8.6 (2.2)	3.6 (3.0)	4.9 (2.9)	6.0 (2.7)	7.9 (2.4)	9.3 (1.4)	4.0 (3.2)
Female (n = 92)	8.4 (2.0)	3.7 (3.0)	9.1 (1.7)	3.7 (3.1)	4.4 (3.0)	6.2 (2.9)	7.7 (2.2)	9.3 (1.3)	3.1 (2.9)
Age									
<30 years old (n = 19)	7.7 (2.3)	3.0 (2.7)	9.2 (1.6)	3.5 (2.8)	4.1 (3.2)	7.0 (2.1)	8.2 (1.8)	9.5 (1.0)	3.2 (3.0)
30–39 years old (n = 34)	7.3 (2.4)	3.4 (2.8)	8.7 (2.1)	3.7 (2.9)	3.8 (2.8)	6.6 (2.9)	7.8 (2.8)	9.3 (1.8)	3.3 (2.9)
40–49 years old (n = 40)	7.7 (2.3)	3.7 (3.2)	9.2 (1.5)	3.5 (2.8)	5.1 (3.1)	6.7 (2.6)	8.4 (1.7)	9.4 (1.1)	4.0 (2.9)
50–59 years old (n = 59)	7.9 (2.3)	3.4 (3.1)	8.5 (2.0)	3.2 (3.1)	4.6 (2.7)	5.7 (2.8)	7.2 (2.5)	9.2 (1.4)	3.2 (3.3)
60–69 years old (n = 35)	7.8 (2.8)	3.5 (2.8)	8.3 (2.3)	4.4 (3.3)	4.2 (3.2)	6.0 (2.6)	8.1 (1.9)	9.0 (1.6)	3.8 (3.0)
>=70 years old (n = 55)	8.2 (2.2)	4.6 (3.1)	8.8 (2.4)	3.9 (3.0)	5.8 (2.8)	5.5 (3.1)	7.8 (2.5)	9.5 (1.1)	4.2 (3.4)
Level of education									
No degree (n = 2)	8.5 (2.1)	8.0 (2.8)	10.0 (0.0)	5.0 (7.1)	7.0 (4.2)	8.5 (2.1)	10.0 (0.0)	10.0 (0.0)	6.0 (5.7)
Elementary qualif. (n = 68)	8.2 (2.4)	3.8 (2.8)	8.7 (2.1)	4.2 (2.9)	5.1 (3.0)	5.7 (2.9)	7.7 (2.3)	9.1 (1.5)	3.9 (3.3)
High school qualif. (n = 115)	7.8 (2.2)	3.8 (3.2)	8.7 (2.1)	3.3 (3.0)	4.8 (2.9)	6.3 (2.7)	7.8 (2.3)	9.4 (1.1)	3.6 (3.1)
University degree (n = 53)	7.2 (2.5)	3.1 (2.7)	8.7 (2.1)	3.5 (2.7)	3.9 (3.0)	6.1 (3.0)	7.9 (2.4)	9.3 (1.7)	3.3 (2.7)
Origin									
Residents in Trento (n = 129)	7.7 (2.4)	3.8 (2.9)	8.7 (2.1)	3.6 (3.0)	4.7 (3.0)	5.9 (2.7)	7.9 (2.2)	9.4 (1.0)	3.8 (3.1)
People from Trentino (n = 62)	8.1 (2.4)	3.4 (2.9)	8.9 (1.9)	4.5 (3.1)	4.8 (3.1)	6.4 (2.7)	7.6 (2.4)	9.3 (1.3)	3.7 (3.4)
People from other regions (n = 51)	7.8 (2.3)	3.9 (3.4)	8.7 (2.3)	2.7 (2.7)	4.8 (2.8)	6.2 (3.1)	7.8 (2.7)	9.0 (1.9)	3.2 (2.8)
Total	7.8 (2.4)	3.7 (3.0)	8.8 (2.1)	3.7 (3.0)	4.7 (3.0)	6.1 (2.8)	7.8 (2.3)	9.3 (1.4)	3.6 (3.1)

Table 3 Perceived importance for human activities in forests by gender, age, level of education and origin (mean and st.dev.)

	Walks	Hunting	Sports	Culture	Picnics	Relaxation	Landscape	Nature	Work	Firewood	Mushrooms
Gender											
Male (n = 150)	8.6 (2.0)	0.8 (2.4)	3.7 (3.7)	8.0 (2.3)	4.0 (3.0)	8.7 (1.8)	8.6 (1.8)	8.7 (2.0)	1.0 (2.2)	2.2 (3.3)	5.8 (3.4)
Female (n = 92)	9.2 (1.4)	0.1 (0.9)	2.6 (3.5)	8.0 (2.5)	3.8 (2.8)	9.1 (1.7)	9.0 (1.4)	9.3 (1.0)	0.7 (1.7)	1.8 (3.0)	5.3 (3.6)
Age											
<30 years old (n = 19)	8.8 (1.9)	1.6 (3.5)	3.5 (2.9)	8.6 (2.4)	4.1 (2.8)	8.5 (2.4)	9.2 (1.1)	9.3 (0.8)	0.8 (1.8)	2.1 (2.8)	3.8 (3.3)
30–39 years old (n = 34)	8.8 (2.0)	0.4 (1.5)	3.8 (3.8)	7.5 (2.5)	4.9 (3.1)	8.8 (2.0)	8.8 (1.9)	8.7 (2.0)	0.2 (0.9)	1.8 (3.3)	4.8 (3.4)
40–49 years old (n = 40)	8.8 (1.7)	0.9 (2.5)	3.4 (3.9)	7.8 (2.2)	4.2 (2.9)	8.9 (1.5)	8.9 (1.6)	8.4 (2.4)	1.5 (2.9)	2.7 (3.6)	4.9 (3.8)
50–59 years old (n = 59)	8.8 (1.8)	0.5 (1.9)	2.7 (3.6)	7.9 (2.5)	3.2 (2.6)	8.7 (1.7)	8.5 (1.7)	9.1 (1.5)	0.9 (1.7)	2.0 (3.2)	5.9 (3.2)
60–69 years old (n = 35)	9.2 (1.2)	0.5 (1.8)	4.0 (3.9)	8.3 (2.0)	4.3 (3.0)	9.3 (1.3)	8.7 (1.8)	9.2 (1.5)	0.9 (1.8)	2.9 (3.2)	7.1 (3.1)
>=70 years old (n = 55)	8.8 (2.0)	0.2 (0.9)	2.9 (3.6)	8.1 (2.4)	3.6 (2.9)	8.7 (1.8)	8.7 (1.6)	8.9 (1.6)	0.9 (2.1)	1.4 (2.6)	6.1 (3.5)
Level of education											
No degree (n = 2)	8.0 (2.8)	3.5 (4.9)	4.0 (5.7)	8.0 (2.8)	8.0 (0.0)	8.0 (2.8)	9.0 (1.4)	8.5 (2.1)	5.0 (7.1)	8.0 (0.0)	8.0 (2.8)
Elementary qual. (n = 68)	9.0 (1.8)	0.6 (2.0)	3.0 (3.6)	8.0 (2.3)	3.8 (2.9)	8.6 (1.9)	8.8 (1.7)	8.9 (1.8)	1.4 (2.5)	2.5 (3.4)	6.7 (3.4)

(continued)

Table 3 (continued)

	Walks	Hunting	Sports	Culture	Picnics	Relaxation	Landscape	Nature	Work	Firewood	Mushrooms
High school qualif. (n = 115)	8.9 (1.7)	0.3 (1.5)	3.9 (3.8)	8.3 (2.0)	4.1 (2.9)	9.1 (1.4)	8.9 (1.5)	9.1 (1.7)	0.7 (1.7)	1.9 (2.9)	5.4 (3.5)
University degree (n = 53)	8.6 (1.9)	1.0 (2.7)	2.3 (3.1)	7.4 (2.8)	3.5 (2.8)	8.6 (2.2)	8.4 (2.0)	8.5 (1.9)	0.5 (1.2)	1.8 (3.2)	4.6 (3.2)
Origin											
Residents in Trento (n = 129)	8.8 (1.8)	0.7 (2.2)	3.4 (3.8)	7.9 (2.3)	4.3 (2.9)	8.7 (1.8)	8.8 (1.5)	8.8 (1.6)	1.0 (2.2)	2.0 (3.3)	5.4 (3.5)
People from Trentino (n = 62)	9.0 (1.6)	0.7 (2.1)	2.9 (3.4)	8.8 (1.3)	3.6 (3.0)	9.1 (1.2)	8.7 (1.6)	9.2 (1.3)	1.0 (2.0)	3.1 (3.4)	6.9 (3.1)
People from other regions (n = 51)	8.7 (2.0)	0.2 (0.7)	3.4 (3.7)	7.2 (3.1)	3.3 (2.8)	8.7 (2.2)	8.8 (2.0)	8.7 (2.4)	0.4 (1.0)	1.0 (2.0)	4.6 (3.5)
Total	8.9 (1.8)	0.6 (2.0)	3.3 (3.7)	8.0 (2.4)	3.9 (2.9)	8.8 (1.8)	8.7 (1.7)	8.9 (1.7)	0.9 (2.0)	2.1 (3.2)	5.6 (3.5)

References

Artmann, M., Bastian, O., & Grunewald, K. (2017). Using the concept of green infrastructure and ecosystem services to specify Leitbilder for compact and green cities—The example of the landscape plan of Dresden (Germany). *Sustainability, 9,* 198.

Cantiani, M. G., Geitner, C., Haida, C., Maino, F., Tattoni, C., Vettorato, D., et al. (2016). Balancing economic development and environmental conservation for a new governance of Alpine Areas. *Sustainability, 8,* 802.

Comune di Trento. (2016). *Trento Statistica. La Popolazione al 31 dicembre 2016*. Accessed as April 14, 2017 from http://www.comune.trento.it/Aree-tematiche/Statistiche-e-dati-elettorali/Statistiche/Avvisi/La-popolazione-al-31-dicembre-2016.

De Meo, I., Paletto, A., & Cantiani, M. G. (2015). The attractiveness of forests: preferences and perceptions in a mountain community in Italy. *Annals of Forest Research, 58*(1), 145–156.

Dudek, T. (2016). Needs of the local population related to development of forests for recreational purposes: Example of south-eastern Poland. *Journal of Forest Science, 62*(1), 35–40.

European Parliament. (2014). *Mapping smart cities in the EU.* Accessed as August 7, 2017 from http://www.europarl.europa.eu/RegData/etudes/etudes/join/2014/507480/IPOL-ITRE_ET(2014)507480_EN.pdf.

Hansen, R., & Pauleit, S. (2014). From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for urban areas. *Ambio, 43,* 516–529.

Hunziker, M., Frick, J., Bauer, N., von Lindern, E., & Graf, O. (2013). *La population Suisse et sa forêt*. Office fédéral de l'environment, Berne et Institut federal de recherches sur la forêt, la neige et le paysage WSL, Birmensdorf.

Inglehart, R. (1997). *Modernization and Postmodernization: Cultural, economic, and political change in societies*. Princeton: Princeton University Press.

Laws, E. (1995). *Tourism destination management: Issues, analysis, and policies*. New York: Routledge.

Manfredi, F. (2015). *Smart community. Comunità sostenibili e resilienti*. Bari: Cacucci Editore, Collana Lum School of Management.

Nielsen, T. S., & Hansen, K. B. (2007). Do green areas affect health? Results from a Danish survey on the use of green areas and health indicators. *Health Place, 13,* 839–850.

Nutsford, D., Pearson, A. L., & Kingham, S. (2013). An ecological study investigating the association between access to urban green space and mental health. *Public Health, 127,* 1005–1011.

Paletto, A., Maino, F., De Meo, I., & Ferretti, F. (2012). Perception of forest values in the alpine community of Trentino region (Italy). *Journal of Environmental Management, 51*(2), 414–422.

Paletto, A., De Meo, I., Cantiani, M. G., & Maino, F. (2013). Social perceptions and forest management strategies in an Italian Alpine Community. *Mountain Research and Development, 33*(2), 152–160.

Pavlikakis, G. E., & Tsihrintzis, V. A. (2006). Perceptions and preferences of the local population in Eastern Macedonia and Thrace National Park in Greece. *Landscape and Urban Planning, 77,* 1–16.

Rametsteiner, E., Eichler, L., & Berg, J. (2009). *Shaping forest communication in the European Union: Public perceptions of forests and forestry*. Rotterdam, The Netherlands: ECORYS Nederland.

Sangster, M. (2010). Well-being and nature: Policy convergence in forestry, health and rural development. *Swiss Forestry Journal, 161*(3), 62–68.

Schmithüsen, F., & Wild-Eck, S. (2000). Uses and perceptions of forests by people living in urban areas: Findings from selected empirical studies. *European Journal of Forest Research, 119,* 395–408.

Šišák, L. (2011). Forest visitors' opinions on the importance of forest operations, forest functions and sources of their financing. *Journal of Forest Science, 57*(6), 266–270.

United Nations. (2016). Accessed as April 14, 2017 from http://habitat3.org/wp-content/uploads/New-Urban-Agenda-GA-Adopted-68th-Plenary-N1646655-E.pdf.

Van Raaij, W. F. (1986). Consumer research on tourism: Mental and behavioral constructs. *Annals of Tourism Research, 13*(1), 1–9.

Smart Cities for Local Growth. Experiences in Liguria, Italy. The Case Studies of the Municipalities of Savona and La Spezia

Giovanni Sergi, Paolo Rosasco and Chiara Bianchi

Abstract The main results of this paper will be the explanation of methods and contents of the experiences in Liguria aiming at converting a consolidated urban organism into a Smart City. Specific attention is paid to the experience in the municipalities of Savona and La Spezia. We can say that, similarly to what happened in the past years in many European and North American cities, the first projects related to the Smart City in Italy concern the possibility of introducing new technologies to make components of the urban system more efficient. In a second step, local institutions identified new technologies as one of the tools to develop new models of economic development and welfare. For some years in Italy, there has been a debate over the issue of the Smart City within research institutions, universities and leading companies in the sector of advanced technologies. This debate has highlighted both some of the most interesting experiences in Italy and the difficulty to develop a holistic approach to this complex issue. The ways in which regional, provincial, metropolitan and municipal administrations cooperate with companies in the ICT sector have changed considerably. Besides proposing technologically-advanced products for public administrations, these companies should undertake to work with universities and research centers in order to promote the growth of the economic system and of local employment through a holistic approach.

Keywords Smart city in Liguria region · Holistic approach · Strategic planning
Master plan

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1 Introduction

1.1 The Debate Over the Issue of the Smart City

By the year 2030, the objectives regarding climate and energy set by the EU members are a reduction by 40% in greenhouse gases, an increase by 27% in renewable energy and at least a 27% improvement in energy efficiency.

The fundamental need to think over urban planning and management models is critical because about 70% of energy is consumed by urban centers. For this reason, the energy-efficient building becomes the core of a broader redevelopment project.

The development of Smart Cities, together with technologies that we can consider as "enabling" such as smart grids and digital infrastructures, can become a very important element for the development of the country as a whole. They can promote meaningful projects to modernize regional and urban systems and improve their economies.

A well-known method to connect these different elements is urban strategic planning that supports decision-making processes and can be used by a municipality to manage urban and regional changes.

Various authors agree on the fact that the relation between strategic planning and the Smart City has very interesting elements and should therefore be studied in-depth.

Within the decision-making process, evaluation can help the decision-maker, mainly in complex and multidimensional areas regarding urban and regional systems; the various techniques outlined by the evaluation activity confront and help to solve issues regarding the development of actions to implement, as well the understanding of cash and non-cash effects.

In particular they refer to multi-criteria analysis that can prioritize alternative project proposals and identify, in relation to meaningful aspects (criteria) and a set objective, the most satisfying solution.

As a result there may be important indications on how to deal with redevelopment projects of urban areas using the tools given by ICT.

1.2 Italian Trends Regarding the Model of the Smart City

The analysis of experiences in 158 Italian municipalities that addressed the issue of Smart City carried out by ANCI (Association of Italian Municipalities) highlights that the municipal administrations mainly focused on mobility, environment and participation of citizens (ANCI 2013).

In Italy, there are two different approaches by regional authorities and municipalities to the issue of the Smart City. The first and most widespread approach deals with one or some specific sectors of the urban system: mobility, environment, energy, economy, etc. The second approach, which we may define as holistic, considers the city as a system able to support and spread innovation (Ernst and Young 2016; Testoni 2016; European House-Ambrosetti 2012).

1.3 The Smart City in Liguria, Today

In Liguria, some large municipalities, including Genoa and La Spezia, have worked on the issue of the Smart City using a holistic approach.

The Municipality of Savona has focused on the issue of e-government, the redevelopment of specific parts of town working on the implementation of a smart-grid prototype, energy-improvement and smart mobility projects.

The Municipality of Genoa has established an important organizational structure called Genova Smart City (see Fig. 1) whose members include the municipality, as well as research bodies and big and medium-sized companies.

Fig. 1 The skyscraper called "Il Matitone". The Association Genova Smart City has promoted a study to optimize energy consumption in this building. *Photo* G. Sergi 2016

2 Savona Smart-City

2.1 The Smart District in the Area of Savona

In 2013, a memorandum was signed in Savona by all members of the "Distretto Smart Comunità Savonesi": the Municipalities of Albissola Marina, Albisola Superiore, Bergeggi, Quiliano, Savona, Vado Ligure, the provincial administration of Savona, and the University of Genoa, as well as other institutions and bodies among which was IPS "Insediamenti Produttivi Savonesi scpa".

2.2 The Savona Smart City

Within the "Distretto Smart Comunità Savonesi", there are some important projects planned by the Municipality of Savona: e-government, the extension of smart grid of the University Campus of Savona close to the neighborhood of Légino, the development of a Standard Construction Regulation, the redevelopment of the Della Rovere Palace in the old town center of Savona, the sustainable mobility project designing the redevelopment of Via Nizza and the waterfront, the development of a bus line with a magnetic induction charger and the e-health project in the health sector (see Table 1).

2.2.1 Smart Environment: Smart Polygeneration Microgrid of the University Campus

The Smart Polygeneration Microgrid of the University Campus in Savona Légino, built by Siemens Italian in cooperation with the University of Genoa (see Fig. 2), is one of the first pilot plants of a smart grid in Europe. The area chosen for the project is occupied by three courses of study: Engineering, Communication Sciences and Sport Sciences, which are attended by a total of 2000 people, including students, professors and administration technical staff covering a surface of 60,000 m^2.

The micro-grid is an experimental infrastructure comprising a high-efficiency gas micro-turbine for the simultaneous production of electricity and thermal energy, a photovoltaic plant on the roof, one thermodynamic concentrated solar plant, two charging stations for electric vehicles and an electrochemical storage system comprising high-efficiency batteries.

The Smart Polygeneration Microgrid of Savona is part of the 100 energy excellencies presented at the Conference on Climate in Paris in 2015, as well as a "laboratory" to test the Smart City that can be repeated in the future on a wider scale and in a part of a city that can be independent in terms of energy consumption and heating. Recently on the Campus of Savona Légino, a remarkable Smart Energy Building has been completed (see Fig. 3).

Table 1 Selection of the main actions planned for the Savona Smart City

Thematic areas	Type of action	No	Proponent	Description of the project
Smart governance	Planning and management	1	Municipality of Savona	Efficiency plan of the municipal organization (2014)
		2	Municipality of Savona	New management system for monitoring public expenditure, supporting the decision-making process, with reference to the energy consumption of municipal buildings (2014)
		3	Municipality of Savona	Implementation of the SIT (Territorial Information System) of the municipality giving specific information to citizens (2016)
	Transparency	4	Municipality of Savona	Dematerialization process and provision of online services: the multifunctional desk for the citizen (2016)
		5	Municipality of Savona	Grid infrastructure made of optic fibers for the connection of various municipal offices and public buildings (2016)
	Other	6	Municipality of Savona	Implementation of the Wi-Fi network in the old town center and along the coast close to the beaches (2014)
Smart mobility	Plan for sustainable mobility	7	Local public transport	Replacement of EURO 0–1–2 buses with EURO 6 buses (2014)
		8	Municipality of Savona	New plan for soft and sustainable mobility (2014)
	Integrated innovative models of transport	9	Municipality of Savona	Construction of a people mover between the railway station Mongrifone and Piazza del Popolo (2014)
		10	Local public transport	E-bus project for three urban lines of the Municipality of Savona with ten electric buses having a magnetic induction charging system (2014)
		11	ASL 2 (Local Healthcare Authority no 2)	Purchase of eight electric means of transport (2014)

(continued)

Table 1 (continued)

Thematic areas	Type of action	No	Proponent	Description of the project
Smart planning	Planning regulation	12	Municipality of Savona	New Municipal Construction Regulation (2014)
	Urban redevelopment	13	Municipality of Savona	Implementation of the plan to promote Della Rovere Palace as seat of the new smart municipal library and some university courses (2014)
		14	Municipality of Savona	Urban redevelopment between Nizza Street and the seaside areas from Le Fornaci to Zinola and construction of a pedestrian and cycle path (2014)
Smart security	Management of natural risks	15	Municipality of Savona	Securing of the stream Rio Molinero (2014)
		16	Municipality of Savona	System to detect citizens' feedback/warning system' regarding hydro-geological risk (2016)
		17	Municipality of Savona	Systems to detect and monitor urban mobility, public safety and cleanliness (2016)
Smart energy	Grids	18	Municipality of Savona	Extension of the smart grid of the University Campus of Savona to the adjacent neighborhood of Légino (2014)
	Energy from renewable sources	19	ASL 2 (Local Healthcare Authority no 2)	Installation of a photovoltaic plant on the roof of the hospital S. Paolo Valloria (2014)
	Energy efficiency	20	Local Promotion Organization for University	Installation of a presence detection sensor and led lights in the whole Savona University Campus (2014)
		21	Municipality of Savona	Energy-efficiency improvement of public municipal buildings (2016)
		22	Municipality of Savona	Energy-efficiency improvement of public lighting (2016)
	Monitoring of consumption	23	Municipality of Savona	Monitoring and management of consumption in public municipal buildings (2016)
		24	Municipality of Savona	Monitoring of energy consumption within the municipal region (2016)

(continued)

Table 1 (continued)

Thematic areas	Type of action	No	Proponent	Description of the project
Smart community	Access to information	25	Municipality of Savona	Integrated tourism: brand, single website and city card (2016)
	Education and training	26	Municipality of Savona	E-learning project (2016)
	E-Health	27	Municipality of Savona and ASL 2 (Local Healthcare Authority no 2)	Home care and database sharing (2016)
	Support to companies	28	Municipality of Savona	Enhancement of the online website of IPS firm (2014)
Smart port	Relationship port-town	29	Municipality of Savona	Enhancement of the relationship port-town by promoting the flow of cruise passengers from port to town (2014)

Source Distretto Smart Comunità Savonesi, 2014—Savona Municipality, 2016—IPS, 2016. This table is a re-elaboration of the authors

Fig. 2 Campus of Savona Légino and Nizza Street urban-renewal project, 2013–2017. *Source* www.google.it/ maps, 2017. This table is a re-elaboration of the authors

Fig. 3 Campus of Savona Légino, the new Smart Energy Building. *Photo* E. Andreoni, March 2017

2.2.2 Smart Mobility: The New Configuration of via Nizza

The Municipality of Savona in 2013 published a call for proposals whose objective was the redevelopment of the urban area around the main road of Aurelia, today called via Nizza, having a length of 2,732 m, between the areas called "Fornaci" and "Zinola". The winner was a project developed by the Municipality of Savona and can be regarded as an interesting example of smart mobility within an established urban area.

This project is divided into two stages. The first stage provides for the change of the main road Aurelia into a new urban road with two lanes of 3.5 m for cars and buses, two new cycle paths, and a limited number of car-parking areas. The project regarding the new road infrastructure of Via Nizza envisages a winding path to limit the speed of cars and buses. Some of the measures are: the building of smart shelters that can work as video-surveillance system, bus stops and charging outlets for mobile devices. Moreover, the new buildings envisaged by the urban redevelopment projects provide the energy produced by their photovoltaic plants for the lighting of Via Nizza. The second stage envisages the building of a new, wooden pedestrian path close to the seaside and the upgrading of some buildings in front of the beach, as well as bathing establishments, etc.

3 La Spezia Smart-City

Started in 2015, the project called "La Spezia 20.20—La città diventa Smart" is part of a strategic planning framework launched by the municipal administration in 1999 to identify a new economic and social development model for the municipal area after the economic crisis in La Spezia in the 1990s (La Spezia Municipality 2015).

3.1 The Master Plan "La Spezia Smart City"

The Municipality of La Spezia, with 94,016 inhabitants as of June 2016, presented the Master Plan "La Spezia Smart City" to the public in November 2015. This master plan was the result of cooperation between public institutions, universities, research bodies, companies and associations (see Fig. 4).

To define the master plan, La Spezia applied the competencies of the Torino Wireless Foundation and identified five specific platforms in which 200 experts took part. To summarize, the master plan envisages the implementation of the 45 measures listed in Table 2.

Some of the 45 measures contained in the master plan have been further developed within the seven specific working groups (see Table 2).

Thanks to the combination of three main components—planning, use of enabling technologies, sharing and cooperation among representatives of the civil society—some plans have been developed and regarded as interesting by the municipal administration, as well as by private and public players.

3.1.1 Smart Energy and Environment: Energy Smart Community and Project on Uncultivated Land

In the energy field, the Energy Smart Community aims at creating a community able of organizing its energy-user points, both active and passive, in an efficient

Fig. 4 The structure of Master Plan "La Spezia Smart City", 2015. *Source* La Spezia Municipality

way, maximizing self-consumption and minimizing the exchange with external networks. The connection between energy-related issues, territorial development and planning is very relevant in this case.

The municipal administration has also worked on the field of Smart Environment, one of the main objectives of the platform, that is the protection and promotion of the territory, in particular of the environmental heritage on the hills in order to develop active practices for territorial maintenance.

The project focusing on uncultivated land aims at redeveloping private, unused land made available by the current owners for carrying out agricultural activities and restoring the forestry.

3.1.2 Smart Mobility: Open City and Seabus Projects

Regarding the issue of smart mobility, through the Project Spezia Open City, the municipal administration, in cooperation with the affiliated company ATCand CIRT-University of Genoa aims at enhancing the monitoring systems in the gulf area and creating a single database on mobility.

This project aims at integrating already the existing info-mobility system to improve the match between supply and demand and the capacity to monitor, evaluate and activate a permanent marketing system of mobility services.

Sustainable mobility in the gulf area is taken into consideration from the point of view of innovative and sustainable mobility by sea. The prototype, which the Seabus project aims to develop (see Fig. 5), is developed by the University Centre of La Spezia and constitutes an innovative system of maritime transport based on a hybrid propulsion system, to provide a meaningful contribution to the passengers who commute for work between the seaside municipalities of the provincial area to La Spezia, as well as to the mobility demand of the tourism sector. This project represents a cooperation between the University Centre G. Marconi, the University of Genoa and the Polytechnic University of Milan. The project managers are Profs. M. Musio-Sale and M. I. Zigniego.

3.1.3 Smart Living and People: Social Housing and the Digital Library

The project called "Abitare sociale" (Social Housing) involves residential communities safeguarded by local welfare and envisages the building of housing, in blocks or as independent houses, connected by services within a network, equipped with technological and IT tools, located in an accessible and well-connected area where people with a disability can be accommodated and supported by health workers and volunteers.

With regard to culture, the Project Digital Library and Museum aims at promoting and easing public access to museum objects and historical archives of the town through ICT tools and applications, integrating the existing Digital Library.

Table 2 Selection of the main actions planned for "La Spezia 20.20 La città diventa SMART"

SPECIFIC PLATFORMS		Name of measure and progressive number out of 45 measures defined by the master plan	Operational data sheet		Envisages an implementation in the territory		The measure is based on a project	Measure being implemented	Completed measure
			Yes	No	Yes	No			
Energy	1	Energy efficiency in municipal buildings and in public residential housing	■		■			■	
	2	Cold ironing		■	■		■		
	5	Locally based wood-production chain	■		■			■	
	6	Energy-efficient apartment blocks	■		■		■		
	8	Smart grid	■		■		■		
	9	Smart Energy Community	■		■			■	
Environment	14	Prevention and monitoring of hydro-geomorphological risks and restoration of uncultivated lands	■		■			■	
Mobility	16	Spezia Open City	■			■	■		
	17	Spezia Pass	■		■		■		
	18	Improvement of accessibility by sea for La Spezia Gulf (Spezia SeatoLand)	■		■		■		
	19	Spezia E-smart (Electrical and Sustainable Spezia)	■		■			■	
GOV	20	Management dashboard	■			■	■		
Economy	29	Didactic and entrepreneurial campus "Tradizione & Innovazione"	■		■		■		
	30	Incubator 2.0: spreading and development of a business culture: start- up and spin-off	■		■		■		
	31	Upgrading of school facilities	■		■		■		

(continued)

Table 2 (continued)

SPECIFIC PLATFORMS		Name of measure and progressive number out of 45 measures defined by the master plan	Operational data sheet		Envisages an implementation in the territory		The measure is based on a project	Measure being implemented	Completed measure
			Yes	No	Yes	No			
People	32	Educational campus for the tourism industry	■		■		■		
	33	Social housing in town: communal housing safeguarded by local welfare	■		■		■		
Living	37	Urban Safety and Integrated monitoring of the territory	■		■		■		
	43	Development of outdoor tourism—Hiking tourism—Fortresses	■		■			■	
	44	Transformation of the submarine "Leonardo da Vinci" into a museum	■		■		■		

Source www.comune.laspezia.it, 2017. This table is a re-elaboration of the authors

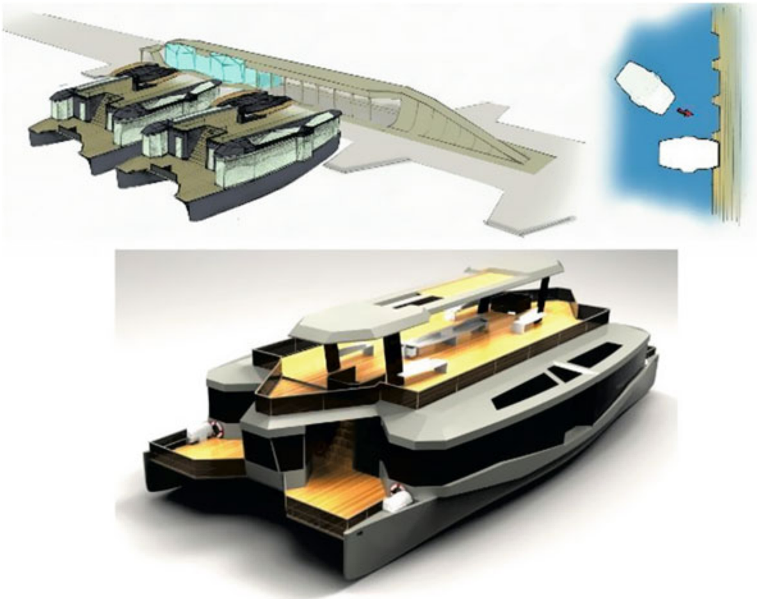

Fig. 5 Project Seabus 2014. *Source* The University Centre G. Marconi, La Spezia

4 Conclusion

The analysis of several case studies available in Italy highlights that the idea to convert the traditional management of a city according to the model of Smart City requires, as shown by some recent successful cases, the need to identify both a shared scenario of future development and a body, within the municipal administration or outside it, able to promote the development process of a Smart City.

References

ANCI Osservatorio Nazionale Smart City. (2013). *Vademecum per la città intelligente*. Accessed as March 17, 2017. http://osservatoriosmartcity.it/.

European House-Ambrosetti. (2012). *Smart Cities in Italia*. Accessed as March 17, 2017 from http://www.ambrosetti.eu.

Ernst and Young. (2016). *Italia smart. Rapporto smart city index 2016*. Accessed as March 17, 2017 from http://www.ey.com.

La Spezia Municipality. (2015). *La Spezia smart city Masterplan*. Accessed as March 17, 2017 from http://www.comune.laspezia.it/.

Testoni, C. (2016). *Towards smart city. Amministrazione pubblica e città di media dimensione: strategie di governance per uno sviluppo intelligente sostenibile e inclusivo dei territori*. Milano: F. Angeli.

Smart-City Development Paths: Insights from the First Two Decades of Research

Luca Mora, Mark Deakin and Alasdair Reid

Abstract More than 20 years have now passed since the concept of smart city first appeared in a scholarly publication, marking the beginning of a new era in urban innovation. Since then, the literature discussing this new concept and the ICT-oriented urban-innovation approach it stands for has been growing steadily, along with the number of initiatives that cities all over the world have launched to pursue their ambition of becoming smart. However, current research still falls short of providing a clear understanding of smart cities and the scientific knowledge policy makers and practitioners both need to deal with their progressive development. In response to this shortfall, this paper offers a bibliometric study of the first two decades of smart-city research, whereby citation link-based clustering and text-based analysis are combined to: (1) build and visualize the network of scholarly publications shaping the intellectual structure of the smart city research field; (2) identify the clusters of thematically related publications; and (3) reveal the emerging development paths of smart cities that these clusters support and the strategic principles they embody. This study uncovers five main development paths: the Experimental Path; the Ubiquitous Path; the Corporate Path; the European Path; and the Holistic Path. Overall, this analysis offers a comprehensive and systematic view of how a smart city can be understood theoretically and as a scientific object of knowledge able to inform policy-making processes.

Keywords Smart cities · Urban innovation · Bibliometric analysis
Co-citation analysis · Content analysis · Development paths

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1 Introduction: Smart-City, One Term, Different Interpretations

As Meijer and Bolivar (2016) note, there is still little agreement over what makes a city smart. Evidence of this trend is provided by Hollands (2008), Paskaleva (2011), Nam and Pardo (2011a, b), Alkandari et al. (2012), Chourabi et al. (2012), Albino et al. (2015) and, more recently, by Komninos and Mora (2018) and Mora et al. (2017: 20), whose bibliometric analyses reveal that the disagreement in the ways of conceptualizing and defining the smart city results from the "*lack of intellectual exchange*" between smart-city researchers and their "*tendency [...] to be subjective and follow personal trajectories in isolation from one another*".

This paper suggests all these subjective, personal and isolated interpretations fall short of providing both a clear understanding of smart cities and the scientific knowledge policy makers and practitioners need to deal with their progressive development. Indeed, we suggest this division is now so entrenched within the scientific community that it has generated different development paths for smart cities. This critical insight is drawn from research by Lazaroiu and Roscia (2012), Zygiaris (2013), Komninos (2014), Deakin (2013), Hollands (2015), Bolici and Mora (2015) and Mora and Bolici (2016, 2017) and serves to corroborate their findings on the state of the art.

In the interests of bridging this division within the scientific community, this paper reports on the findings of a bibliometric study covering the first two decades of research on smart cities. In this study, citation link-based clustering and text-based analysis are combined to: (1) build and visualize the network of scholarly publications shaping the intellectual structure of the smart-city research field; (2) identify the clusters of thematically related publications that shape the intellectual structure of the smart-city research field; and (3) reveal the emerging development paths of smart cities that these clusters support, along with the strategic principles they embody. This analysis offers a comprehensive and systematic view of how a smart city is understood by the scientific community and helps to bridge the structural divisions affecting smart-city research by supporting "*the construction of [that] collaborative environment which is necessary to generate a possible agreement concerning the way of thinking about, conceptualizing and defining the smart city*" (Mora et al. 2017: 21).

2 Research Methodology

In this bibliometric study, the hybrid techniques proposed by Braam et al. (1991a, b) and Glanzel and Czerwon (1996) are applied to analyze the intellectual structure of the smart-city research field and identify the main development paths. This structure is first outlined and graphically visualized and then split into sub-groups of publications by conducting a document co-citation analysis. The result is a co-citation network composed of 2273 publications divided into 18 thematic clusters. After tracing the network of relationships between these documents, a description of the content relating to the most representative clusters is provided based on the identification of their core documents[1] and the construction of word profiles.

The study begins with a keyword search that aims to develop a representative dataset of literature on smart cities. The literature search covers the period from the beginning of 1992 to the end of 2012 and is implemented by using multiple scholarly databases. This search makes it possible to identify all the English-language literature containing the term smart city in the title, abstract, keyword list or within the body of the text. The following search query is used: "smart city" OR "smart cities" (Baseline 1992).[2] It is important to note that all types of documents are considered in this study, including grey literature[3] (Schopfel and Farace 2010).

The documents found by using this search criteria are then included in a single dataset and checked to identify and correct any errors in the titles, names of authors and publication dates. Duplicate documents that are found in more than one database are eliminated. Finally, the title, abstract, keyword list and body of the text of each remaining publication are manually examined to verify the effective presence of the keyword. Documents for which this search is negative are eliminated.

After completing the search phase, the publications remaining in the dataset are 1067, and all of them are used to collect the raw data needed to conduct the bibliometric study. For this reason, they can be considered as source documents (Small and Crane 1979; Schneider et al. 2009; Shiau and Dwivedi 2013; Ingwersen et al. 2014). Data for the co-citation analysis is collected manually by extracting the list of references from each source document. Altogether, 22,137 citations are extracted and used to build a frequency table showing each cited publication, along with the number of citations it has received. The total number of cited references is 17,574.

By considering only the 2273 cited references with at least two citations, a co-citation network is then outlined, whereby each cited reference is represented as

[1]In this study, core documents of a thematic cluster are considered as those publications with the highest number of connections with other publications in the same cluster.

[2]The following databases are used to conduct the keyword search: Google Scholar; ISI Web of Science; IEEE Xplore; Scopus; SpringerLink; Engineering Village; ScienceDirect; and Taylor and Francis Online. Considering the specific interest of this study for smart cities, a decision was made to set the keyword search so that only the scholarly publications containing the singular of plural form of the term 'smart city' are identified and not the literature using other terms that are considered as equivalent despite having different meanings (Hollands 2008). These terms include sustainable cities, green cities, digital cities, intelligent cities, smarter cities, information cities, resilient cities, eco cities, low-carbon cities and liveable cities. This choice is based on research by de Jong et al. (2015), which reveals these categories of cities are characterized by conceptual and practical differences and cannot be used interchangeably with the term "smart city".

[3]Grey literature can be considered as "*all the scholarly work that is published without a formal peer-review (or equivalent) process outside the traditional journal and book channels*" (Schopfel 2010).

a node. Only 124 source documents are included in the network, where the nodes that are co-cited are connected with an edge. The total number of edges is 45,534 and their weight is measured considering the CoCit-Score, which is calculated according to the formula proposed by Allmayer and Winkler (2013) and Gmur (2003). Subsequently, nodes and edges are entered into the open source software Gephi (Version 0.8.2-beta) and the co-citation network is graphically visualized. The result is an undirected and weighted network which is subsequently split into sub-networks using Gephi's modularity-class algorithm. The sub-networks represent the thematic clusters, i.e., groups of densely connected publications that are used to identify the main development paths within the smart-city research field.

3 Results of Data Processing

The results obtained through data processing are summarized in Table 1 and displayed in Fig. 1, which graphically represents the co-citation network. Within the network, each publication is represented as a node in which the size of the circle is proportional to its degree of centrality. This attribute is calculated by adding up the number of times the publication is co-cited. The greater the quantity of co-citations associated with a node, the greater its number of links within the network and, consequently, its centrality in the whole system. The same approach is extended to clusters by summing up the values obtained for each of their publications.

The network is composed of 18 thematic clusters in which the distribution of source documents varies considerably. The clusters are labelled from mc.01 to mc.18, and how they breakdown is shown in Table 1. The sub-networks mc.02, mc.05, mc.08, mc.14 and mc.17 can be considered as the main thematic clusters. In addition to containing the largest number of publications, they also include most of the source documents. Given their dominant role in the co-citation network, these clusters are used to provide insight into the intellectual structure of the smart-city research field. To achieve this aim, their content is analyzed by combining the use of core documents (Glanzel and Czerwon 1996; Glanzel and Thijs 2011; Meyer et al. 2013) and word profiles (Braam et al. 1991a, b).

Five core documents for each cluster are selected by considering the in-degree measurement of the publications falling into them. This attribute represents the sum of internal relationships that a document has with other publications of the same cluster and can be used for measuring the degree of centrality in that cluster (Gmur 2003). Because of their high connectivity, these documents provide most of the information about the content of the clusters. A list of the core documents is provided in Table 2.

In addition, for each of the five clusters, a word profile with ten keywords is built by combining the full-texts of its source documents. More specifically, a file containing the textual data of each source document is created. These text files are then analyzed using the software WordStat (Version 6.0) to extract and combine the

Table 1 Thematic clusters' size and degree of centrality

Cluster	Size no publications	% on total	No source doc.	Degree of centrality
mc.01	57	2.5	0	2944
mc.02	**578**	**25.4**	**18**	**15,435**
mc.03	25	1.1	0	449
mc.04	26	1.1	0	461
mc.05	**306**	**13.5**	**9**	**16,446**
mc.06	78	3.4	1	1811
mc.07	109	4.8	4	4636
mc.08	**283**	**12.4**	**35**	**11,373**
mc.09	56	2.5	1	1400
mc.10	6	0.3	0	30
mc.11	21	0.9	0	382
mc.12	3	0.1	0	6
mc.13	6	0.3	0	30
mc.14	**261**	**11.5**	**22**	**4120**
mc.15	13	0.6	1	183
mc.16	58	2.6	1	2710
mc.17	**324**	**14.2**	**32**	**24,206**
mc.18	63	2.8	0	4446
Total	2273		124	

Main clusters are in bold

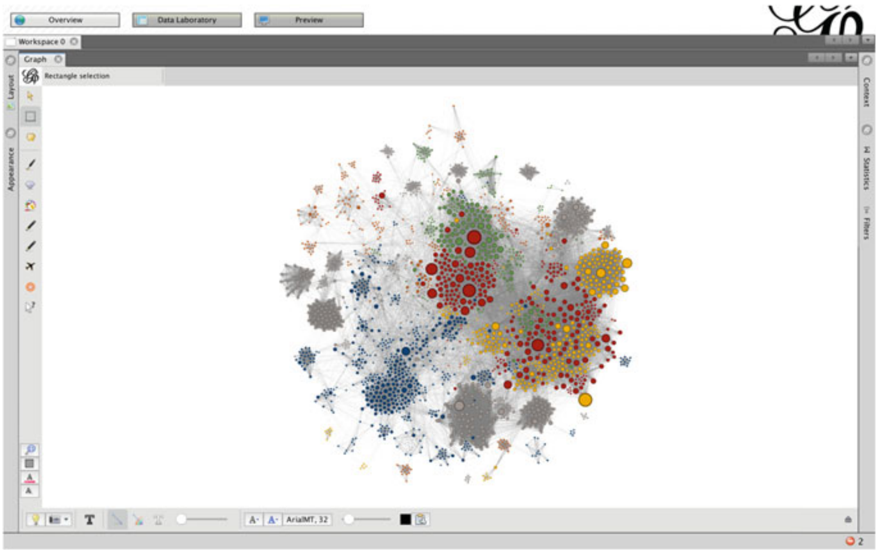

Fig. 1 Co-citation network: the intellectual structure of the smart-city research field for the period 1992–2012. Screenshot from Gephi. Within the network, each publication is represented as a node in which the size of the circle is proportional to its degree of centrality. Blue: mc.02; yellow: mc.05; green: mc.08; orange: mc.14; red: mc.17; grey: others

Table 2 Core documents

Cluster	Core document Reference	Title	Year	Type	In-degree
mc.02	Weiser (1991)	The computer for the 21st century	1991	Art	185
mc.02	**Atzori et al. (2010)**	**The Internet of Things: a survey**	**2010**	**Art**	**100**
mc.02	Polastre et al. (2004)	Versatile low power media access for wireless sensor networks	2004	Conf	97
mc.02	ITU (2005)	ITU Internet Reports 2005: the Internet of Things	2005	Gr	90
mc.02	Sundmaeker et al. (2010)	Vision and challenges for realising the Internet of Things	2010	Bo	86
mc.05	Florida (2002)	The rise of the creative class: and how it's transforming work, leisure, community and everyday life	2002	Bo	157
mc.05	Landry (2000)	The creative city: a toolkit for urban innovation	2000	Bo	157
mc.05	Yigitcanlar et al. (2008b)	Creative urban regions: harnessing urban technologies to support knowledge city initiatives	2008	Bo	124
mc.05	Yigitcanlar et al. (2008b)	Knowledge-based urban development: planning and applications in the information era	2008	Bo	120
mc.05	Florida (2005)	Cities and the creative class	2005	Bo	106
mc.08	**Dirks et al. (2010)**	**Smarter cities for smarter growth: how cities can optimize their systems for the talent-based economy**	**2010**	**Gr**	**100**
mc.08	**Moss Kanter and Litow (2009)**	**Informed and interconnected: a manifesto for smarter cities**	**2009**	**Gr**	**90**
mc.08	**Dirks and Keeling (2009)**	**A vision of smarter cities: how cities can lead the way into a prosperous and sustainable future**	**2009**	**Gr**	**84**
mc.08	**Harrison et al. (2010)**	**Foundations for smarter cities**	**2010**	**Art**	**81**
mc.08	**Washburn et al. (2010)**	**Helping CIOs understand "Smart City" initiatives**	**2010**	**Gr**	**80**
mc.14	European Commission (2006)	European SmartGrids Technology Platform: vision for Europe's electricity networks of the future	2006	Bo	47
mc.14	US Department of Commerce—NIST (2010)	NIST framework and roadmap for smart-grid interoperability standards	2010	Grey	37
mc.14	**Karnouskos and Nass de Holanda (2009)**	**Simulation of a smart-grid city with software agents**	**2009**	**Conf**	**34**

(continued)

Table 2 (continued)

Cluster	Core document Reference	Title	Year	Type	In-degree
mc.14	**The Climate Group (2008)**	**SMART 2020: enabling the low carbon economy in the information age**	**2008**	**Gr**	**28**
mc.14	**European Commission (2009a)**	**Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Investing in the development of low carbon technologies (SET-Plan)**	**2009**	**Gr**	**26**
mc.17	**Komninos (2002)**	**Intelligent cities: innovation, knowledge, systems and digital spaces**	**2002**	**Bo**	**194**
mc.17	**Caragliu et al. (2009)**	**Smart cities in Europe**	**2009**	**Conf**	**180**
mc.17	Ishida and Isbister (2000)	Digital cities: technologies, experiences, and future perspectives	2000	Bo	170
mc.17	Komninos (2006)	The architecture of intelligent cities: integrating human, collective and artificial intelligence to enhance knowledge and innovation	2006	Conf	162
mc.17	Graham (2004b)	The cybercities reader	2004	Bo	160

Source documents are in bold. *Bo* books; *Art* articles published in scholarly journals; *Conf* conference papers; *Gr* grey literature

words and phrases contained in the source documents and estimate their frequency and occurrence. The keywords included in the word profiles are the phrases with the highest frequency that are found in at least 30% of the source documents belonging to the cluster (see Table 3).

4 The Smart-City Research Field: Main Development Paths

After completing the bibliometric analysis, word profiles and core documents are used to outline an in-depth description of the main thematic clusters and to shed light on the main development paths emerging from the intellectual structure of the smart city research field.

Table 3 Word profiles

Cluster	Word profile
mc.02	**INFORMATION TECHNOLOGY** (fr. 1998–oc. 100.0%); **INTERNET OF THING** (fr. 1433–oc. 38.9%); **UBIQUITOUS COMPUTING** (fr. 517–oc. 38.9%); **INFORMATION AND COMMUNICATION TECHNOLOGY** (fr. 494–oc. 38.9%); **SENSOR NETWORK** (fr. 215–oc. 61.1%); **MOBILE DEVICE** (fr. 175–oc. 44.4%); **MOBILE PHONE** (fr. 171–oc. 55.6%); **RFID TAG** (fr. 136–oc. 33.3%); **SMART CITY** (fr. 128–oc. 100.0%); **WIRELESS SENSOR** (fr. 116–oc. 61.1%)
mc.05	**INFORMATION TECHNOLOGY** (fr. 293–oc. 100.0%); **INFORMATION AND COMMUNICATION TECHNOLOGY** (fr. 157–oc. 77.8%); **KNOWLEDGE CITY** (fr. 73–oc. 55.6%); **URBAN DEVELOPMENT** (fr. 55–oc. 66.7%); **LOCAL GOVERNMENT** (fr. 47–oc. 66.7%); **ECONOMIC DEVELOPMENT** (fr. 46–oc. 66.7%); **SMART CITY** (fr. 39–oc. 100.0%); **URBAN INFRASTRUCTURE** (fr. 39–oc. 44.4%); **UBIQUITOUS COMPUTING** (fr. 27–oc. 33.3%); **KNOWLEDGE ECONOMY** (fr. 25–oc. 55.6%)
mc.08	**INFORMATION TECHNOLOGY** (fr. 2265–oc. 100.0%); **SMART CITY** (fr. 838–oc. 100.0%); **INFORMATION AND COMMUNICATION TECHNOLOGY** (fr. 354–oc. 62.9%); **DIGITAL CITY** (fr. 235–oc. 34.3%); **LOCAL GOVERNMENT** (fr. 87–oc. 45.7%); **QUALITY OF LIFE** (fr. 79–oc. 48.6%); **SMARTER CITY** (fr. 68–oc. 31.4%); **CITY INFRASTRUCTURE** (fr. 56–oc. 31.4%); **PUBLIC SERVICE** (fr. 55–oc. 48.6%); **URBAN DEVELOPMENT** (fr. 50–oc. 37.1%)
mc.14	**INFORMATION TECHNOLOGY** (fr. 642–oc. 100.0%); **INFORMATION AND COMMUNICATION TECHNOLOGY** (fr. 471–oc. 73.9%); **SMART CITY** (fr. 307–oc. 100.0%); **ENERGY EFFICIENCY** (fr. 129–oc. 56.5%); **SMART GRID** (fr. 105–oc. 52.2%); **CLIMATE CHANGE** (fr. 84–oc. 34.8%); **ENERGY CONSUMPTION** (fr. 70–oc. 60.9%); **URBAN DEVELOPMENT** (fr. 63–oc. 30.4%); **SMART METER** (fr. 55–oc. 56.5%); **RENEWABLE ENERGY** (fr. 51–oc. 34.8%)
mc.17	**INFORMATION TECHNOLOGY** (fr. 2056–oc. 96.9%); **SMART CITY** (fr. 1148–oc. 100.0%); **INTELLIGENT CITY** (fr. 586–oc. 53.1%); **INFORMATION AND COMMUNICATION TECHNOLOGY** (fr. 426–oc. 78.1%); **LIVING LAB** (fr. 296–oc. 46.9%); **DIGITAL CITY** (fr. 280–oc. 37.5%); **INNOVATION SYSTEM** (fr. 273–oc. 34.4%); **INTERNET OF THING** (fr. 161–oc. 31.3%); **SOCIAL CAPITAL** (fr. 129–oc. 40.6%); **URBAN DEVELOPMENT** (fr. 98–oc. 59.4%)

Frequency (fr.): number of times the keyword appears in the cluster's source documents; Occurrence (oc.): percentage of cluster's source documents in which the keyword is included

4.1 Cluster Mc.02—Experimental Path: Smart Cities as Testbeds for IoT Solutions

Interest in the technological component is dominant in the smart-city research field and represents one of the main driving forces behind its progressive growth. This becomes evident by observing the clusters' word profiles, in which Information Technology (IT) and Information and Communication Technology (ICT) are always two of the keywords with the highest frequency. Additional evidence is also provided by the content analysis of the sub-network mc.02, which is the largest thematic cluster of the co-citation network. 25.4% of the total 2273 publications are part of this cluster, where research focuses attention on ICT devices and infrastructures that have enabled ubiquitous computing and the Internet of Things (IoT), and stresses the potential contribution that they can offer in supporting cities' sustainable development. Some of the technological components discussed in the core documents are indeed included in the cluster's word profile: sensor networks; RFID tags; mobile devices; mobile phones; and wireless sensors.

Ubiquitous computing is one of the key technical visions underlying the IoT (ITU 2005) and originates from the work carried out by a group of researchers at Xerox PARC in Palo Alto, California. This group was led by Weiser (1991), who was the first to discuss this concept in a scholarly publication. As explained by Weiser et al. (1999), ubiquitous computing is based on the idea of spreading computers throughout the physical environment, moving away from the one-person-one-computer paradigm. According to his vision, formulated in the early 1990s, computers will be diffused in the real world and interconnected by ubiquitous networks. In addition, they will be able to control a countless range of functions in the physical space and work without human intervention, as autonomous and invisible agents (Weiser 1993). This vision becomes a reality with the advent of wireless technologies that activate a large number of networks composed of physical objects containing embedded technology to populate the Internet and communicate, sense and interact with both their internal states and the external environment in a completely autonomous way (Mitchell 2003).

This emerging wave of Internet-connected things leads to the appearance of the IoT, a new concept which is rapidly growing within the scenario of the potential benefits of ICTs in the sustainable development of urban environments. Despite difficulties in understanding what this term really means, due to the numerous interpretations provided by the scientific community, "*the basic idea of this concept is the pervasive presence around us of a variety of things or objects, such as Radio-Frequency IDentification (RFID) tags, sensors, actuators, mobile phones,* etc.*, which […] are able to interact with each other and cooperate with their neighbors to reach common goals*" (Atzori et al. 2010: 2787). All these things can be called smart objects, that are "*small computers with a sensor or actuator and a communication device, embedded in objects such as thermometers, car engines, light switches and industry machinery [which] enable a wide range of applications*" (Sundmaeker et al. 2010: 15).

The IoT can be considered as an integral part of the Future Internet (Atzori et al. 2010; ITU 2005; Tselentis et al. 2009) and an extension of the existing Internet, which generates new digital services and applications. The fields of application are many and include agriculture, home automation, building automation, factory monitoring, health-management systems, education, smart grids, transportation and, in a broader vision, smart cities (Holler et al. 2014; Sundmaeker et al. 2010). As reported by Miorandi et al. (2012: 1510), indeed, "*IoT technologies can find a number of diverse applications in smart cities' scenarios*". Based on this assumption, the thematic cluster mc.02 interprets smart cities as cities and urban territories that become testbeds for experimenting IoT technologies and analyzing their functioning, relevance and potential impact in real-life environments, as in the case of Santander, that is described in the cluster's publications (Sanchez et al. 2011, 2013).

Located on the north coast of Spain, this small city has become an urban laboratory for the European research project SmartSantander. During the project, Santander and its surroundings have been equipped with more than 12,000 IoT devices (Sanchez et al. 2011) and transformed into "*a European experimental test facility for the research and experimentation of architectures, key enabling technologies, services and applications for the IoT in the context of a smart city*" (Sanchez et al. 2013: 1). According to the consortium leading the project, this facility should be "*instrumental in fostering key enabling technologies for IoT and providing the research community with a […] platform for large scale IoT experimentation and evaluation under realistic operational conditions*" (Sanchez et al. 2013: 1).

4.2 Cluster Mc.05—Ubiquitous Path: The Korean Experience of Ubiquitous Cities

Within the cluster mc.05, smart city and ubiquitous city are considered as two equivalent terms (Lee et al. 2008). Both are described as a technical evolution of the knowledge-city concept, which is discussed in a number of source documents of this thematic cluster (Dvir and Pasher 2004; Yigitcanlar et al. 2008a, d) and in the core documents published by Yigitcanlar et al. (2008b, c). Knowledge city is a term resulting from research on the knowledge economy and is used to identify cities where knowledge production is one of the main key drivers of their development strategy (Yigitcanlar et al. 2008d). As suggested by Yigitcanlar et al. (2008b), in the knowledge economy, urban development is mainly driven by global market forces and the role of knowledge in wealth creation has become a critical issue for cities. Therefore, it is necessary to define new approaches able to exploit the opportunities this abstract production offers for supporting sustainable growth and innovation in urban environments. This idea is supported in research carried out in the early years of 2000s by Landry (2000) and Florida (2002, 2005), both engaged in discussing and demonstrating the growing importance of knowledge and information in urban development processes, especially in terms of economic development and competitiveness.

Knowledge cities "*firmly encourage and nurture locally focused innovation, science and creativity within the context of an expanding knowledge economy and society*" (Yigitcanlar et al. 2008a: 63). This implies the progressive implementation of a growth-oriented path based on more viable and sustainable models of urban development. According to Yigitcanlar et al. (2008a) and Lee et al. (2008), the possibility to achieve this aim by leveraging ICTs has marked the shift from the knowledge city to the ubiquitous city (or u-city). This term comes from the concept of ubiquitous computing proposed by Weiser (1991) and is used to identify urban areas equipped with ubiquitous technologies that offer citizens and visitors the possibility to use digital services anywhere and anytime. Such services provide them with access to data and information, mainly collected in real time, which describe the functioning of the city (Shin 2007, 2010; Shin and Kim 2010; Lee et al. 2008). Ubiquitous cities are therefore places where all information systems are linked together and everyone is connected to them (Shin and Kim 2010).

Most of the attention received by this concept comes from the Republic of Korea, where a national program on ubiquitous cities was launched by the central government in 2007. The aim was building the world's first u-society based on the world's best u-infrastructure (Republic of Korea 2007b). Only a few practical experiences linked to the ubiquitous city concept and developed outside the Korean territory can be found in scholarly literature. For example, Anthopoulos and Fitsilis (2010a, b) describe the activity developed by the city of Trikala, Greece, while research by Gil-Castineira et al. (2011) and Shin and Lee (2011) report on a number of projects that are implemented in Oulu, San Francisco, Philadelphia, Tokyo, Singapore, Hong Kong, Taiwan and Malaysia.

The initiative of the South Korean government has driven many municipal administrations to integrate ubiquitous technologies in their urban environments. In 2007, the construction of u-cities extended to 22 cities (Republic of Korea 2007a), and, only three years later, they become 36, with a total number of 53 ubiquitous city initiatives in progress (Tekes 2011). Among the many projects developed under the ubiquitous city brand, Busan Green u-City, Songdo International Business District and Incheon Eco-City seem to be the most discussed in the cluster's literature, in which they are described overlapping the terms smart city and u-city[4] (GSMA 2012; Strickland 2011; Juan et al. 2011).

The Korean experience of ubiquitous cities has been analyzed in-depth and criticized by Shin (2007, 2009, 2010). His research sheds light on the limits and weaknesses of this national program, which is based on a top-down approach and "*is largely biased toward industrial and economic development, reflecting business providers' interests and leaving out users' […] benefits*" (Shin 2007: 636). According to Shin (2009, 2010), the many actors involved in the development of u-cities only appear to be interested in technical and market perspectives, competitiveness, financial aspects and economic impacts, rather than city users and their needs. As a consequence, "*South Korean u-cities, in general, fall short of the ontologically bounded […] information society [and] tend to be designed primarily to serve the demands of major corporate suppliers and industry at the expense of public interests. The primary driving force to develop the u-cities has been the arrangement or outlay of technological equipment to increase technical capability*" (Shin 2009: 516).

[4]This tendency can also be found in more recent studies by Yigitcanlar and Lee (2014), Clarke (2013) and Shwayri (2013).

4.3 Cluster Mc.08—Corporate Path: IBM and the Corporate Smart-City Model

The technology-led vision of smart cities proposed in the cluster mc.05 is the engine that fuels ICT multinational companies and their involvement in the smart city market, which is expected to exceed hundreds of billion dollars by 2020 (Zanella et al. 2014; Buscher and Doody 2013). Driven by the will to acquire a strong position in this new and promising market, companies such as Cisco Systems (Amato et al. 2012a, b, c), Hitachi (Kohno et al. 2011; Kurebayashi et al. 2011; Yoshikawa et al. 2011), Fujitsu (Tamai 2014) and IBM (Brech et al. 2011; Cosgrove et al. 2011; Kehoe et al. 2011; Katz and Ruano 2011; Paul et al. 2011; Ruano et al. 2011; Schaefer et al. 2011; Chen-Ritzo et al. 2009; Harrison et al. 2010, 2011) have started working in the domain of urban technology and feeding the smart-city debate.

This trend has led to the growth of the corporate smart-city model discussed and criticized in recent research by Hollands (2008, 2015, 2016), Townsend (2013), Soderstrom et al. (2014) and McNeill (2016). According to Hollands (2015), in the corporate model, the smart city represents a technology-led urban utopia. Cities are conceived as systems of systems affected by inefficiencies that can be eliminated by using a massive dose of technological solutions provided by ICT companies (Soderstrom et al. 2014). The presence of these technologies automatically enable the transformation of ordinary urban environments in smart cities.

The corporate smart-city model has resulted in a new urbanism, whereby IT solution providers try to persuade municipalities to support urban development by adopting their smart technologies. IBM is one of the main supporter of this model and its relevant role and influence in the smart-city debate are demonstrated by the content analysis of the thematic cluster mc.08. This sub-network is almost totally linked to the vision proposed by the US multinational company. The cluster's most-cited source documents are produced by its researchers and their degree of centrality is significantly high (Moss Kanter and Litow 2009; Dirks et al. 2009, 2010; Dirks and Keeling 2009; Harrison et al. 2010), indeed, four out of five core documents are publications from IBM. What is more, the word profile contains the term smarter city, which is a trademark officially registered by this company and used for its smart-city campaign, under the motto: Building a Smarter Planet (Palmisano 2008).

The IBM's Smarter Planet initiative is a commercial venture launched at the end of 2008 and has positioned IBM at the forefront of smart city construction (Palmisano 2008; IBM Corporation 2017). Many cities all over the world have embraced its view of a smart city, which is based on the following assumption: to build a smarter planet, its cities need to be instrumented, interconnected and intelligent (Harrison et al. 2010). As explained by Dirks et al. (2009: 1): "*Instrumentation enables cities to gather more high-quality data in a timely fashion than ever before. For example, utility meters and sensors that monitor the capacity of the power generation network can be used to continually gather data on supply* *and demand of electricity […]. Interconnection creates links among data, systems and people […], opening up new ways to gather and share information. Intelligence—in the form of new kinds of computing models and new algorithms—enables cities to generate predictive insights for informed decision making and action. Combined with advanced analytics and ever-increasing storage and computing power, these new models can turn the mountains of data generated into intelligence to create insight as a basis for action*". According to IBM, this ICT-based transformation can automatically make any city smarter and, consequently, more efficient, democratic, livable, attractive, environment-friendly, and economically prosperous (Dirks and Keeling 2009).

One of the flagship project falling within the Smarter Planet initiative has been developed in Rio de Janeiro. With an investment of 14 million dollars, the municipal administration has worked with IBM to build an emergency response system. Their collaboration has resulted in the Rio Operations Center, which opened at the end of 2010. The Center is based on a digital platform applying the analytical models developed by IBM, which are asked to: (1) provide a holistic view of how the city is functioning; and (2) predict possible emergency situations, especially flood-related incidents, because every summer Rio de Janeiro faces the consequences of intense rainfall, including landslides and flooding. The data used for predicting emergency includes: real-time images captured by a surveillance system with 900 cameras located around the city; weather sensors; historical data series; and the messages that are sent by the city's users via phone, Internet and radio (IBM Corporation 2011; Naphade et al. 2011; Kitchin 2014). The project has been criticized because: the top-down surveillance system generates negative social implications in terms of privacy; the civil society has not been engaged and actively involved in the implementation process; and IBM's technological solutions and computer algorithms are put in charge of city management, leaving very limited space for the human component (Singer 2012; Townsend 2013).

4.4 Cluster Mc.14—European Path: Smart City for a Low-Carbon Economy

According to data provided by the American Association for the Advancement of Science (2001) and the United Nations Human Settlements Programme (2011), urban areas: host more than 50% of the world's population; consume about 70% of the global energy; and release more than 70% of the carbon dioxide, which is damaging the Earth's atmosphere. These numbers provide a clear picture of the role played by the urbanized world in intensifying the environmental crisis and accelerating climate change. Fighting against this situation has become one of the most relevant priority for local and national governments, which are offering their contribution by implementing sustainable energy policies, initiatives and projects.

ICTs have proven to be a decisive means in helping governments to face up to this critical situation and enable the progressive growth of a low-carbon future. The core documents of the thematic cluster mc.14 explore this possibility, in particular the report "*SMART 2020*" published by The Climate Group, an international non-profit organization that supports leaders in government, business world and society to address climate risks and accelerate the transition to a low-carbon economy. This report demonstrates the ICT industry's technological solutions can drastically unlock emissions reductions. More specifically, according to the authors, "*the biggest role ICTs could play is in helping to improve energy efficiency in power transmission and distribution (T&D), in buildings and factories that demand power, and in the use of transportation to deliver goods*" (The Climate Group 2008: 9). By acting on these five sectors, ICTs could "*deliver emissions saving of 15% […] of global […] emissions in 2020*" (The Climate Group 2008: 7).

This study and the other core documents make it clear that unlocking the potential of ICTs is the critical challenge which faces climate change globally. In addition, they identify the sector of smart grids as one of the most promising application domain. Smart grids are described as the electricity networks of the future because they improve the efficiency of current power transmission and distribution networks while responding to the new challenges and opportunities arising from the energy market (European Commission 2006; The Climate Group 2008; Karnouskos and Nass de Holanda 2009).

The importance and urgency of modernizing current electric power infrastructures by transforming them into smart grids is widely recognized. The Indian government has been developing policies to overcome barriers that limit the implementation of smart grid initiatives since 2001 (The Climate Group 2008). In 2005, the European Commission has set up the SmartGrids Technology Platform, in which all the relevant European stakeholders working in the energy sector have been included. Together, they designed a joint vision for the European energy network of 2020 and beyond that is based on activating smart-grid solutions across Europe (European Commission 2006). The same aim is pursued by the US government, where specific interoperability standards and protocols for smart-grid devices and systems have been established to accelerate their diffusion in the US territory (US Department of Commerce—NIST 2010).

Mobilizing ICTs to facilitate the transition to an energy-efficient and low-carbon economy is a key ambition of the European Union. This is demonstrated by the contents of the Strategic Energy Technology Plan (SET-Plan), that was published in 2009: a policy instrument that describes the strategy of the European Union for accelerating innovation in cutting-edge low-carbon technologies and their diffusion across Europe (European Commission 2009a).

This is the context in which the European interpretation of the smart-city concept supported in the cluster mc.14 has grown. As reported in the SET-plan, according to the European Commission, smart cities are those that will "*create the conditions to trigger the mass market take-up of energy efficiency technologies [by transforming] their buildings, energy networks and transport systems into those of the future, demonstrating transition concepts and strategies to a low carbon economy […].*

These cities will be the nuclei from which smart networks, a new generation of buildings and low carbon transport solutions will develop into European wide realities that will transform [the] energy system" (European Commission 2009a: 7).

4.5 Cluster Mc.17—Holistic Path: Digital, Intelligent, Smart

The thematic cluster mc.17 is the second sub-network of the system in terms of size and has the highest degree of centrality. Here the debate on smart cities is linked to the scientific foundations of "*urban ICT studies*" (Graham 2004a: 3), a sub-discipline of urban studies in which research aims at better understanding the relationship between ICT and the urban environment. This knowledge area starts growing between the end of 1990s and the early 2000s, and some of the first publications that have provided a significant contribution in laying down its intellectual structure are part of this cluster (Castells 1996; Graham and Marvin 1996, 2001; Mitchell 1995, 1999, 2003), including the book "*The Cybercities Reader*" (Graham 2004b), which is one of the core documents.

These publications and their authors started filling "*the gap left by the long neglect of telecommunications in urban studies and policy-making [by exploring] the complex and poorly understood set of relationships between telecommunications and the development, planning and management of contemporary cities*" (Graham and Marvin 1996: XII). In the meantime, cities all over the world started experimenting with the use of digital technologies for supporting urban innovation and development by implementing projects and initiatives which have been labeled by using three different terms: digital city; intelligent city; and smart city. These terms clearly emerges in both the cluster's word profile and the core documents by Ishida and Isbister (2000), Komninos (2002, 2006) and Caragliu et al. (2009).

The term digital city dates back to the end of the 20th century and is used as a label for a number of projects launched by European, North American and Asian cities (Ishida and Isbister 2000). These projects have resulted in the construction of websites that were used for providing access to cities' digital services. The aim was supporting social and economic development in urban environments (Aurigi and Graham 2000). Research by Aurigi (2000) shows that these websites were mainly used to: stimulate local economic development; improve the image of a city; widen access to the Internet and support community networking; support the implementation of online debates, discourses and communities; and improve the management of cities' physical infrastructures.

The digital city movement was very active in Europe, in which many cities have been involved in the construction of their digital counterparts (Aurigi 2000, 2003; Mino 2000). Successful experiences have been identified in Amsterdam (van den Besselaar 2001), Helsinki (de Bruine 2000), Antwerp, Newcastle upon Tyne (Peeters 2000; Firmino 2004), Bologna and Bristol (Aurigi 2003, 2005).

At the beginning of the 21st century, while the world was experiencing the construction of digital cities, the term intelligent city has emerged in research by Komninos (2002, 2006, 2008). Its interpretation is provided in a conference paper which was published in 2006: "*intelligent cities […] are territories with high capacity for learning and innovation, which is built-into the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management*" (Komninos 2006: 13). According to this definition, the distinguishing feature of intelligent cities is their capacity to exploit ICTs for supporting growth and innovation in urban environments while increasing the problem-solving capability of urban communities (Komninos 2002). Consequently, intelligent cities and digital cities share the same interest for ICT-driven urban development. However, while the former focuses attention on facilitating some aspects of the social and economic life of urban areas, in the latter ICT infrastructures and applications aim at strengthening their ability to produce new knowledge and innovation.

The transition from intelligent to smart seems to be the result of two different forces. On the one hand, there is the technological innovation in the ICT sector that has produced the huge wave of smart objects which are discussed in the cluster mc.02, opening up new possibilities in addressing cities' issues and development priorities using digital technologies (Komninos 2011; Schaffers et al. 2011). On the other hand, there is a request for a more progressive view of ICT-driven urban innovation strategies, which emerges in recent smart city literature (Caragliu et al. 2009; Hollands 2008; Schaffers et al. 2011; Paskaleva 2009; Ratti and Townsend 2011; Townsend et al. 2011; Deakin and Al Wear 2011; Leydesdorff and Deakin 2011) and is supported in the work previously undertaken by Aurigi (2005, 2006), Mino (2000), Graham and Marvin (1999) and Castells (1996).

These authors propose a holistic interpretation of smart cities in which human, social, cultural, environmental, economic and technological aspects stand alongside one another. In this cluster, smart cities are urban areas where ICT is adopted to meet local development needs, be they of social, economic or environmental nature, and the strategies for building smart cities are grounded in collective intelligence, participatory governance, collaboration, community-led urban development, open innovation and user-driven innovation.

5 Discussion and Conclusions

This paper reports on a bibliometric study of the first two decades of research on smart cities (1992–2012) in which co-citation cluster analysis and text-based analysis are combined to map the publications dealing with the smart-city concept and provide a visual representation of their organization. The clusters of publications that are thematically related are then identified and the emerging development paths of smart cities and the strategic perspectives each of them embodies are revealed. The analysis shows five main development paths:

1. Experimental Path, in which smart cities are described as urban testbeds for experimenting Internet of Things infrastructures and service applications and analyzing their functioning, relevance and potential impact in real-life environments;
2. Ubiquitous Path, where smart cities and ubiquitous cities overlap and are considered as two equivalent concepts;
3. Corporate Path, in which urban areas become smart when they are equipped with a platform of digital solutions provided by ICT consultancies;
4. European Path, which represents smart cities as highly efficient urban systems in which digital technologies are used to tackle environmental degradation and fight climate change by transforming buildings, energy networks and transport systems;
5. Holistic Path, where smart cities are considered as urban settlements in which digital technologies are assembled to meet local development needs and their development process is grounded in collective intelligence, participatory governance, collaborative association, community-led urban development and open and user-driven innovation.

By comparing the strategic perspectives for smart-city development that each path stands for, however, divergent choices seem to emerge. This requires future research to produce the scientific knowledge necessary to improve decision-making processes in the field of smart cities:

1. While the Experimental Path, Ubiquitous Path and Corporate Path suggest smart-city development requires a technology-driven and market-oriented approach, the Holistic Path proposes a human-centric and people-driven vision;
2. According to the Corporate Path and Ubiquitous Path, smart-city development needs to be top-down and centralized rather than bottom-up, decentralized and diffused, as the Holistic Path suggests;
3. The Corporate Path also suggests that smart cities result from a double-helix collaborative model, where IT solution providers try to sell their products to local governments, but the Holistic Path is oriented towards accessing a more open and inclusive collaborative model where university, industry, government and civil society work together;
4. The Holistic Path, Experimental Path, Ubiquitous Path and Corporate Path propose an integrated and multi-dimensional approach to smart-city development, which embraces as many smart-city domains as possible, and is opposed to the mono-dimensional intervention logic of the European Path, that focuses attention only on low-carbon technologies for smart transports, smart buildings and smart grids.

This study systematically captures the division affecting research on smart cities and provides the scientific knowledge necessary to start developing that clear and common understanding of smart cities which is still missing. However, an extension of this bibliometric analysis to the literature published after 2012 would be a relevant research activity for understanding whether and how the scenario represented in this paper and the smart-city development paths it reveals have evolved in relation to the most recently published material.

Appendix A

See Tables 1, 2 and 3.

References

Albino, V., Berardi, U., & Dangelico, R. M. (2015). Smart cities: Definitions, dimensions, performance, and initiatives. *Journal of Urban Technology, 22*(1), 3–21.

Alkandari, A., Alnasheet, M., & Alshekhly, I. F. (2012). Smart cities: Survey. *Journal of Advanced Computer Science and Technology Research, 2*(2), 79–90.

Allmayer, S., & Winkler, H. (2013). Interface management research in supplier–customer relationships: Findings from a citation analysis of international literature. *Journal of Business Economics, 83*(9), 1015–1061.

Amato, V., Bloomer, L., Holmes, A., & Kondepudi, S. (2012a). *Government competitiveness drives smart + connected communities initiative*. White paper. Cisco Systems. http://www.smartconnectedcommunities.org/docs/DOC-2174. Accessed January 4, 2013.

Amato, V., Bloomer, L., Holmes, A., & Kondepudi, S. (2012b). *Using ICT to deliver benefits to cities by enabling smart + connected communities*. White paper. Cisco Systems. http://www.smartconnectedcommunities.org/docs/DOC-2150. Accessed January 4, 2013.

Amato, V., Kondepudi, S., & Holmes, A. (2012c). *Transforming communities with smart + connected services*. White Paper. Cisco Systems. http://www.smartconnectedcommunities.org/docs/DOC-2129. Accessed January 4, 2013.

American Association for the Advancement of Science. (2001). *AAAS atlas of population and environment*. Oakland, CA: University of California Press.

Anthopoulos, L., & Fitsilis, P. (2010a). From digital to ubiquitous cities: Defining a common architecture for urban development. In V. Callaghan, A. Kameas, S. Egerton, I. Satoh, & M. Weber (Eds.), *Proceedings 2010 Sixth International Conference on Intelligent Environments (IE), Kuala Lumpur, 19–21 July 2012* (pp. 301–306). Piscataway, NJ: Institute of Electrical and Electronics Engineers (IEEE).

Anthopoulos, L., & Fitsilis, P. (2010b). From Online to Ubiquitous cities: The technical transformation of virtual communities. In A. B. Sideridis & C. Z. Patrikakis (Eds.), *Next Generation Society. Technological and Legal Issues: Third International Conference, E-Democracy 2009, Athens, Greece, September 23–25, 2009, Revised Selected Papers* (pp. 360–372). Berlin: Springer.

Atzori, L., Iera, A., & Morabito, G. (2010). The internet of things: A survey. *Computer Networks, 54*(15), 2787–2805.

Aurigi, A. (2000). Digital city or urban simulator? In T. Ishida & K. Isbister (Eds.), *Digital cities: Technologies, experiences and future perspectives* (pp. 33–44). Berlin: Springer.

Aurigi, A. (2003). *The first steps of digital cities: Development of social shaping of web-based urban cyberspace in Europe* (Doctoral thesis). University of Newcastle upon Tyne. https://theses.ncl.ac.uk/dspace/handle/10443/506. Accessed May 13, 2014.

Aurigi, A. (2005). Urban cyberspace as a social construction: Non-technological factors in the shaping of digital Bristol. In P. van den Besselaar & S. Koizumi (Eds.), *Digital Cities III. Information Technologies for Social Capital: Cross-cultural Perspectives. Third International Digital Cities Workshop, Amsterdam, the Netherlands, September 18–19, 2003. Revised Selected Papers* (pp. 97–112). Berlin: Springer.

Aurigi, A. (2006). New technologies, same dilemmas: Policy and design issues for the augmented city. *Journal of Urban Technology, 13*(3), 5–28.

Aurigi, A., & Graham, S. (2000). Cyberspace and the city: The "virtual city" in Europe. In G. Bridge & S. Watson (Eds.), *A companion to the city* (pp. 489–502). Malden, MA: Blackwell Publishing.

Bolici, R., & Mora, L. (2015). Urban regeneration in the digital era: How to develop smart city strategies in large European cities. *TECHNE: Journal of Technology for Architecture and Environment, 5*(2), 110–119.

Braam, R. R., Moed, H. F., & van Raan, A. F. J. (1991a). Mapping of science by combined co-citation and word analysis. I: Structural aspects. *Journal of the American Society for Information Science and Technology, 42*(4), 233–251.

Braam, R. R., Moed, H. F., & van Raan, A. F. J. (1991b). Mapping of science by combined co-citation and word analysis. II: Dynamical aspects. *Journal of the American Society for Information Science and Technology, 42*(4), 252–266.

Brech, B., Rajan, R., Fletcher, J., Harrison, C., Hayes, M., & Hogan, J. (2011). Smarter cities series: Understanding the IBM approach to efficient Buildings. *IBM Corporation*. http://www.redbooks.ibm.com/redpapers/pdfs/redp4735.pdf. Accessed September 14, 2012.

Buscher, V., & Doody, L. (2013). *The smart city market: Opportunities for the UK*. BIS research paper no 136, United Kingdom Government—Department for Business, Innovation and Skills. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/249423/bis-13-1217-smart-city-market-opportunties-uk.pdf. Accessed January 23, 2014.

Caragliu, A., Del Bo, C., & Nijkamp, P. (2009). *Smart cities in Europe*. Paper presented at 3rd Central European Conference in Regional Science, Kosice, 7–9 October 2009. http://www.inta-aivn.org/images/cc/Urbanism/background%20documents/01_03_Nijkamp.pdf. Accessed December 29, 2012.

Castells, M. (1996). *The rise of the network society*. Oxford: Balckwell Publishing Ltd.

Chen-Ritzo, C., Harrison, C., Paraszczak, J., & Parr, F. (2009). Instrumenting the planet. *IBM Journal of Research and Development, 53*(3), 338–353.

Chourabi, H., Nam, T., Walker, S., Gil-Garcia, R. J., Mellouli, S., & Nahon, K. (2012). Understanding smart cities: An integrative framework. In R. H. Sprague (Ed.), *Proceedings of the 45th Hawaii International Conference on System Sciences (HICSS), Maui, HI, 04–07 January 2012* (pp. 2289–2297). Piscataway, NJ: Institute of Electrical and Electronics Engineers (IEEE).

Clarke, R. Y. (2013). Smart cities and the internet of everything: The foundation for delivering next-generation citizen services. *White paper. International Data Corporation (IDC)*. http://www.cisco.com/web/strategy/docs/scc/ioe_citizen_svcs_white_paper_idc_2013.pdf. Accessed April 1, 2014.

Cosgrove, M., Harthoorn, W., Hogan, J., Jabbar, R., Kehoe, M., & Meegan, J. (2011). Smarter cities series: Introducing the IBM city operations and management solution. *IBM Corporation*. http://www.redbooks.ibm.com/redpapers/pdfs/redp4734.pdf. Accessed September 14, 2012.

de Bruine, A. (2000). Digital city Bristol: A case study. In T. Ishida & K. Isbister (Eds.), *Digital cities: Technologies, experiences and future perspectives* (pp. 110–124). Berlin: Springer.

de Jong, M., Joss, S., Schraven, D., Zhan, C., & Weijnen, M. (2015). Sustainable-smart-resilient-low carbon-eco-knowledge cities; making sense of a multitude of concepts promoting sustainable urbanization. *Journal of Cleaner Production, 109,* 25–38.

Deakin, M. (Ed.). (2013). *Smart cities: Governing, modelling and analysing the transition*. New York City, NY: Routledge.

Deakin, M., & Al Wear, H. (2011). From intelligent to smart cities. *Intelligent Buildings International, 3*(3), 140–152.

Dirks, S., Gurdgiev, C., & Keeling, M. (2010). *Smarter cities for smarter growth: How cities can optimize their systems for the talent-based economy* (Executive report). IBM Corporation. http://public.dhe.ibm.com/common/ssi/ecm/en/gbe03348usen/GBE03348USEN.PDF. Accessed February 3, 2012.

Dirks, S., & Keeling, M. (2009). *A vision of smarter cities: How cities can lead the way into a prosperous and sustainable future* (Executive report). IBM Corporation. http://www-03.ibm.com/press/attachments/IBV_Smarter_Cities_-_Final.pdf. Accessed February 3, 2012.

Dirks, S., Keeling, M., & Dencik, J. (2009). *How smart is your city: Helping cities measure progress* (Executive report). IBM Corporation. http://public.dhe.ibm.com/common/ssi/ecm/en/gbe03248usen/GBE03248USEN.PDF. Accessed June 6, 2014.

Dvir, R., & Pasher, E. (2004). Innovation engines for knowledge cities: An innovation ecology perspective. *Journal of Knowledge Management, 8*(5), 16–27.

European Commission. (2006). *European smartgrids technology platform: Vision for Europe's electricity networks of the future*. Belgium: European Union.

European Commission. (2009a). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions. Investing in the Development of Low Carbon Technologies (SET-Plan). COM (2009) 519 final. European Commission. http://eur-lex.europa.eu/legal-content/IT/TXT/PDF/?uri=CELEX:52009DC0519&from=EN. Accessed February 2, 2014.

European Commission. (2009b). Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on Mobilising Information and Communication Technologies to Facilitate the Transition to An Energy Efficient, Low-carbon Economy. COM(2009) 111 final. European Commission. http://ec.europa.eu/information_society/activities/sustainable_growth/docs/com_2009_111/com2009-111-en.pdf. Accessed February 2, 2014.

Firmino, R. J. (2004). Building the virtual city: The dilemmas of integrating strategies for urban and electronic spaces (Ph.D. thesis). University of Newcastle upon Tyne. http://www.academia.edu/1112229/Building_the_virtual_city_the_dilemmas_of_integrating_strategies_for_urban_and_electronic_spaces. Accessed September 1, 2014.

Florida, R. (2002). *The rise of the creative class: And how it's transforming work, leisure, community and everyday life*. New York City, NY: Basic Books.

Florida, R. (2005). *Cities and the creative class*. New York City, NY: Routledge.

Gil-Castineira, F., Costa-Montenegro, E., Francisco, J. G., Lopez-Bravo, C., Ojala, T., & Bose, R. (2011). Experiences inside the ubiquitous Oulu smart city. *Computer, 44*(6), 48–55.

Glanzel, W., & Czerwon, H. J. (1996). A new methodological approach to bibliographic coupling and its application to the national. *Regional and Institutional Level. Scientometrics, 37*(2), 195–221.

Glanzel, W., & Thijs, B. (2011). Using 'core documents' for the representation of clusters and topics. *Scientometrics, 88*(1), 297–309.

Gmur, M. (2003). Co-citation analysis and the search for invisible colleges: A methodological evaluation. *Scientometrics, 57*(1), 27–57.

Graham, S. (2004a). Introduction: From dreams of transcendence to the remediation of urban life. In S. Graham (Ed.), *The cybercities reader* (pp. 1–29). New York, United States: Routledge.

Graham, S. (Ed.). (2004b). *The cybercities reader*. New York City, NY: Routledge.

Graham, S., & Marvin, S. (1996). *Telecommunications and the city: Electronic spaces, urban places*. New York City, NY: Routledge.

Graham, S., & Marvin, S. (1999). Planning cyber-cities? Integrating telecommunications into urban planning. *Town Planning Review, 70*(1), 89–114.

Graham, S., & Marvin, S. (2001). *Splintering urbanism: Networked infrastructures, technological mobilities and the urban condition*. New York City, NY: Routledge.

GSMA. (2012). *South Korea: Busan green u-city* (Report). GSMA. http://www.gsma.com/connectedliving/wp-content/uploads/2012/08/cl_busan_08_121.pdf. Accessed June 20, 2013.

Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., et al. (2010). Foundations for smarter cities. *IBM Journal of Research and Development, 54*(4), 1–16.

Harrison, C., Paraszczak, J., & Williams, R. P. (2011). Preface: Smarter cities. *IBM Journal of Research and Development, 55*(1–2), 1–5.

Hollands, R. G. (2008). Will the real smart city please stand up? *City: Analysis of Urban Trends, Culture, Theory, Policy, Action, 12*(3), 303–320.

Hollands, R. G. (2015). Critical interventions into the corporate smart city. *Cambridge Journal of Regions, Economy and Society, 8*(1), 61–77.

Hollands, R. G. (2016). Beyond the corporate smart city? Glimpses of other possibilities of smartness. In S. Marvin, A. Luque-Ayala, & C. McFarlane (Eds.), *Smart urbanism: Utopian vision or false dawn?* (pp. 168–184). New York City, NY: Routledge.

Holler, J., Tsiatsis, V., Avesand, S., Karnouskos, S., & Boyle, D. (2014). *From machine-to-machine to the internet of things: Introduction to a new age of intelligence*. Oxford: Elsevier.

IBM Corporation. (2011). *City of Rio De Janeiro and IBM collaborate to advance emergency response system* (Press release). IBM Corporation. http://www-03.ibm.com/press/us/en/pressrelease/35945.wss. Accessed October 12, 2012.

IBM Corporation. (2017). *IBM Smarter Planet*. http://www.ibm.com/smarterplanet. Accessed February 15, 2015.

Ingwersen, P., Larsen, B., Garcia-Zorita, J. C., Serrano-Lopez, A. E., & Sanz-Casado, E. (2014). Influence of proceedings papers on citation impact in seven sub-fields of sustainable energy research 2005–2011. *Scientometrics, 101*(2), 1273–1292.

Ishida, T., & Isbister, K. (Eds.). (2000). *Digital cities: Technologies, experiences and future perspectives*. Berlin: Springer.

ITU. (2005). *ITU internet reports 2005: The internet of things*. International Telecommunication Union. http://www.itu.int/osg/spu/publications/internetofthings/. Accessed June 4, 2014.

Juan, Y. K., Wang, L., Wang, J., Leckie, J., & Li, K. M. (2011). A Decision-support system for smarter city planning and management. *IBM Journal of Research and Development, 55*(1–2), 3:1–3:12.

Karnouskos, S., & Nass de Holanda, T. (2009). Simulation of a smart grid city with software agents. In *EMS '09: Third UKSim European Symposium on Computer Modeling and Simulation, Athens, 25–27 November 2009* (pp. 424–429). Piscataway, NJ: Institute of Electrical and Electronics Engineers (IEEE).

Katz, J. S., & Ruano, J. (2011). Smarter cities series: Understanding the IBM approach to energy innovation. *IBM Corporation*. http://www.redbooks.ibm.com/redpapers/pdfs/redp4739.pdf. Accessed September 14, 2012.

Kehoe, M., Cosgrove, M., De Gennaro, S., Harrison, C., Harthoorn, W., & Hogan, J. (2011). Smarter cities series: A foundation for understanding IBM smarter cities. *IBM Corporation*. http://www.redbooks.ibm.com/redpapers/pdfs/redp4733.pdf. Accessed September 14, 2012.

Kitchin, R. (2014). The real-time city? *Big Data and Smart Urbanism. GeoJournal, 79*(1), 1–14.

Kohno, M., Masuyama, Y., Kato, N., & Tobe, A. (2011). Hitachi's smart city solutions for new era of urban development. *Hitachi Review, 60*(2), 79–88.

Komninos, N. (2002). *Intelligent cities: Innovation, knowledge, systems and digital spaces*. New York City, NY: Spon Press.

Komninos, N. (2006). The architecture of intelligent cities: Integrating human, collective and artificial intelligence to enhance knowledge. In *Proceedings of the 2nd IET International Conference on Intelligent Environments, Athens, 05–06 July 2006* (pp. 13–20). Norwich: Page Bros Ltd.

Komninos, N. (2008). *Intelligent cities and globalization of innovation networks*. New York City, NY: Routledge.

Komninos, N. (2011). Intelligent cities: Variable geometries of spatial intelligence. *Intelligent Building International, 3*(3), 172–188.

Komninos, N. (2014). *The age of intelligent cities: Smart environments and innovation-for-all strategies*. New York City, NY: Routledge.

Komninos, N., & Mora, L. (2018). Exploring the big picture of smart city research. *Scienze Regionali: Italian Journal of Regional Science*, *1*(2018), 15–38.

Kurebayashi, T., Masuyama, Y., Morita, K., Taniguchi, N., & Mizuki, F. (2011). Global initiatives for smart urban development. *Hitachi Review, 60*(2), 89–93.

Landry, C. (2000). *The creative city: A toolkit for urban innovation*. London: Earthscan.

Lazaroiu, G. C., & Roscia, M. (2012). Definition methodology for the smart cities model. *Energy, 47*(1), 326–332.

Lee, S., Han, J., Leem, Y., & Yigitcanlar, T. (2008). Towards Ubiquitous city: Concept, planning, and experiences in the Republic of Korea. In T. Yigitcanlar, K. Velibeyoglu, & S. Baum (Eds.), *Knowledge-based urban development: Planning and applications in the information era* (pp. 148–169). Hershey, PA: IGI Global.

Leydesdorff, L., & Deakin, M. (2011). The triple-helix model of smart cities: A neo-evolutionary perspective. *Journal of Urban Technology, 18*(2), 53–63.

McNeill, D. (2016). IBM and the visual formation of smart cities. In S. Marvin, A. Luque-Ayala, & C. McFarlane (Eds.), *Smart urbanism: Utopian vision or false dawn?* (pp. 34–51). New York City, NY: Routledge.

Meijer, A., & Bolivar, M. P. R. (2016). Governing the smart city: A review of the literature on smart urban governance. *International Review of Administrative Sciences, 82*(2), 392–408.

Meyer, M., Libaers, D., Thijs, B., Grant, K., Glanzel, W., & Debackere, K. (2013). Origin and emergence of entrepreneurship as a research field. *Scientometrics, 98*(1), 473–485.

Mino, E. (2000). Experiences of European digital cities. In T. Ishida & K. Isbister (Eds.), *Digital cities: Technologies, experiences and future perspectives* (pp. 58–72). Berlin: Springer.

Miorandi, D., Sicari, S., De Pellegrini, F., & Chlamtac, I. (2012). Internet of things: Vision, applications and research challenges. *Ad Hoc Networks, 10*(7), 1497–1516.

Mitchell, W. J. (1995). *The city of bits: Space, place, and the infobahn*. Cambridge, MA: The MIT Press.

Mitchell, W. J. (1999). *E-topia: Urban life, Jim–but not as we know it*. Cambridge, MA: The MIT Press.

Mitchell, W. J. (2003). *Me++: The cyborg self and the networked city*. Cambridge, MA: The MIT Press.

Mora, L., & Bolici, R. (2016). The development process of smart city strategies: The case of Barcelona. In J. Rajaniemi (Ed.), *Re-city: Future city—combining disciplines* (pp. 155–181). Tampere: Juvenes Print.

Mora, L., & Bolici, R. (2017). How to become a smart city: Learning from Amsterdam. In A. Bisello, D. Vettorato, R. Stephens, & P. Elisei (Eds.), *Smart and sustainable planning for cities and regions: Results of SSPCR 2015* (pp. 251–266). Cham: Springer.

Mora, L., Bolici, R., & Deakin, M. (2017). The first two decades of smart-city research: A bibliometric analysis. *Journal of Urban Technology, 24*(1), 3–27.

Moss Kanter, R., & Litow, S. S. (2009). *Informed and interconnected: A manifesto for smarter cities* (Working paper). Harvard Business School. http://www.hbs.edu/faculty/Publication%20Files/09-141.pdf. Accessed January 24, 2012.

Nam, T., & Pardo, T. A. (2011a). Conceptualizing smart city with dimensions of technology, people and institutions. In J. Bertot, K. Nahon, S. A. Chun, L. Luna-Reyes, & V. Atluri (Eds.), *Proceedings of the 12th Annual International Conference on Digital Government Research: Digital Government Innovation in Challenging Times, College Park, MD, 12–15 June 2011* (pp. 282–291). New York City, NY: ACM Press.

Nam, T., & Pardo, T. A. (2011b). Smart city as urban innovation: Focusing on management, policy, and context. In E. Estevez, & M. Janssen (Eds.), *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance (ICEGOV2011), Tallinn, 26–28 September 2011* (pp. 185–194). New York City, NY: ACM Press.

Naphade, M., Banavar, G., Harrison, C., Paraszczak, J., & Morris, R. (2011). Smarter cities and their innovation challenges. *Computer, 44*(6), 32–39.

Palmisano, S. J. (2008). *A smarter planet: The next leadership agenda* (Speech). IBM Corporation. www.ibm.com/ibm/blf/pdf/SJP_Smarter_Planet.pdf. Accessed March 3, 2011.

Paskaleva, K. A. (2009). Enabling the smart city: The progress of city e-governance in Europe. *International Journal of Innovation and Regional Development, 1*(4), 405–422.

Paskaleva, K. A. (2011). The smart city: A nexus for open innovation? *Intelligent Building International, 3*(3), 133–152.

Paul, A., Cleverley, M., Kerr, W., Marzolini, F., Reade, M., & Russo, S. (2011). Smarter cities series: Understanding the IBM approach to public safety. *IBM Corporation*. http://www.redbooks.ibm.com/redpapers/pdfs/redp4738.pdf. Accessed September 14, 2012.

Peeters, B. (2000). The information society in the city of Antwerp. In T. Ishida & K. Isbister (Eds.), *Digital cities: Technologies, experiences and future perspectives* (pp. 73–82). Berlin: Springer.

Polastre, J., Hill, J., & Culler, D. (2004). Versatile low power media access for wireless sensor networks. In *SenSys '04: Proceedings of the 2nd International Conference on Embedded Networked Sensor Systems, Baltimore, MD, 3–5 November 2004* (pp. 95–107). New York City: ACM Press.

Ratti, C., & Townsend, A. (2011). The social nexus. *Scientific American*, 42–48.

Republic of Korea (2007a). *U-city. Brochure. Republic of Korea*. http://www.eng.nia.or.kr/english/bbs/download.asp?fullpathname=%5CData%5Cattach%5C201112221611231975%5Cu-City(2007).pdf&filename=u-City(2007).pdf. Accessed September 6, 2014.

Republic of Korea (2007b). *U-Korea master plan: To achieve the world first Ubiquitous society. Republic of Korea*. http://www.ipc.go.kr/servlet/download?pt=/ipceng/publicandfn=u-KOREA+Master+Plan+.pdf. Accessed September 6, 2014.

Ruano, J., Chao, T., Hartswick, P., Havers, B., Meegan, J., & Wasserkrug, S. (2011). Smarter cities series: Understanding the IBM approach to water management. *IBM Corporation*. http://www.redbooks.ibm.com/redpapers/pdfs/redp4736.pdf. Accessed September 14, 2012.

Sanchez, L., Galache, J. A., Gutierrez, V., Hernandez, J. M., Bernat, J., Gluhak, A., et al. (2011). SmartSantander: The meeting point between future internet research and experimentation and the smart cities. In P. Cunningham & M. Cunningham (Eds.), *Future network & mobile summit 2011 conference proceedings, Warsaw, 15–17 June 2011* (pp. 1–8). Piscataway, NJ: Institute of Electrical and Electronics Engineers (IEEE).

Sanchez, L., Gutierrez, V., Galache, J. A., Sotres, P., Santana, J. R., & Casanueva, J. (2013). SmartSantander: Experimentation and service provision in the smart city. In *2013 16th International Symposium on Wireless Personal Multimedia Communications (WPMC), Atlantic City, NJ, 24–27 June 2013* (pp. 1–6). Piscataway, NJ: Institute of Electrical and Electronics Engineers (IEEE).

Schaefer, S., Harrison, C., Lamba, N., & Srikanth, V. (2011). Smarter cities series: Understanding the IBM approach to traffic management. *IBM Corporation*. http://www.redbooks.ibm.com/redpapers/pdfs/redp4737.pdf. Accessed September 14, 2012.

Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). Smart cities and the future internet: Towards cooperation frameworks for open innovation. In J. Domingue, A. Galis, A. Gavras, T. Zahariadis, D. Lambert, F. Cleary, P. Daras, S. Krco, H. Muller, M. Li, H. Schaffers, V. Lotz, F. Alvarez, B. Stiller, S. Karnouskos, S. Avessta, & M. Nillson (Eds.), *The Future Internet. Future Internet Assembly 2011: Achievements and Technological Promises* (pp. 431–446). Berlin: Springer.

Schneider, J. W., Larsen, B., & Ingwersen, P. (2009). A comparative study of first and all-author co-citation counting, and two different matrix generation approaches applied for author co-citation analyses. *Scientometrics, 80*(1), 1053–1320.

Schopfel, J. (2010). Towards a Prague definition of grey literature. In D. J. Farace, & J. Fratzen (Eds.), *Twelfth International Conference on Grey Literature: Transparency in Grey Literature. Grey Tech Approaches to High Tech Issues, Prague, 6–7 December 2010* (pp. 11–26). Amsterdam: Textrelease.

Schopfel, J., & Farace, D. J. (2010). Grey Literature. In M. J. Bates & M. N. Maack (Eds.), *Encyclopedia of library and information sciences* (pp. 2029–2039). New York City, NY: Taylor & Francis.

Shiau, W., & Dwivedi, Y. K. (2013). Citation and co-citation analysis to identify core and emerging knowledge in electronic commerce research. *Scientometrics, 94*(3), 1317–1337.

Shin, D. (2007). A critique of Korean national information strategy: Case of national information infrastructures. *Government Information Quarterly, 24*(3), 624–645.

Shin, D. (2009). Ubiquitous city: Urban technologies, urban infrastructure and urban informatics. *Journal of Information Science, 35*(5), 515–526.

Shin, D. (2010). A realization of pervasive computing: Ubiquitous city. In D. F. Kocaoglu, T. R. Anderson, & T. U. Daim (Eds.), *2010 Proceedings of PICMET '10: Technology Management for Global Economic Growth, Seoul, 18–22 July 2010* (pp. 1–10). Piscataway, NJ: Institute of Electrical and Electronics Engineers (IEEE).

Shin, D., & Kim, T. (2010). Large-scale ICT innovation and policy. In D. F. Kocaoglu, T. R. Anderson, T. U. Daim, A. Jetter, & C. M. Weber (Eds.), *PICMET 2010 proceedings: Technology management for global economic growth, Seoul, 18–22 July 2010* (pp. 148–161). Piscataway, NJ: Institute of Electrical and Electronics Engineers (IEEE).

Shin, D., & Lee, C. (2011). Disruptive innovation for social change: How technology innovation can be best managed in social context. *Telematics and Informatics, 28*(2), 86–100.

Shwayri, S. T. (2013). A model Korean Ubiquitous eco-city? The politics of making Songdo. *Journal of Urban Technology, 20*(1), 39–55.

Singer, N. (2012). *Mission control, built for cities: IBM takes 'smarter cities' concept to Rio De Janeiro* (Online article). The New York Times. http://www.nytimes.com/2012/03/04/business/ibm-takes-smarter-cities-concept-to-rio-de-janeiro.html?pagewanted=all&_r=0. Accessed October 12, 2012.

Small, H. G., & Crane, D. (1979). Specialties and disciplines in science and social science: An examination of their structure using citation indexes. *Scientometrics, 1*(5–6), 445–461.

Soderstrom, O., Paasche, T., & Klauser, F. (2014). Smart cities as corporate storytelling. *City: Analysis of Urban Trends, Culture, Theory, Policy, Action, 18*(3), 307–320.

Strickland, E. (2011). Cisco bets on South Korean smart city. *IEEE Spectrum, 48*(8), 11–12.

Sundmaeker, H., Guillemin, P., Friess, P., & Woelfflé, S. (Eds.). (2010). *Vision and challenges for realising the internet of things*. Brussels: European Commission.

Tamai, H. (2014). Fujitsu's approach to smart cities. *Fujitsu Scientific and Technical Journal, 50*(2), 3–10.

Tekes. (2011). *Ubiquitous city in Korea: Services and enabling technologies* (Report). Tekes. https://www.tekes.fi/globalassets/global/ohjelmat-ja-palvelut/ohjelmat/ubicom/aineistot/raportit/korea/ubiquitouscityinkorea.pdf. Accessed May 15, 2014.

The Climate Group. (2008). *SMART 2020: Enabling the low carbon economy in the information age* (Report). The Climate Group. http://www.smart2020.org/_assets/files/02_Smart2020Report.pdf. Accessed June 5, 2014.

Townsend, A. (2013). *Smart cities: Big data, civic hackers, and the quest for a new Utopia*. New York City, NY: W.W. Norton & Company Ltd.

Townsend, A., Maguire, R., Liebhold, M., & Crawford, M. (2011). *A planet of civic laboratories: The future of cities, information and inclusion*. White paper. Institute for the Future. http://www.iftf.org/uploads/media/IFTF_Rockefeller_CivicLaboratoriesMap_01.pdf. Accessed December 8, 2011.

Tselentis, G., Domingue, J., Galis, A., Gavras, A., Hausheer, D., Krco, H., et al. (Eds.). (2009). *Towards the future internet: A European research perspective*. Amsterdam: IOS Press.

United Nations Human Settlements Programme. (2011). *Cities and climate change: Global report on human settlements 2011*. London: Earthscan.

US Department of Commerce—NIST. (2010). *NIST framework and roadmap for smart grid interoperability standards* (Report). National Institute of Standards and Technology—US Department of Commerce. http://www.nist.gov/public_affairs/releases/upload/smartgrid_interoperability_final.pdf. Accessed September 30, 2014.

van den Besselaar, P. (2001). E-community versus e-commerce: The rise and decline of the Amsterdam digital city. *AI & Society: Knowledge, Culture and Communication, 15*(3), 280–288.

Washburn, D., Usman, S., Balaouras, S., Dines, R. A., Hayes, N. M., & Nelson, L. E. (2010). *Helping CIOs understand "smart city" initiatives*. White paper. Forrester Research. http://www.forrester.com/Helping+CIOs+Understand+Smart+City+Initiatives/quickscan/-/E-RES55590. Accessed March 20, 2012.

Weiser, M. (1991). The computer for the 21st century. *Mobile Computing and Communications Review, 3*(3), 3–11.

Weiser, M. (1993). Hot topics: Ubiquitous computing. *Computer, 26*(10), 71–72.

Weiser, M., Gold, R., & Brown, J. S. (1999). The origins of Ubiquitous computing research at PARC in the late 1980s. *IBM System Journal, 38*(4), 693–696.

Yigitcanlar, T., & Lee, S. H. (2014). Korean Ubiquitous-eco-city: A smart-sustainable urban form or a branding hoax? *Technological Forecasting and Social Change, 89,* 100–114.

Yigitcanlar, T., O'Connor, K., & Westerman, C. (2008a). The making of knowledge cities: Melbourne's knowledge-based urban development experience. *Cities, 25*(2), 63–72.

Yigitcanlar, T., Velibeyoglu, K., & Baum, S. (Eds.). (2008b). *Creative urban regions: Harnessing urban technologies to support knowledge city initiatives*. Hershey, PA: IGI Global.

Yigitcanlar, T., Velibeyoglu, K., & Baum, S. (Eds.). (2008c). *Knowledge-based urban development: Planning and applications in the information era*. Hershey, PA: IGI Global.

Yigitcanlar, T., Velibeyoglu, K., & Martinez-Fernandez, C. (2008d). Rising knowledge cities: The role of urban knowledge precincts. *Journal of Knowledge Management, 12*(5), 8–20.

Yoshikawa, Y., Tada, K., Furuya, S., & Koda, K. (2011). Actions for realizing next-generation smart cities. *Hitachi Review, 60*(6), 89–93.

Zanella, A., Bui, N., Castellani, A., Vangelista, L., & Zorzi, M. (2014). Internet of things for smart cities. *IEEE Internet of Things Journal, 1*(1), 22–32.

Zygiaris, S. (2013). Smart city reference model: Assisting planners to conceptualize the building of smart city innovation ecosystems. *Journal of the Knowledge Economy, 4*(2), 217–231.

Energy Communities in a Distributed-Energy Scenario: Four Different Kinds of Community Arrangements

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Abstract Distributed-energy generation enables a closer link to be established between energy production and energy consumption, but it does not, in itself, necessarily entail any (new) particular role or organization for groups of people. Nevertheless, because of the distributed-energy spread, the phenomenon of so-called energy communities is growing: all over the world, different kinds of groups organized to produce and consume energy are flourishing. In this regard, the term "energy community" is used in a generic sense to refer to heterogeneous phenomena. This work contributes to the study of energy communities by identifying key features that enhance understanding of what energy communities are. Since the literature seems to offer only partial points of view, this chapter intends to contribute to building a new taxonomy of energy communities with which to understand the nature and possible effects of the phenomenon. A first distinction can be drawn between place-based communities and non-place-based ones: in the first case, there is coherence between the community and a specific territory; this does not occur in the second case. Another difference is apparent between communities which form (and operate) only for energy purposes and those which instead add other purposes; in this regard, we can further distinguish between "energy-only communities" and "multi-issue communities". These two pairs of

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possibilities give rise to a four-cell matrix: that is, to four main cases of energy communities.

Keywords Distributed energy · Energy communities · Energy policies Taxonomy

1 Introduction: Focus and Methodology

The idea of "distributed generation" suggests that electricity production would no longer be centralized (as has been the case to date), but generated closer to the actual consumers, when not directly produced by them. From large-scale plants and long transmission networks to reach end consumers, generation would move to small on-site plants, eliminating the need to carry the energy produced over long lines. As is now widely recognized, this solution would be advantageous in many respects (e.g., providing reliable power, reducing electricity losses along lines etc.), for both developed countries (Carl 2013) and developing ones (Tenenbaum et al. 2014).

The changes introduced by a distributed-generation system do not only involve technological innovation or a fuel switch. They are drivers of a wider social transition: "In addition to the distribution of technology, a distributed energy system means the reallocation of decision-making, expertise, ownership, and responsibility in terms of energy supply" (Alanne and Saari 2006: 556). However, it should be noted that the idea of distributed generation does not, in *itself*, entail any particular role for organized groups. The idea that organized groups, particularly *communities*, can play a crucial role may be an empirical hypothesis (based on the consideration of economic and functional advantages that are possible in this case: for example, lower costs for the plants and infrastructures if shared between a group of users, the possibility of making use of smart micro-grids to better manage energy flows etc.); and/or it can be an additional value-driven hypothesis (based on the recognition of a special value to the decentralization of power, freedom of association and the self-organization of individuals).

This chapter discusses what "energy communities" actually are or may be, in relation to the various possible forms of generation and/or of shared-energy management. It is divided into three sections: the first proposes a specific *taxonomy* of energy communities; the second presents some relevant *examples*, while the third discusses certain elements that emerge and considers the main *policy implications*. In methodological terms, the analysis is based on a review of the literature (which is summarized in the second section) and the study of various cases [for a more extensive analysis, see the work by one of the co-authors of this chapter: Alberti (2015)]. However, the main contribution of this study is not empirical: the cases presented (in the third section) are in fact treated as examples of various organizational forms in order to build an analytical framework.

2 Concepts and Categories

A substantial proportion of the current literature is focused specifically on "energy communities" (Devine-Wright 2005; Hoffman and High-Pippert 2005; Kellett 2007; Walker et al. 2007, 2010; Schweizer-Ries 2008; van der Horst 2008; Mendes et al. 2011; Bomberg and McEwan 2012; Seyfang et al. 2013; Doci and Vasileiadou 2015; Doci et al. 2015; van der Schoor and Scholtens 2015). Nevertheless, this term denotes a wide variety of entities (Walker et al. 2007; Seyfang et al. 2013). As Seyfang et al. (2013: 988) observe, when referring to the energy communities sector: "This is a highly diverse sector representing many types of actor and organizational forms, multiple sets of objectives (not all of which relate to energy), holistic and multi-faceted repertoires of action, and many different practical strategies and technologies to achieve their goals. It is therefore exceedingly difficult to pinpoint specific features of the sector as a whole, or to aggregate these diverse groups and their activities into simple categories. Community energy is not reducible to a single entity".

In very general terms, the expression "energy community" may be used to indicate those groups of individuals who voluntarily accept rules to pursue shared goals connected to the production and distribution of energy (mainly electricity, often from renewable sources). They are mid-sized entities, between the (traditional) large-scale utility scale and the individual one (Bronin 2015). As St. Denis and Parker (2009: 2088) write: "Energy has traditionally been managed at the level of the individual customer or by regional/national utilities. A recent trend is for communities to create plans to directly manage their energy systems". The crucial point is that they are *communities of choice*, *intentional communities* (i.e., *contractual communities*: Brunetta and Moroni 2012; Moroni 2014), and not *communities of fate* or *communities of chance*. They are characterized by a kind of *associative entrepreneurship* (Cato et al. 2008); these are examples of *social enterprise* (van der Horst 2008).

For the sake of clarity, we shall consider two pairs of possibilities that give rise to a four-cell matrix, i.e., to four main cases of energy communities (see Table 1). Obviously, in this case as in others, it is possible to create taxonomies based on the

Table 1 Types of energy communities

	Place-based communities	Non-place based communities
Energy-only communities	Localized communities formed for the sole purpose of producing/distributing energy according to shared rules	Non-localized communities formed for the sole purpose of producing/distributing energy according to shared rules
Multi-issue communities	Localized communities formed in order to share the management/consumption of various goods and services, including those related to energy	Non-localized communities formed in order to share the management/consumption of various goods and services, including those related to energy

most diverse elements: Here, we will focus on those which, in our opinion, can highlight aspects that are particularly relevant to the topics of discussion.

A first distinction can be drawn between *place-based communities* and *non-place-based communities*: in the first case, there is coherence between the community and a specific territory; this does not occur in the second case. Another difference is apparent between communities which form (and operate) only for energy purposes and those which instead add other purposes to the latter; in this regard, we can further distinguish between *energy-only communities* and *multi-issue communities*.

Let us examine what these differences entail in more detail.

Place-based communities are, therefore, composed of members who aggregate on a spatial basis of different dimensions, from the condominium (tower or high-rise block) to the neighborhood (Antoniucci et al. 2015), up to more extended territorial contexts, on the basis of co-existence rules and shared goals. The spatial reference can be found in the tract of land where the community resides and/or in which the energy resource is harvested and transformed. The technologies used for energy production make reference to this: in fact, the community chooses the sources, the size of the plants and the energy form to be generated, based on the shared tract of land, which affects the needs of production and consumption. A factor that characterizes place-based communities is the density of settlements according to the shared spatial reference (Moroni et al. 2016). This aspect is linked mainly to the infrastructures and the equipment's frequently shared ownership and is particularly important in the case of thermal energy production (primarily for the costs of the distribution network and for heat losses).

In the case of *non-place-based communities*, the lack of a connection with a specific tract of land enables members to hook up in more unrestrained and varied ways. We can, for instance, imagine situations in which a group of individuals simply buys into a share of a larger energy project that is not within the neighborhoods in which they live or work. Ownership of equipment and infrastructures is not absolutely necessary in this case.

Energy-only communities are formed by individuals that share a system of rules for the exclusive management of energy production and consumption. What binds them together in the community is, therefore, a single well-defined goal.

Multi-issue communities also have other types of infrastructures/services, in addition to the sharing of energy systems, and are more aware of other possible co-benefits they can grasp (Bisello et al. 2017). Clearly, they may have been formed from the outset as a multi-purpose community, also including energy objectives, or may have arisen for other reasons and have only later also incorporated energy objectives as a result of technological innovations or new tax and legislative opportunities.

Note that in our diagram, it makes no difference whether the communities are purely *not-for-profit* or may also have a *profit* feature. This point does not seem to us to be decisive, and it is however linked to the variety and variability of the individual motivations (on the variety of individual motivations in the case of energy communities, see, e.g., Bomberg and McEwan 2012; Doci and Vasileiadou 2015).

3 Examples

We now briefly refer to some examples of the four cases mentioned. The examples have been selected in both Italy and other European countries (irrespective of the amount of the investment and/or the actors involved) in order to focus on the strategies and organizational processes of private entities that operate autonomously from the local public authority and/or the traditional service provider(s) (multiutilities).

Let us first focus on non-place-based communities.

Two examples of *non-place-based energy-only* communities in Italy are the "Abbassa la bolletta" (Lower the energy bill) initiative (www.abbassalabolletta.it), which is an Italian purchasing group for electricity and gas spread over a national scale, and the German "*Solardachboerse*" (Solar roof exchange) experience (http://www.solardachboerse.de), which is a virtual community to facilitate the matching of available roofs, rented out by building owners, with the interest of private investors looking for construction sites for PV plants. An example of a *non-place-based multi-issue* community is *Retenergie* (Energy-network) (http://www.retenergie.it), which is an Italian cooperative society whose purpose is the dissemination of collective energy management, now also extended to other environment-related services.

Let us now consider some examples (more complex and interesting) of *place-based communities*. As evidenced, a fundamental feature shared by these kinds of communities is the fact that they are strictly tied to an identifiable territory. This amounts to a tract of land with distinct boundaries—whether these are physically demarcated (as in the case of a wall, fence or hedge) or not. In other words, these kinds of communities are physically "located". Therefore, the community's aggregation on a spatial basis entails the local production/distribution of energy. This aspect can determine new interactions between members, links between the parties involved and the energy production facilities, and between the latter and the local activities.

Examples of place-based energy communities are numerous and of a different organizational nature. As already discussed, it is possible to distinguish initiatives in which energy is the key driver that animates the community and others in which energy is just one of the reasons why the community acts.

Localized communities of users that share goals linked exclusively to energy primarily stem from the intention to intervene on a local basis by exploiting the on-site resources. Each community adopts a customized associative form through which it regulates itself (Adil and Ko 2016). The most common form for today seems to be a cooperative one (Tham and Muneer 2013) which, in several cases, especially in central and northern Europe, has already been tested for issues related to the management of agricultural land and breeding farms (DTI 2004).

A prime example of an *energy-only place-based community* is the *St. Gorran Community* in Cornwall (United Kingdom). As of 2011, the St. Gorran Community invested in the construction of a wind farm by benefitting from the Community Power Cornwall's support (https://communitypowercornwall.coop/about-community-power-cornwall/), a company that promotes community energy projects. The community is organized by adopting the cooperative's formula: it not only holds the plants' ownership but also the revenue from energy production. By statute, such revenue must be locally re-invested in renewable-energy developments to support the spread of community-owned renewable-energy generation. In experiences such as that of St. Gorran, the community aggregation's positive effects do not only relate to the increase in cohesion between the community's members, but also to the improvement of the environmental performance of both public and private buildings.

A second example of an *energy-only place-based community* is the Local Solar Community of *Casalecchio di Reno* (Italy) (http://comunitasolare.eu/). In 2014, a group of families organized themselves by establishing the first Local Solar Community. The members' goal is to manage energy through the purchase of a new power-generation plant (photovoltaic). The community includes various types of members. To join the community, an initial registration fee plus a one-off fee need to be paid to avail oneself of advisory services. This community model has been replicated in several municipalities especially in Emilia Romagna, but in each municipality it has taken on a specific form depending on the people's sensitivity and requirements. The public's presence is not necessary and, if present, is a mere support to actions carried out independently by the community of people. Last year, this model has expanded to encompass shared services for recharging electric cars.

A third example of an energy-only place-based community is *SEV—Südtiroler Energieverband* (South Tyrolean Energy Association in Italy) (http://www.sev.bz.it/it/unione-energia-alto-adige/1-0.html), which was founded in 2006. It is a cooperative of cooperatives, each of which has a direct link with a territory. It manages about 850 photovoltaic plants, 400 hydroelectric plants, 25 electricity grids, and 45 district heating systems (plants and networks). The ownership of the energy infrastructures remains with each single member, while SEV is in charge of the provision of centralized services at the cost price (billing, trading, gaining incentives etc.). To join the community, an initial registration fee plus a yearly fee is mandatory.

A fourth example, this time of a *multi-issue place-based community* is Samsø Island (Denmark) (https://energiakademiet.dk/en/om-energiakademiet/). In this case, the community exists for more general reasons, which *also* include energy issues. There is ownership of equipment and infrastructures by the community. In the *multi-issue* model, energy is associated with other types of services that involve the sharing of additional infrastructures. Consider, for example, digital or transport infrastructures. In these cases, energy projects form the basis for the identification of other needs shared by the community members who, strengthened by a structure that is now well-established for energy purposes, develop new funding mechanisms and the creation of new shared infrastructures. The *Samsø Island* (Denmark) case is not composed of a single cooperative, but of multiple associative experiences that promote the small Danish island's energy transition. To date on the island, there are eleven wind farms and four biomass plants, whose ownership is structured between private individuals and local associations. The experience began in 1997. The multi-issue aspect of the Samsø energy community only manifests itself later when, with the revenue from the sale of energy, it was possible to establish the Energy Academy (a not-only energy community hub), to build a new harbor on the island's eastern shore (previously not served by any maritime transport), and to provide the island with an independent Wi-Fi network.

4 Conclusions and Implications

The analysis of the cases highlights how the various communities considered have diverse organizational and ownership structures, affect the real estate and services market in various ways, and involve various different scales and thematic areas. Lumping the different types of communities described together in a single undifferentiated class—as often happens in the current literature—threatens to impoverish the interpretation of the various phenomena and forms of public action to support and promote them. This study does not align itself with one solution or the other (or for one form of community or another); its purpose is solely to emphasize the urgency of a more critical approach to the problem and the need for more appropriate analytical categories.

This seems particularly important in regard to public measures, because some measures—for example certain fiscal policies at the national level, rather than specific choices in local planning or the deregulation of certain aspects of the built environment—could favor some community arrangements but not others (Kellett 2007; Bonifaci et al. 2016; Hall et al. 2016). The proposed taxonomy may therefore be a useful instrument with which to classify public policies for the growth of distributed energy (evidencing how differentiated public measures may match different cases). Policies and incentives can, for example, be significantly different if they relate only to the price of energy or if, on the other hand, they concern buildings and neighborhoods characterized by certain energy performances (Bonifaci and Copiello 2015).

Moreover, it should also be noted that even the communities' internal success factors may significantly differ depending on the type of community: a shared vision is, for example, a very different thing if it relates to a single item—energy—rather than to a broader common cohabitation project where energy is only one of the components; trust in unknown individuals with whom a space is not shared is something very different from trust in known individuals with whom one also shares a living space.

References

Adil, A. M., & Ko, Y. (2016). Socio-technical evolution of decentralized energy systems: a critical review and implication for urban planning and policy. *Renewable and Sustainable Energy Reviews, 57*(16), 1025–1037.

Alanne, K., & Saari, A. (2006). Distributed energy generation and sustainable development. *Renewable Energy Reviews, 10*(6), 539–558.

Alberti V. (2015). *L'attivazione dei territori svantaggiati attraverso il ripensamento delle fonti energetiche rinnovabili. Responsabilità e limiti dei processi di pianificazione*, Tesi di dottorato in Pianificazione Territoriale e Urbana, Sapienza Università di Roma.

Antoniucci, V., D'Alpaos, C., & Marella, G. (2015). Energy saving in tall buildings: From urban planning regulation to smart grid building solutions. *International Journal for Housing Science and Its Applications, 39*(2), 101–110.

Bisello, A., Grilli, G., Balest, J., Stellin, G., & Ciolli, M. (2017). Co-benefits of smart and sustainable energy district projects: An overview of economic assessment methodologies. *Green Energy and Technology*, 127–164. https://doi.org/10.1007/978-3-319-44899-2_9.

Bomberg, E., & McEwan, N. (2012). Mobilizing community energy. *Energy Policy, 51,* 435–444.

Bonifaci, P., & Copiello, S. (2015). Real estate market and building energy performance: Data for a mass appraisal approach. *Data in Brief, 5,* 1060–1065. https://doi.org/10.1016/j.dib.2015.11.027.

Bonifaci, P., Copiello, S., & Stanghellini, S. (2016). Assessing policy measures on building energy efficiency through a multi-actor multi-criteria analysis. In *CESB 2016—Central Europe Towards Sustainable Building 2016: Innovations for Sustainable Future* (1343–1350).

Bronin, S. C. (2015). *Energy in the Ecopolis*. Environmental Law Report, 45.

Brunetta, G., & Moroni, S. (2012). *Contractual communities in the self-organizing city. Freedom, creativity, subsidiarity*. Berlin: Springer.

Carl, J. (Ed.). (2013). *Distributed power in the United States. Prospects and policies*. Stanford: Hoover Institutions Press.

Cato, N. S., Arthur, L., Keenoy, T., & Smith, R. (2008). Entrepreneurial energy associative entrepreneurship in the renewable energy sector in Wales. *International Journal of Entrepreneurial Behaviour & Research, 14*(5), 313–329.

Devine-Wright, P. (2005). Local aspects of UK renewable energy development: Exploring public beliefs and policy implications. *Local Environment, 10*(1), 57–69.

Doci, G., & Vasileiadou, E. (2015). 'Let's do it ourselves'. Individual motivations for investing in renewable at community level. *Renewable and Sustainable Energy Reviews, 49,* 41–50.

Doci, G., Vasileiadou, E., & Peterson, A. C. (2015). Exploring the transition potential of renewable energy communities. *Futures, 66,* 85–95.

DTI (Department of Trade and Industry). (2004). *Co-operative energy: Lessons from Denmark and Sweden*. Global watch Mission Report. UK: Pera Innovation Ltd.

Hall, S., Foxon, T. J., & Bolton, R. (2016). Financing the civic energy sector: How financial institutions affect ownership models in Germany and the United Kingdom. *Energy Research & Social Science, 12,* 5–15.

Hoffman, S. M., & High-Pippert, A. (2005). Community energy: A social architecture for an alternative energy future. *Bulletin of Science, Technology & Society, 25*(5), 387–401.

Kellett, J. (2007). Community-based energy policy: A practical approach to carbon reduction. *Journal of Environmental Planning and Management, 50*(3), 381–396.

Mendes, G., Ioakimidis, C., & Ferrão, P. (2011). On the planning and analysis of integrated community energy systems. *Renewable and Sustainable Energy Reviews, 15,* 4836–4854.

Moroni. S. (2014). Towards a general theory of contractual communities. In D. Andersson & S. Moroni (Eds.), *Cities and Private Planning. Property Rights, Entrepreneurship and Transaction Costs* (pp. 38–65). Cheltenham: Edward Elgar.

Moroni, S., Antoniucci, V., & Bisello, A. (2016). Energy sprawl, land taking and distributed generation: Towards a multi-layered density. *Energy Policy, 98,* 266–273. https://doi.org/10.1016/j.enpol.2016.08.040.

Schweizer-Ries, P. (2008). Energy sustainable communities: Environmental psychological investigations. *Energy Policy, 36,* 4126–4135.

Seyfang, G., Park, J. J., & Smith, A. (2013). A thousand flowers blooming? An examination of community energy in the UK. *Energy Policy, 61,* 977–989.

Denis, G., & Parker, P. (2009). Community energy planning in Canada: The role of renewable energy. *Renewable and Sustainable Energy Reviews, 13,* 2088–2095.

Tenenbaum, B., Greacen, C., Siyambalapitiya, T., & Knuckles, J. (2014). *From the bottom up. How small power producers and mini-grids can deliver electrification and renewable energy in Africa*. Whashington, D.C.: The World Bank.

Tham, Y., & Muneer, T. (2013). Energy co-operatives in the UK. *International Journal of Low-Carbon Technologies, 8,* 43–51.

van der Horst, D. (2008). Social enterprise and renewable energy: Emerging initiatives and communities of practice. *Social Enterprise Journal, 4*(3), 171–185.

van der Schoor, T., & Scholtens, B. (2015). Power to the people: Local community initiatives and the transition to sustainable energy. *Renewable and Sustainable Energy Reviews, 43,* 666–675.

Walker, G., Hunter, S., Devine-Wright, P., Evans, B., & Fay, H. (2007). Harnessing community energies. Explaining and evaluating community-based localism in renewable energy policy in the UK. *Global Environmental Politics, 7*(2), 64–81.

Walker, G., Devine-Wright, P., Hunter, S., High, H., & Evans, B. (2010). Trust ad community: Exploring the meanings, context and dynamics of community renewable energy. *Energy Policy, 38,* 2655–2663.

Post-war Strategy Itzling—A Methodological Approach

Markus Karnutsch, Stefan Netsch and Thomas Reiter

Abstract Post-war neighborhoods all over Europe are facing various kinds of challenges in order to adapt them for use in the future. The predominant factor in many concepts of neighborhood refurbishment is the energy demand of the buildings. In connection, many research projects focus on the reduction of CO_2 emissions, omitting the fact that this specific value does not have any immediate benefit for the residents themselves, neither on the psychological nor on the economic level. The sole positive effects can be found on the macroeconomic level, which rarely is calculated and most likely cannot be communicated as a benefit to the residents in a comprehensible fashion. This approach may lead to considerable resistance among the residents against ambitious redevelopment plans. The methodological approach presented in this paper reflects the establishment of a vision for a neighborhood-development strategy. Its core is an iterative process using the tools of questionnaires, workshops and focus-group discussions, which involves the owners of the buildings, the local energy provider, policy makers, representation of the residents and research experts. The methodological framework was developed based on the reference neighborhood Itzling, which is situated in the city of Salzburg/Austria. It is an urban area with mostly social housing erected between 1966 and 1976, which houses approximately 2500 inhabitants. The singular priorities of this neighborhood's refurbishment plans were harmonized in the form of a questionnaire and multiple workshops. As a result of this process, five key areas of action (energy, living space, open space, social and mobility) were identified. The developed iterative process is multipliable and transferrable to comparable urban areas that share a set of similarities. It is the basis for future decisions and gives orientation to the building owners, the energy provider and policy

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makers. Besides the methodology, the outcomes of this process are a poster, a folder and a detailed catalog of measures. The poster and the folder visualize the neighborhood development strategy. A set of characters, icons and photos including easily comprehensible comics was developed. These design features are important in order to create a recognition value and to stimulate acceptance among the inhabitants of the neighborhood. Moreover, the low-threshold approach of the design facilitates future communication with the concerned public. The described methodology of the neighborhood-development strategy guarantees the inclusion of all stakeholders and supports a prioritization of future measures that can lead to a more energy-efficient and livable development of neighborhoods in need of adaptation.

Keywords Stakeholder inclusion · Post war refurbishment · Neighborhood development strategy · Adaption of building stock · Carbon neutrality

1 Introduction

The need to mitigate the threats of climate change is undisputable (Kennedy and Sgouridis 2011: 5259). There is strong scientific consensus that anthropogenic influences are the dominant cause for a range of developments, e.g., warming of the atmosphere and the oceans, changes in the global water cycle, as well as a rise in the global mean sea level (IPCC 2013: 17). The carbon-dioxide concentration in the atmosphere has reached unprecedented levels for at least the last 800,000 years and has increased by approximately 40% since pre-industrial times. The primary cause is the combustion of fossil fuels (IPCC 2013: 11).

As a result, it can be observed that a large number of communities follow a trend to announce targets for carbon emissions and develop plans for reduction of energy and resources consumption. The aim is to lower their carbon footprint in order to become “zero carbon”, “carbon neutral” or “CO_2 neutral” communities (Kennedy and Sgouridis 2011: 5259), eventually even “climate neutral”.

In particular, the post-war neighborhoods all over Europe are posing various kinds of challenges in regard to their adaptation for use in the future. The predominant factor in many concepts of neighborhood refurbishment is the energy demand of the buildings, which sums up to 40% of the global energy demand (Bindra and Scanlon 2010). However, many research projects focus on the reduction of CO_2 emissions only, omitting the fact that this specific value does not have any immediate benefit for the residents themselves, neither on the psychological nor on the economic level. Benefits are solely on a macroeconomic level, which rarely is calculated and most likely cannot be communicated as an advantage to the residents in a comprehensible fashion.

1.1 Definitions

The research project "*SmartItzGoes—Smarte Stadtteilsanierung Itzling-Goethesiedlung*", on which this paper is based, also aimed to examine the possibilities for redeveloping the reference *neighborhood* into a *carbon-neutral* urban district. In order to avoid misinterpretations, a definition of these two key terms, often referred to in this paper, is necessary.

A wide variety of definitions of the term "neighborhood" exists and an elaborate discussion is ongoing among planners and sociologists. Albert Hunter states: "undoubtedly, there is consensus that the neighborhood is a 'social/spatial' unit of social organization […] larger than a household and smaller than a city" (Hunter 1978: 270). Mostly, this is where the consensus ends. In this paper, a neighborhood is "a social space, smaller than an administrative district, but more multifaceted than a residential area, which is strictly defined for residential purposes by law" (Alisch 2002: 60).

Current literature offers a multitude of different categorizations of concepts (Erman 2014: 831) that aim at reducing CO_2 emissions. The list of terms that have been established includes but is not limited to "zero carbon", "carbon neutral", "CO_2 neutral" or "climate neutral".

Carbon neutral or CO_2 neutral are synonyms, describing a condition in which the activities of an individual, an organization, a city or a country do not contribute to the gross output of global CO_2 emissions. Either the activities themselves do not cause CO_2 emissions, or compensation alternatives, also referred to as "offsets" within or beyond the system, counterbalance the emissions. The term "CO_2 neutrality" only refers to carbon dioxide and does not take the other greenhouse gases,[1] in total responsible for the greenhouse effect, into consideration (Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung 2017: 29).

Within the concept of "climate neutrality" or "net-zero GHG emissions", the effect of all GHG emissions on the atmosphere (according to the Kyoto protocol), expressed in the unit of CO_2 equivalent (CO_2e), is being accounted for. This does not imply that these concepts are "emission free". There is a slight difference between the two concepts. "Climate neutrality" can be reached if all GHG emissions can be compensated for through analogous reduction. The goal of "net-zero GHG emissions" can only be accomplished if the emissions are counterbalanced with real negative emissions, e.g., through CCS (carbon capture and storage) (Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung 2017: 31–32).

[1]There are natural and anthropogenic greenhouse gases. The primary greenhouse gases in the Earth's atmosphere are water vapor (H_2O), carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4) and ozone (O_3). Besides those gases exists a number of entirely human-made greenhouse gases (IPCC 2013: 1455).

Recent research, e.g., the CLUE project (Climate Neutral Urban Districts in Europe[2]), are guided by the idea that climate-neutral urban districts should function as test beds for new planning approaches in order to accomplish a transformation towards low-carbon societies. Primarily new developments are in focus, although the biggest challenge is the conversion of the existing urban fabric. It has to be stated that there is no climate-neutral urban district today that could serve as an example. Only a patchwork of experiences and good practices exists, which in their totality would eventually lead to a climate-neutral urban district (Erman 2014: 831).

1.2 Description of the Reference Neighborhood

This paper deals with the methodology and the visualization of a participatory neighborhood development strategy for an urban area in Salzburg. This neighborhood incorporates mostly social housing, which was erected between 1966 and 1976, in a period of reconstruction and housing shortage in Salzburg. At that time, the welfare state established numerous collective housing structures, still known as social housing. The reference neighborhood is situated in the district of Itzling in the north of the city of Salzburg in Austria. The district is shaped by heterogeneous forms of housing developments with varying densities and manifold uses (residential area, trade, industry, education). The reference neighborhood itself consists of 26 buildings, housing approximately 2500 inhabitants in 1257 apartments over a gross floor area of almost 100,000 m^2. Figure 1 offers an aerial view of the neighborhood.

It can be observed that the neighborhood was built upon transition from the urban concept of the “structured and loosened town” to the model of “urbanity through density”. Settlements like the reference one are products of a time when modernism as a method of urbanism was in its heyday. A strict separation of functions into places for housing, work, education, recovery and provision was predominant. Mobility by car was the central feature of a city. Hence, many of these settlements are situated in former suburban locations, now encircled by the encroaching urban development over the past 40 years.

In the north of the area, a large enclosed space is used predominantly for parking. The zone between the buildings is characterized by green space, with a smooth transition between public and private free spaces. The building stock, characterized by uniform height and following the row typology, is undergoing thermal renovation in a gradual manner. The institutional framework of social housing provides favorable conditions for change due to less complex ownership structures and the established system of residential building subsidies.

[2]More information can be obtained here: http://www.clue-project.eu/.

Fig. 1 Aerial view of the reference neighborhood. *Source* Google Earth, 2016

Nevertheless, many of the buildings still have sub-standard insulation and inadequate HVAC systems, which no longer meet today's energy-efficiency standards. Migrant communities, low-income households and an aged population (more than 40% of the inhabitants are over 60 years old) have replaced the original target group. The settlement will be subject to strong pressure for change over the next few years, mainly caused by a foreseeable generational change in the tenant base, the demand for higher-quality accommodation and the increasing requirements for energy efficiency and climate protection.

2 Methodology

In order to be able to formulate a neighborhood-development strategy, a detailed inventory of the building stock and an urbanistic analysis followed by a SWOT analysis were performed. The main goal of the neighborhood-development strategy is to frame and visualize a desired target condition, which is shared by all relevant stakeholders (i.e. the building owners, policy makers, energy provider and the institution representing the residents). It must create an inward orientation and project a positive image to the public. Section 2.1 explains the iterative development of the content. Section 2.2 elaborates on the components, as well as the graphical structure of the poster and folder representing the neighborhood-development strategy visually. It should serve as a powerful communication tool for future projects concerning similar neighborhoods in need of adaptation.

Fig. 2 Schematic representation of the iterative process of neighborhood-development strategy. Salzburg University of Applied Sciences

2.1 Content

The methodology proposed in this paper includes three kinds of instruments (questionnaires, workshops, focus group discussion), which are explained in Sect. 2.1.1. At the core of the neighborhood-development strategy is an iterative development process, which is shown schematically in Fig. 2 and presented in detail in Sect. 2.1.2. Participants in this process include the owners of the buildings, the local energy provider, policy makers, an institution representing the residents and research experts.

2.1.1 Instruments

Detailed and tested *questionnaires* are the instrument of choice in providing a strong foundation for the neighborhood-development strategy. They are necessary in order to harmonize singular priorities of the building owners and in a following step prioritize the possible measures.

The method of the *workshops* was chosen because it provides the opportunity to work on many different topics and problems in a short period of time. The involvement of experts and relevant stakeholders as a valuable source of knowledge and experience, as well as a high degree of interaction, secure an arranged approach for the development process. Utilizable results and valuable input can be deduced and allow for a refinement of the neighborhood-development strategy. Moreover, workshops enable a clarification of opinions and the identification and discussion of various perceptions. In an iterative process, all information is collected, structured, combined and evaluated. The result of this collective effort is a common understanding among the stakeholders.

Another important instrument in the development process is the moderated *focus-group discussion*. It is organized and carried out by a trained sociologist. Participants are an institution serving as the representative of the residents, the housing office of the city of Salzburg, and representatives of the urban planning and traffic department of the city of Salzburg, as well as the building owners and the building management. Within this workshop, the opinions, interests and sentiments of the stakeholders are collected. The results are included in the process of the neighborhood-development strategy leading finally—together with the other two instruments—to a common vision for the neighborhood.

2.1.2 Iterative Process

The results of the urbanistic analysis, as well as the conclusion drawn from the SWOT analysis, serve as the basis for the formulation of possible measures for the future neighborhood development. Regarding the political frame conditions, a first catalog of measures is developed by the research experts and building owners, as well as the energy provider.

The presentation of this first draft in a workshop in front of the policy makers in the city of Salzburg and the discussion of the measures leads to a concretization of the objectives from the city government's point of view. Including policy makers in the process is a vital step in order to create acceptance and support for the project. Research experts document and reflect on the results of this workshop with the aim to provide suggestions for a necessary adaptation of the neighborhood-development strategy.

A questionnaire targeted towards the building owners is developed. Within this questionnaire, the building owners are asked to prioritize the envisioned measures. The responses from the returned questionnaires are collected, structured, evaluated and graphically treated. This serves as preparation for the following workshop with the building owners. The neighborhood-development strategy is adapted accordingly. In the workshop with the building owners, the results of the questionnaire are presented and discussed. Additional input, as well as clarification and concretization of the suggested measures are the results. The iterative process continues with the graphic treatment of the outcomes of the workshop, resulting in a voting questionnaire from the findings, which is sent to the building owners and the energy provider in order to deliver a second round of prioritization. The results are structured and harmonized leading to an adaption of the neighborhood-development strategy and the catalog of measures. The moderated focus-group discussion follows and the recommendations are included. In a final workshop with policy makers, the objectives are further concretized and a final version of suggested measures under a mutual understanding is established. The neighborhood-development strategy is finalized according to the results.

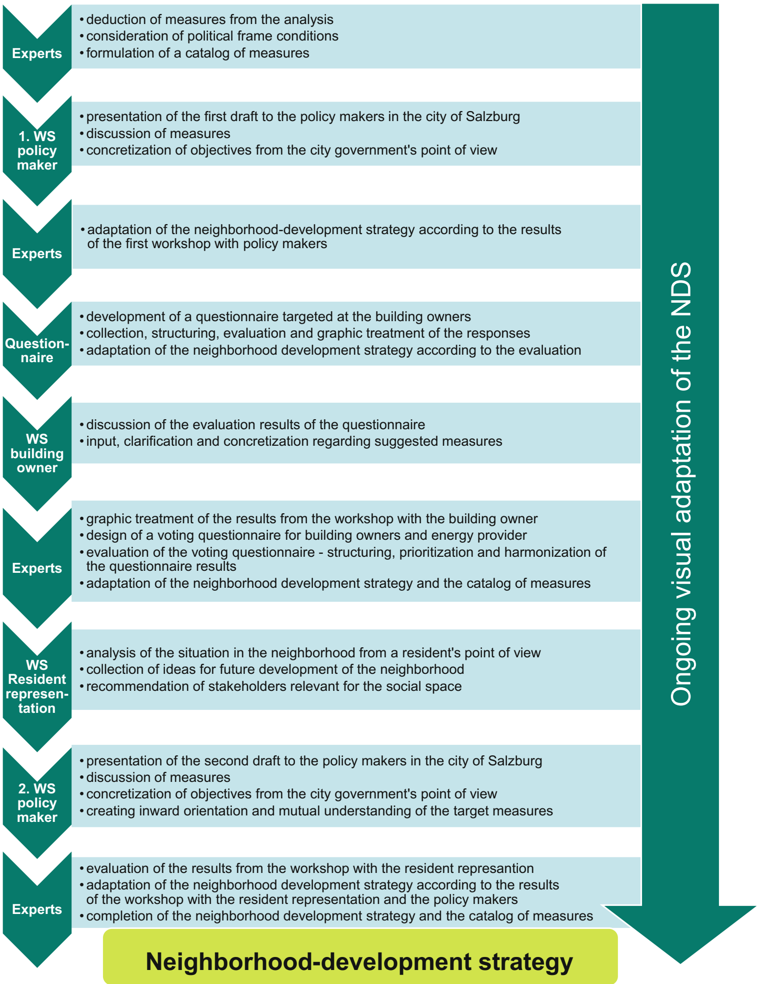

Fig. 3 Workflow of the iterative process for the neighborhood-development strategy. Salzburg University of Applied Sciences

Figure 3 shows the workflow of the iterative development process chronologically.

Based on the iterative harmonization and prioritization process, five key areas of action (energy, living space, open space, social and mobility) have been identified. Among those five key areas, no hierarchical order exists and hence they can be classified as equally important. They are visualized in Fig. 4. For each key area of action, an illustrative icon with a high recall value is designed.

Fig. 4 Five key areas of action. Salzburg University of Applied Sciences

2.2 *Components and Design*

The visual representation of the neighborhood-development strategy follows a low-threshold approach. It is necessary to establish an original and aesthetically appealing concept in order to use it for future communication with relevant stakeholders and the concerned public. For this reason, a set of characters representing the residents is developed. The neighborhood-development strategy consists of three components, which differ in scale and content according to the addressed target group. Starting with sketches of the agreed measures, the following three components are developed:

- The *site plan* is graphically enhanced according to aerial photos. It serves the purpose of localization and gives an overview of the neighborhood.
- During site visits, the situation in the neighborhood was captured. These photographs are enhanced with an individual set of characters and a visionary statement concerning the key area of action, as well as generally understandable messages. The concept follows a *comic-book* style, which helps to simplify complex content.
- A detailed *catalog of measures* for each key area of action, including keywords, a visionary statement and background information relevant to the examined neighborhood forms the backbone of the neighborhood-development strategy. This catalog is the basis for future decisions and gives orientation to the building owners, the energy provider and policy makers.

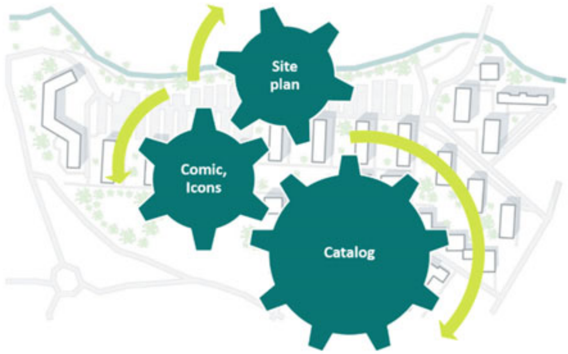

Fig. 5 Components of the neighborhood-development strategy. Salzburg University of Applied Sciences

Figure 5 visualizes the three components of the neighborhood development strategy graphically.

3 Results

As an outcome of the iterative development process, a *poster* (see Fig. 6, Appendix 1) with a unique concept serves as the visual representation of the neighborhood development. The set of characters, icons, photos and visionary statements is easily comprehensible. It represents a collective identification and action basis for all stakeholders and should stimulate acceptance among the residents.

A *folder* (see Fig. 7, Appendix 2) was designed as an additional communication tool and a basis for future action. It is especially targeted towards the residents of the neighborhood to support direct communication. They should be well-informed and welcome in the process of change. Moreover, it is of great importance for the residents to realize that the planned changes will improve their quality of life.

Finally, the *catalog of proposed measures* (see an overview in Table 1) provides a detailed insight into the desired target condition from the viewpoint of the involved stakeholders.

In the course of the research project, all partners agreed that this iterative neighborhood development process should be integrated in the planning of future projects. The focus on establishing a CO_2-neutral neighborhood should not be the sole driver of change, although it is an important step for the transformation of a neighborhood in need of transition in order to reach climate and comfort goals. Only an integrated planning and developing process, incorporating energy, living space, public space, social agendas and mobility guarantees direct benefits for the residents and visitors alike.

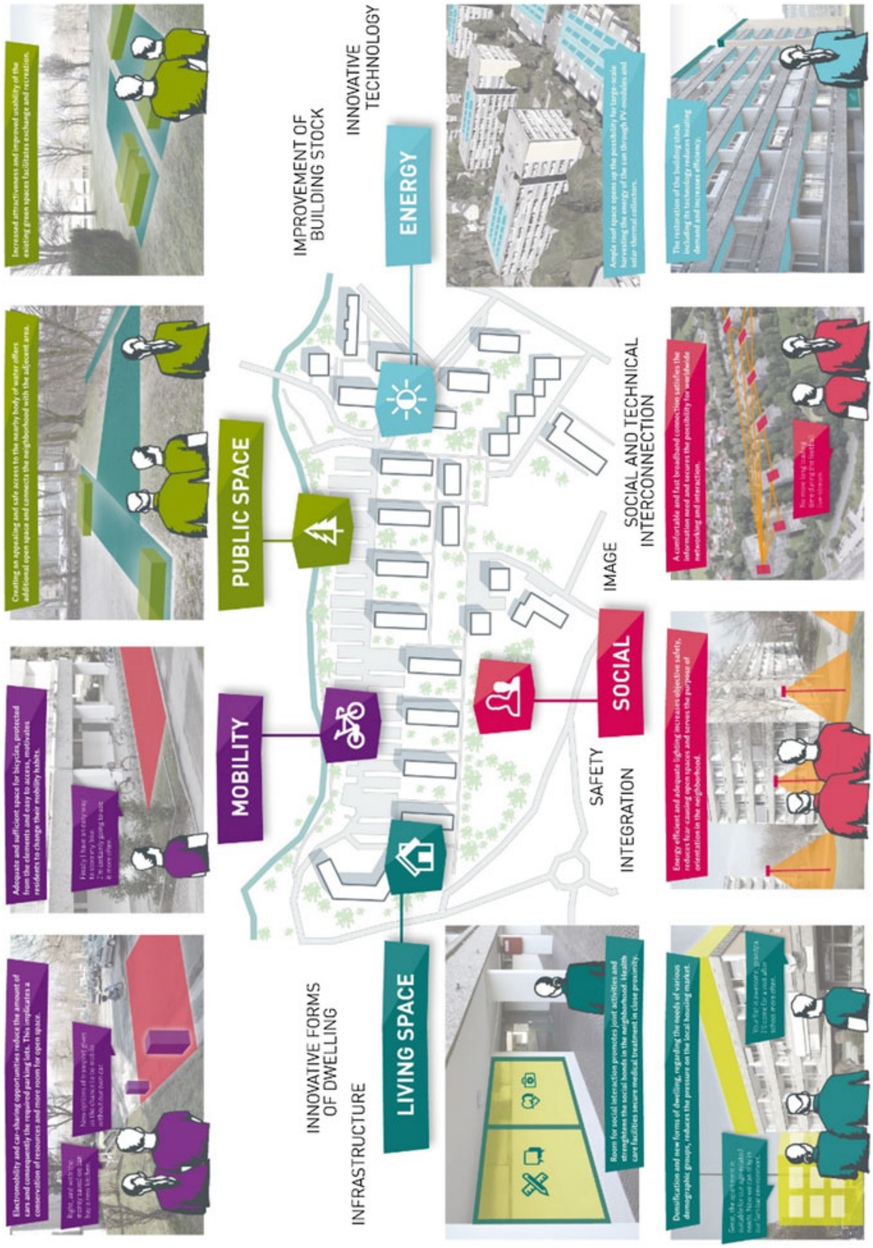

Fig. 6 Poster—neighborhood-development strategy. Salzburg University of Applied Sciences

Fig. 7 Folder and basic set of characters—neighborhood-development strategy. Salzburg University of Applied Sciences

Table 1 Overview of the catalog of measures

Key areas of action		Exemplary measures
ENERGY		Thermal improvement of building stock; use of renewable energy; increase in efficiency
PUBLIC SPACE		Increased attractiveness; improved usability
MOBILITY		Sufficient space for bikes; e-mobility; car-sharing
LIVING SPACE		Careful densification; new forms of dwelling; room for interaction and health care
SOCIAL		Energy-efficient lighting; reduction of fear causing open spaces; social and technical interconnection

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4 Conclusion

The presented methodology of a neighborhood-development strategy guarantees the inclusion of all stakeholders and supports a prioritization of future measures that can lead to a more energy-efficient and livable development of neighborhoods in need of adaptation. It can provide assistance in meeting the present and future comfort demands of the inhabitants, reaching climate goals and reacting to demographic and social phenomena.

The developed concept is multipliable and transferrable to comparable urban areas, which share a set of similarities. In Austria, 11% (Statistics Austria 2016) and in Europe 18% (Birchall et al. 2016) of the building stock are multi-family homes erected in the same time as the reference neighborhood.

The proposed visual representation of the neighborhood-development strategy is a powerful communication tool, which can be a vital element in the process of implementing ambitious redevelopment plans applicable to social housing in Europe.

Support, acceptance and identification with the redevelopment plans of urban neighborhoods need to be achieved by residents and other relevant actors alike. In Austria, there is no legal basis for resident participation. Building owners and political decision makers are aware of the power of the residents and hence often fear their participation at early stages of a project. Understandably, if information is transported in an uncoordinated manner, it can assume self-propelling power. Mixed with personal sentiments and perceptions of people with no deep understanding of the situation, it can cause a downward spiral to the point where there is strong resistance against any measures. Comprehensible information for the residents, even at an early stage of a project, with the possibility to participate, should be seen as an indispensable ingredient for the redevelopment of the existing social housing stock and its immediate environment.

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Layout and Design of poster and folder: Salzburg University of Applied Sciences in cooperation with 2|4 Designbureau.

Appendix 1

See in Fig. 6.

Appendix 2

See in Fig. 7.

References

Alisch, M. (2002). Soziale Stadtentwicklung. Politik mit neuer Qualität. In U. J. Walther (Ed.), *Soziale Stadt—Zwischenbilanzen. Ein Programm auf dem Weg zur Sozialen Stadt?* Opladen: Leske+Budrich.

Bindra, S., & Scanlon, X. C. (2010). *UNEP annual report 2009. Seizing the green opportunity.* Nairobi: United Nations Environment Programme (UNEP).

Birchall S., Gustafsson, M., Wallis, I., Dipasquale, C., Bellini, A., Fedrizzi, R. et al. (2016). Survey and simulation of energy use in the European building stock. http://www.diva-portal.org. Accessed March 01, 2017.

Bundesinstitut für Bau-, Stadt- und Raumforschung (BBSR) im Bundesamt für Bauwesen und Raumordnung (Ed.) (2017). *CO_2-neutral in Stadt und Quartier. Die europäische und internationale Perspektive.* BBSR-Online-Publikation. http://www.bbsr.bund.de/BBSR/DE/Veroeffentlichungen/BBSROnline/2017/bbsr-online-03-2017.html?nn=1187544. Accessed March 01, 2017.

Erman, M. (2014). Climate neutral city districts—The smartest form of a city's district? In M. Schrenk, V. Popovic, V. Vasily, P. Zeile (Eds.), *Plan it Smart. Clever solutions for Smart Cities. Proceedings of 19th International Conference on Urban Planning, Regional Development and Information Society* (pp. 831–838). http://www.corp.at/archive/CORP2014_171.pdf. Accessed March 01, 2017.

Hunter, A. (1978). The urban neighborhood. Its analytical and social contexts. *Urban Affairs Quarterly, 14,* 267–288.

IPCC: Climate Change. (2013). In T. Stocker, D. Qin, G.-K. Plattner, M. Tignor, S. K. Allen, A. Boschung et al. (Eds.), *The physical science basis*. Contribution of Working Group I to the fifth assessment report of the Intergovernmental Panel on Climate Change. 1. publ. Cambridge and New York.

Kennedy, S., & Sgouridis, S. (2011). Rigorous classification and carbon accounting principles for low and zero carbon cities. *Energy Policy, 39*(9), 5259–5268.

Statistics Austria. (2016). Gebäude 2011 nach überwiegender Gebäudeeigenschaft, Errichtungsjahr und Bundesland. https://www.statistik.at/web_de/statistiken. Accessed March 03, 2017.

SEA for Sustainable Cities: How the Strategic Environmental Assessment Has Driven the ESI Programme Towards Urban Sustainability

Gaia Galassi, François Levarlet and Elodie Lorgeoux

Abstract Under Cohesion Policy, sustainable development is implemented at the territorial level through the five European Structural and Investment funds (ESIF). Among the uses for these funds, during the 2014–2020 period the European Regional Development Fund (ERDF) key priority areas include issues such as energy, transport, climate change adaptation and green infrastructure, all of which relate to sustainable cities. In this framework, the Strategic Environmental Assessment (SEA) procedure, carried out in the programming phase, is an important tool in driving ERDF Operational Programmes (OPs) towards sustainability. In this work, we examine 20 ERDF Italian program 2014–2020 and some related SEA Environmental reports to understand how much the theme of sustainable cities has been considered and how far SEA procedures have contributed to urban sustainability planning in local development strategies. Illustrations are given of sustainable approaches adopted in the OPs and SEA reports. Moreover, the analysis identifies recommendations to improve integration of the theme into the current and following programming periods.

Keywords Strategic environmental assessment · ESIF-ERDF programmes
Urban sustainable development approaches · SEA environmental reports

1 Introduction

The Italian urban system is highly heterogeneous. Cities are decentralized, spread across the country and have very diverse dimensions and features. The Corine Land Cover database shows that artificial surfaces are concentrated in lower, flatter areas, such as coasts and river courses (Appendix 2, Fig. 4). Accordingly, as seen in

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Appendix 2, Fig. 5, the majority of the population is near the coast and in the Po valley. This helps delineate 14 official metropolitan areas, with seven in the north and three in Sicily (see Appendix 2, Fig. 3). Indicators reveal significant socioeconomic differences. For example, the rate of employment highlights a strong north-to-south gradient, from above 60% in the north to less than 40% in the south (Appendix 2, Fig. 6). There is a higher percentage of foreign-born residents in metropolitan areas, as in the rest of Europe, with a peak in Rome (Appendix 2, Fig. 7). Public services, such as public transport, show significant differences. The indicator 'seat kilometers per capita at province level', for example, shows large differences between neighboring provinces. Expenditure on local public transport is proportional to the service provided (as showed in Appendix 2, Fig. 8).

Given the territorial and socioeconomic diversity over regions, urban systems require various paths to achieve urban sustainability. The ERDF Regulation (Reg. No 1301/2013) and the Italian Partnership agreement (EC decision, C (2014) 8021 final, 29.10.2014) give each region the opportunity to develop, through OPs, a strategy for urban sustainability in accordance with their specific needs.

According to Article 7(1) of the ERDF regulation, sustainable urban development should be promoted through strategies covering integrated actions to tackle economic, environmental, climate, demographic and social challenges affecting urban areas, while taking into account urban-rural links. Point 2 of the same article states that sustainable urban development can be promoted through Integrated Territorial Investments (ITIs) or through a Priority Axis.

According to the Guidance for Member States on Integrated Sustainable Urban Development, key elements must be developed in the programming phase related to:

- **The selection of urban areas through specific procedures** based on a preliminary analysis of local needs;
- **A delegation** to urban authorities designated as intermediate bodies helping design and implement sustainable urban development on behalf of the managing authority and 'shall be responsible for tasks relating, at least, to the selection of operations' (Article 7 of the ERDF regulation);
- **The identification of a method of implementation**: the various methods for implementing sustainable urban development include defining ITIs in specific OPs or using ad hoc instruments;
- **Using integrated sustainable urban strategies** as planning approaches.

The Italian Partnership Agreement identifies three potential drivers for sustainable urban development:

- Restyling and modernizing urban service, including actions for sustainable mobility, energy saving and renewable energy, and reinforcement of existing services and their development;
- Actions for social inclusion that aim to sustain the existing social policies targeting vulnerable groups of people and run-down districts;

- Enhancing urban capacity by boosting local components of global production chains.

The Partnership Agreement selected four Thematic Objectives (TOs) in accordance with these drivers:

- TO2 'Enhancing access to, and use and quality of, information and communication TO2 technologies', enhancing digital services for citizens, digital inclusion and on-line participation;
- TO4 'Supporting the shift towards a low-carbon economy', for sustainable energy and quality of life, including sustainable mobility;
- TO3 'Enhancing the competitiveness of SMEs', enforcement of economic activities with social contents and new enterprises linked to the urban context;
- TO9 'Promoting social inclusion, combating poverty and any discrimination', concerning social inclusion, reduction of housing deprivation, and enhancement of legality.

In addition, the Partnership Agreement identifies two additional TOs that promote urban sustainability:

- TO5 'Promoting climate change adaptation, risk prevention and management', for flooding and coastal erosion, and fire and seismic risks;
- TO6 'Preserving and protecting the environment and promoting resource efficiency', concerning waste management, water management, improvement of cultural and natural heritage, as well as enhanced competitiveness for tourism.

In this context, the SEA is an important tool, including urban sustainability concerns in OPs co-financed with ESI funds.

The SEA procedure, defined by Directive 2001/42/EC, went hand-in-hand with drafting the program as described in ERDF regulation (see Appendix 1, Fig. 1).

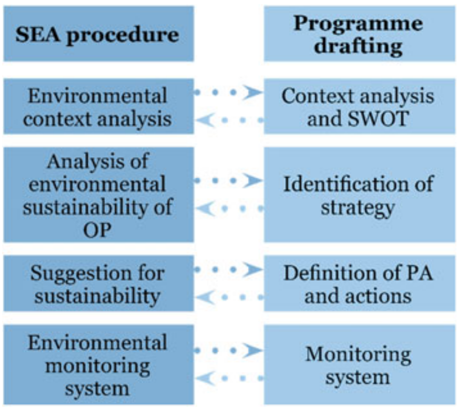

Fig. 1 Relationship between the SEA procedure (according to Directive 42/2001/EC) and programme drafting (ERDF regulation)

This scrutinizes program documentation, assessing environmental effects from program implementation, as well as consistency of the program with the strategic environmental context. The SEA helps drive the program toward sustainability, during both programming and implementation, through environmental monitoring.

Past studies have analyzed the contribution of SEA to urban sustainability, but they mainly focused on urban planning (see, e.g., Shepherd and Ortolano 1996; He et al. 2011) or on infrastructure sustainability (Arce and Gullón 2000). In this work, for the first time, we propose analyzing if and to what extent urban sustainability has been included, through SEA, in (ESIF) programming instruments, which differs from the standard urban planning. In this paper, we examine 20 ERDF Italian programs during 2014–2020 and three related SEA environmental reports to understand how much sustainable cities were considered and the contribution of SEA procedures to promoting urban sustainability planning in local-development strategies.

2 Data and Methods

The approach used in this study focuses on two activities (i.e., program reviewing through a desktop analysis):

- Analysis of Italian OPs;
- Analysis of SEA environmental reports.

The **analysis of OPs** aims to understand if and how sustainable cities are considered in the program strategy. The analysis followed three steps.

Step 1. Identification of strategic elements. Each OP is analyzed to find out if a strategic approach was used to implement urban sustainability. In particular, OPs were scrutinized to find one or more of the following:

- a priority axis explicitly devoted to urban sustainability;
- an integrated strategy for sustainable urban development;
- any ITI for urban sustainability.

Step 2. Identification of TOs for urban sustainability. Note that TOs that are consistent with (and can contribute to) urban sustainability, but do not explicitly refer to at least one of the three strategic elements (priority axis, integrated strategy or ITI), are not considered in the analysis.

Step 3. Identification of financial resources. The financial resources allocated to urban sustainability in each OP are calculated, per TO, considering:

- any resources allocated to the priority axis related to urban sustainability;
- definition at TO level based on the 'intervention field dimension' (Reg. EU 184/2014, Annex I, Table 1);
- any resources allocated to the integrated strategy. Note that the definition of financial resources is given for each priority axis within the description of the

'financial form' asterritorial delivery mechanism dimension', according to Regulation EU 184/2014, Annex I, Table 4); and finally;
– the allocation to ITI (here the definition for each TO is usually made explicit in the OP itself).

In addition to the previous steps, a specific analysis identified potential selection criteria linked to urban sustainability in the programs.

The **SEA contribution to the program** is analysed based on the Environmental Reports. We selected three OPs as case studies. The selection was based on geographical location (north-center-south), the amount of resource allocated, the presence of metropolitan areas/cities and the main issues concerning urban systems. The three cases represent various situations in Italy.

Each case study considered the following questions:

- **Was urban sustainability considered in drafting the OP?** Checking if and how urban sustainability was considered during preparation of the OP, including results from the consultation process and, in the section related to context analysis, analyzing the concept of 'urban sustainability' used.
- **Is the urban sustainability approach consistent with other urban sustainability strategies in the program area**? The external coherence in the environmental report verifies if the principles and objectives of the OP are consistent with plans, programs and strategies at national, European and international levels.
- **Has the SEA procedure actively contributed to increased urban sustainability in the OP?** Analyzing the extent to which SEA conclusions produced concrete recommendations on urban sustainability, especially for the selection of operations and the use of indicators or other monitoring measures.

3 Results

3.1 Analysis of the Operational Programmes

3.1.1 Strategies for Urban Sustainability (SUS)

Analysis of Italian ERDF OPs highlights very different strategies to implement urban sustainability between regions (see Appendix 1, Table 1). Specific priority axes are included in some 43%, or nine of 21 OPs, whereas integrated strategies for urban sustainability are in 66% of OPs (14 of 21). ITIs are activated in only a small fraction and only when an integrated strategy is not included. When both a priority axis and an integrated strategy for urban sustainability are defined in the OP, the integrated strategy is mainly (or exclusively) based on actions included in the priority axis.

Table 1 Urban sustainability strategies in Italian OPs for programming period 2014–2020 (see Sect. 2 for the method)

ERDF Operational Programme (OP) 2014–2020	Integrated strategy	PA devoted to Urban sustainability	ITI (integrated territorial investment)	Share of resources (%)
Abruzzo	X	X		10
Basilicata			X	4
Calabria	X		X	9
Campania	X	X		5
Emilia Romagna		X		6
Friuli Venezia Giulia	X	X		3
Lazio				0
Liguria	X	X		5
Lombardia	X			12
Marche	X			2
Molise	X		X	12
Piemonte	X	X		3
Apulia	X	X		3
Sardegna	X		X	3
Sicilia	X		X	7
Toscana	X	X		3
Umbria	X	X		5
Valle d'Aosta				0
Veneto	X	X		6
Trento				0
Bolzano				0

The right-hand column shows the share of OP resources allocated for integrated strategy and/or relevant priority axis

Some OPs have both integrated strategies and priority axes for urban sustainability. In these cases, integrated strategies are completely, or even exclusively, based on a priority axis (e.g., for Abruzzo and Liguria). Few integrated strategies include expenditures under an axis other than the priority axis directly dedicated to urban sustainability (e.g., Apulia, Campania). OPs that do not include any axis for urban sustainability base their integrated strategies mainly on a priority axis for sustainable mobility, energy saving and environmental protection. Four OPs chose not activate any specific measure for urban sustainability. For three of them (namely, Valle D'Aosta Region, and the Independent Provinces of Bolzano and Trento), this is because the characteristics and the socioeconomic conditions of the territory mean the 'urban system' is not a developmental priority. The fourth case is the Lazio region that hosts the most important city in Italy, Rome.

3.1.2 Thematic Objectives and Financial Resources

As shown in Appendix 1, Fig. 2, the amount of resources for urban sustainability, computed as described in Sect. 2, differs significantly from OP to OP, from 0 (Lazio

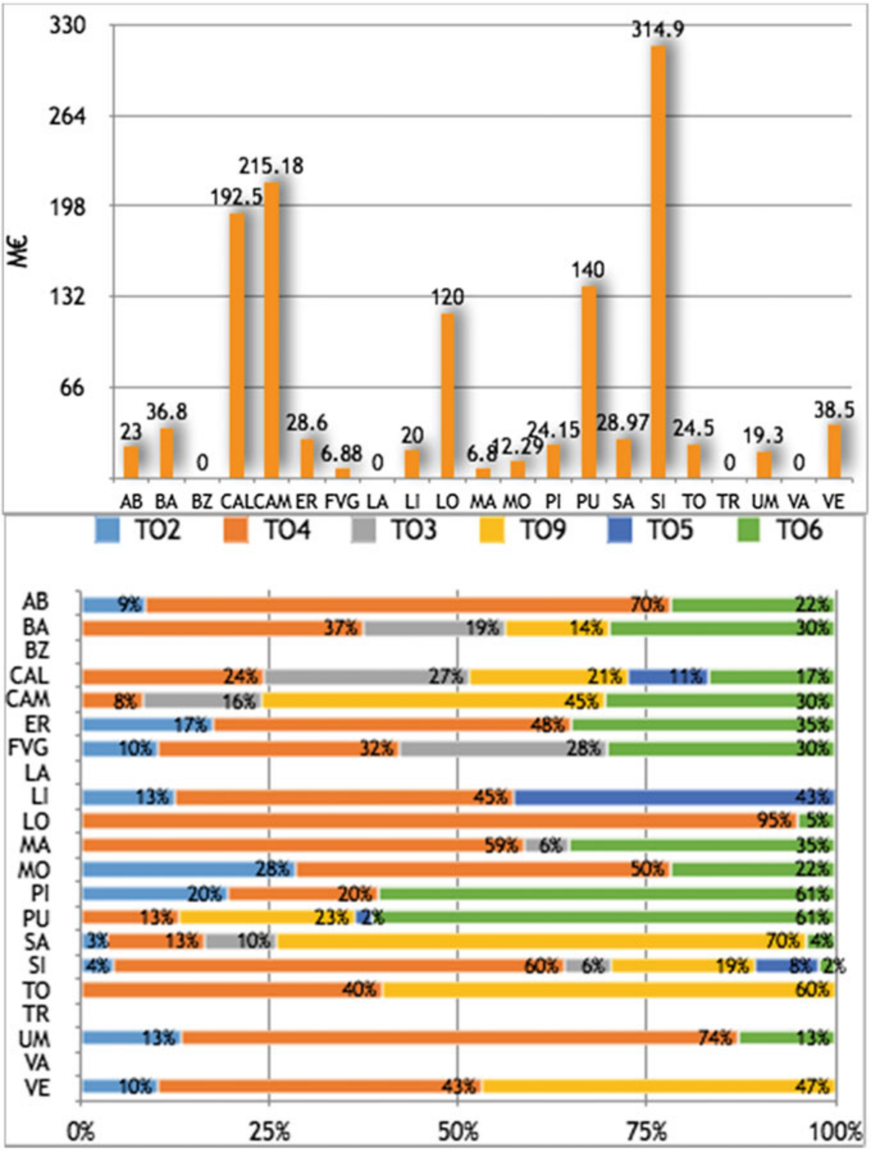

Fig. 2 Absolute amount of resources (in millions of euros) for Italian OPs in the programming period 2014–2020 (upper frame) and the share of resource budget for each TO as reported in the approved OPs (bottom frame)

and Valle d'Aosta) to more than €300 million (Sicilia). This depends both on the strategy (as described in the previous section, four administrations did not activate any specific strategy on urban sustainability), as well as on the resources allocated to each OP. According to the needs and the socioeconomic situation of the territory, resources range significantly from less than €100 million (Valle d'Aosta) to more than €4000 million (Campania, Sicilia, Apulia). The total amount of the program does not reflect the share dedicated to urban sustainability. Regions with the highest share are Lombardia, Molise and Abruzzo (see Appendix 1, Table 1), whose OPs are in the midrange of the total financial resources ranking.

Some TOs are implemented more than others (see Appendix 2, Fig. 2): TO4 (mobility and energy) is included in 17 of the 21 OPs; TO5 and TO3 are the less implemented (in four and seven OPs, respectively); TO6 (that was 'additional' in the partnership agreement) is activated for urban sustainability in 13 OPs, with actions mainly focused on tourism. TO4 attracted about 40% of the resources allocated to each TO, followed by TO9 (23%) and TO6 (19%).

3.2 Urban Sustainability and SEA: Three Case Studies

Three case studies, Apulia, Veneto and Campania, reflect very different situations.

The OP ERDF of Apulia Region has about €5.5 billion and is organized into 13 priority axes (including Technical Assistance), one of which is devoted to urban sustainability (Priority Axis 12). Total resources allocated for Priority Axis 12 are €65 million. This priority includes TO4 (Reduction in energy consumption and improvement of sustainable urban mobility in urban areas), TO5 (Reduction in hydrogeological risk and coastal erosion), TO6 (Maintenance and improvement of water quality and improvement of offer and fruition of cultural heritage) and TO9 (Reduction of families with social and economic fragilities and increase legality).

An integrated strategy for sustainable urban development is also included. This integrated strategy requires urban authorities to complete a Programme Document of Urban Regeneration including an overall strategy of sustainable development for urban areas (based on urban requalification, social inclusion, environmental sustainability). Total resources for the integrated strategy are €140 million (€65 million from Priority Axis 12 and €75 million from Priority Axis VI on environmental protection). ITI are not activated.

The OP ERDF of the Campania Region is organized with ten priority axes plus Technical Assistance, and financial resources of €4.1 billion. Priority Axis 10 focuses on urban development and includes TO3 (Promoting competitiveness of SMEs), TO4 (Reduction in energy consumption), TO6 (Improvement of cultural heritage and tourist destinations) and TO9 (three socio-educational services and Specific Objective 9.6, legality in urban areas). The resources for Priority Axis 10 are about €215 million.

The OP also includes an integrated strategy for urban development for 19 cities. In the 2007–2013 programming period, there were Urban Integrated Programmes (which needed updating). The integrated strategy is mainly based on Priority Axis 10, but further resources are allocated to an 'integrated mechanism for sustainable urban development' under different priority axes. These total €115 million (€21 million for TO3 in Priority Axis 3, €9.7 million for TO4 in Priority Axis 4, €38.3 million for TO6 in PA6 and €46.6 million for TO9 in PA8). ITI are not activated.

The OP ERDF of the Veneto Region has resources of about €600 million. The OP is organized in seven priority axes (including Technical Assistance), Priority Axis 6 is devoted to urban sustainability and includes: TO2 (Digitalization of administrative processes and diffusion of digital services); TO4 (Increased sustainable urban mobility); and TO9 (Reduction of families at risk, related to economic and housing conditions). The total resources for Priority Axis 6 is €38.5 million. An integrated strategy for sustainable urban development is based on Priority Axis 6 and preselects two types of areas: 'functional urban areas' and metropolitan cities (Venezia, Vicenza, Padova, Treviso, Verona and hinterland municipalities), as well as minor cities with relevant urban functions (Mirano, Montebelluna, Castelfranco Veneto, Camposampiero, Cittadella, Monselice, Este, Isola della Scala, Legnago, Schio, Thiene, Bassano del Grappa). Calls for integrated strategies will include environmental sustainability conditions. ITI are not activated.

3.2.1 Inclusion of Urban Sustainability in OP Drafting

For the Apulia and Campania OPs, the program was drafted in collaboration with economic, social and institutional stakeholders. In Apulia, five roundtable discussions activated partner consultation, one of which covered urban and territorial development. In Campania, even though both the municipality network and the regional office for urban policy participated in preliminary consultations, discussions do not seem to have focused on urban sustainability. In Veneto, while drafting the OP, no specific attention was given to urban sustainability. Nevertheless, authorities responsible for urban policies were involved in the consultation from the beginning of the OP drafting, as were urban authorities.

Only Campania described the 'urban environment' as an actual environmental issue. Cities are not only considered as a source of pressure on the natural environment, but also as a system whose sustainability could be improved through the OP. The context analysis included a section devoted to the urban environment, describing building stock, poor housing, illegal building, demography, commuting, noise, air and electromagnetic pollution, urban greenery and urban planning. In addition, potential problems were taken into account in the description of other environmental issues, including the conservation of urban parks in the description of nature and biodiversity, or risks to the urban population in the discussion of natural and technological risks. For Apulia and Veneto, the context analysis does not include a separate section on urban sustainability. In the Apulia OP, the urban dimension was analyzed under various environmental issues, such as:

- Adaptation to climate change: the interaction between climate and the human system analysis also considered the urban dimension (especially urbanization);
- Air quality: there are air-quality indicators for urban settlements;
- Water quality: water treatment is also presented in relation to the main urban settlements;
- Soil and natural risk: urbanization is considered a threat;
- Natural system and ecological quality: urbanization is considered a threat;
- Quality of coastal water: waste water from urban settlements are considered a pressure.

For the Veneto OP, the preamble to the context analysis describes the territory of the Veneto Region, with a broad review of the structure and functionality of urban, peri-urban and non-urban areas. Cities and urban environment are taken into account in the 'air quality' description (as places where air pollution is a critical issue) and in the 'waste' section (related to the production of urban waste). Urbanization is discussed in relation to hydrogeological risks and to landscape and ecosystem conservation.

3.2.2 Coherence and Synergies Between the OPs and Other Urban Sustainability Strategies

An external coherence analysis in the Apulia Environmental Review highlights high coherence between Priority Axis 12, the 'Landscape territorial urban plan' and the 'Landscape Plan', as well as good coherence with existing Plans for Natura 2000 Network. In these cases, the coherence is probably linked with actions on 'ecological requalification of productive areas' (Investment Priorities 6c and 6e). Specific action on water quality and risk management are in line with 'Regional plan for aqueducts', 'Regional plan for water quality' (and in turn with 'Regional plan for coastal system'), as well as with other regional and district plans on hydrogeological management.

The coherence with 'Regional plan for Air quality' and 'Regional energy plan' is linked to action under TO4 (Investment Priorities 4c and 4e) related to sustainable urban mobility and energy consumption. Coherence between Priority Axis 12 on urban sustainability and the regional programs, assessed in the environmental review, is not completely clear. For example, coherence between Priority Axis 12 and the Regional Strategy for Transport 2009–2013 has not been considered.

For Campania, the environmental review assesses direct coherence between Priority Axis 10 and the regional territorial plan for improving services and quality in urban systems ('Smart Cities'). There is indirect coherence with the regional plan for air quality, concerning the reduction in emissions from supporting sustainable mobility actions. The contribution description for Priority Axis 10 points out coherence with other regional plans for the improvement of the urban environment.

The Veneto Environmental Review shows coherence between Priority Axis 6 and the main regional plans. Coherence with the Regional Development Programme is linked to implementation of sustainable mobility and sustainable energy (TO4), to an improvement of sustainability of urban settlements and social inclusion (TO9), to the improvement of accessibility (TO2) and to enhancing the economy and SMEs (TO3). Similarly, actions for the restoration and valorization of existing public buildings inside the social inclusion strategy enhance coherence between Priority Axis 6 and the Regional Landscape Plan. Implementation for TO4 under Priority Axis 6 is also coherent with the 'Regional Air Quality Plan' (for actions on sustainable mobility) and with the 'Regional Energy Plan' (for interventions on energy saving and renewables). The only 'non-coherence' for Priority Axis 6 is with the 'Regional Waste Plan' and is connected with the possible increase in specific waste from industries following investment in SMEs.

The Campania OP has numerous synergies with other programs and strategies. The 'National Operational Programme for metropolitan cities' ('PON Città Metropolitane') 2014–2020 aims to coordinate the effort at national level between 18 cities, including Naples, to improve access to ICT (TO 2), to sustain the transition toward a low-carbon economy (TO4) and to promote social inclusion (TO2).

The Campania Region OP has direct coherence with 'PON Città' since Priority Axis 10 and its integrated strategy implement the TO mentioned in the National Programme.

Priority Axis 6 and the Integrated Strategy for Urban Sustainability of OP **Veneto** are in line with Strategy Europe 2020. Synergy with other ESI funds is ensured for all TOs covering urban sustainability. In particular, projects implemented in Interreg Europe, MED, Alpine Space, Central Europe and Italy-Slovenia can promote changes in knowledge and competence regarding energy efficiency in public buildings and sustainable mobility (TO4), also promoting new solutions and strategies for energy planning. The implementation of integrated strategy for urban sustainability in the city of Venice is synergetic with 'PON Città'.

For Apulia, synergies are described with macroregional strategies such as the EUSAIR Strategy.

3.2.3 Recommendation and Monitoring System in SEA

In the three case studies, the environmental reviews do not contain specific recommendations for urban sustainability. For Apulia, some of the suggestions covering other specific issues relate to cities and can improve the urban environment. These include the priority to complete, update and optimize drainage and cleaning systems in urban settlements with highly seasonal tourism; the priority for ecological networks in urban areas; as well as the priority for urban requalification in historic centers, suburbs and coastal settlements.

The Campania OP requires the Environmental Authority to maximise sustainability during OP implementation. Nevertheless, the environmental review recommended including environmental objectives into implementation tools, as is done with the integrated project for urban areas.

Monitoring systems proposed in the SEA Environmental Reports did not devote specific sections to urban sustainability. The environmental monitoring system of Apulia OP includes indicators that can monitor the change in pressure on (and from) urban systems. These refer to water quality (water treatment in terms of inhabitant coverage and compliance of water treatment systems with regulations), soil use (including soil consumption for new urbanization) and green urban areas.

The Campania Environmental Report does not include in-depth indicators for an environmental monitoring system, but refers to the 'PUMA' (Unique Plan for Environmental Monitoring) that will be implemented for all Campania OPs and co-financed with ESI funds. Nevertheless, the environmental review includes a list of context indicators, some of which are suitable for monitoring the implementation of urban sustainability. These include nature and biodiversity: density of historic parks in urban centers; landscape and cultural heritage; density of urban greenery in major cities; landscape and cultural heritage; and availability of urban greenery in major cities.

Similarly, the monitoring system proposed in the Veneto SEA Environmental Report does not contain specific indicators for urban sustainability, but includes some indicators useful to monitor the change in pressure on (and by) urban systems. In particular, the indicators referred to air quality and energy consumption (emission of CO_2 from traffic, PM10 concentration, etc.) and help for monitoring the efficacy of actions under TO4.

4 Discussion and Conclusion

Analysis of the OPs has shown how urban sustainability is relevant for all Italian regions. Nevertheless, with the exception of Regions with problems related to legality, social inclusion and public housing, urban sustainability is usually considered in terms of pressure generated by urban systems on the environment. This confirms studies (see, e.g., Wu 2010; While et al. 2004) that point out how urbanization—defined as the spatial expansion of the built-up environment, densely packed people and their socioeconomic activities—has often been held responsible for most environmental problems. As discussed in Wu (2008), urbanization should not be viewed merely as a cause for environmental problems, but also as an inevitable path to regional and global sustainability, enabling people to experiment with new solutions and technologies. For this, policies should actively take into account urban sustainability, involving people and stakeholders at various governance levels.

As Haughton (1999) pointed out, there are various categories of approaches to sustainable urban development, including market-based and social approaches. For EC cohesion funds, sustainable urban-development issues are addressed through the choice of specific priority axes and program objectives, as well as through specific financial allocations for dedicated actions.

In our analysis, social issues (TO9) are included in urban sustainability strategies only for a fraction of the OPs reviewed (eight out of 20) and only a few devoted to these considerable resources (see Fig. 2). Even less is devoted to competitiveness of enterprises (TO3) and to ICT (TO2). This, together with the greater resources for environmental TOs (4, 5 and 6, on low carbon, natural risks and environmental protection, respectively), confirm the tendency of Italian OPs to consider urban sustainability only in relationship to environmental pressure.

Strategic environmental assessments should be the tools through which environmental issues and the other elements for sustainability in urban system are integrated. Even if our study analyzed only three environmental reports, analysis of all the Italian OPs has led to some conclusions.

SEA conclusions and recommendations should be included more systematically in OP documents. Our analysis has shown that OPs have not always included SEA outputs, for example, in relation to more systematic involvement of stakeholders. Furthermore, it is worth noting that only a few OPs included selection criteria or other urban sustainability implementation tools.

4.1 How Was Urban Sustainability Considered in Drafting the OP?

SEA has helped programming authorities include urban sustainability issues, by involving stakeholders in urban aspects during OP preparation (Apulia), as well by including urban concerns in the context and the SWOT analysis (Campania). Nevertheless, the urban environment is often considered merely as a pressure on 'classical' environmental compartments (air quality, soil, water, etc.), instead of being considered as a separate issue with specific features, needs and developmental opportunities.

4.2 Coherence and Synergies Between OPs and Other Urban Sustainability Strategies

In the three case studies, the OPs are coherent with other plans, programs or strategies concerning urban sustainability in the region. In some cases, synergies with other strategies are actively pursued, as with the Veneto OP and in Campania with the 'PON Città' (the National Operational Programme on Cities).

4.3 Potential Contribution of SEAs to Urban Sustainability in OP Implementation

SEAs can help include urban sustainability in OPs through recommendations and environmental monitoring systems. In the three case studies, none included explicit recommendations for urban sustainability. Nevertheless, some recommendations for specific environmental issues affect urban areas as well, such as a priority for ecological networks to be implemented in urban areas, or the drainage and cleaning infrastructure in tourism cities suggested by the Apulia Environmental Report.

The Campania Environmental Review indicates that the Environmental Authority will be involved in the whole OP implementation to maximize overall sustainability. In the three cases, environmental monitoring systems will be refined during the program set-up phase. Nevertheless, the Apulia and Veneto Environmental Reviews included environmental indicators suitable for monitoring the expected effects of actions for urban sustainability.

Most OPs do not include specific criteria for selecting operations linked to urban sustainability. Nevertheless, in most cases this is because operation selection is detailed by the Monitoring Committee during program implementation in the OP drafting phase.

Appendix 1

See Figs. 1, 2 and Table 1.

Appendix 2

See Figs. 3, 4, 5, 6, 7 and 8.

Fig. 3 Financial allocation for urban sustainability in Italian ERDF Operational Programmes 2014–2010 (see Sect. 2 for the method)

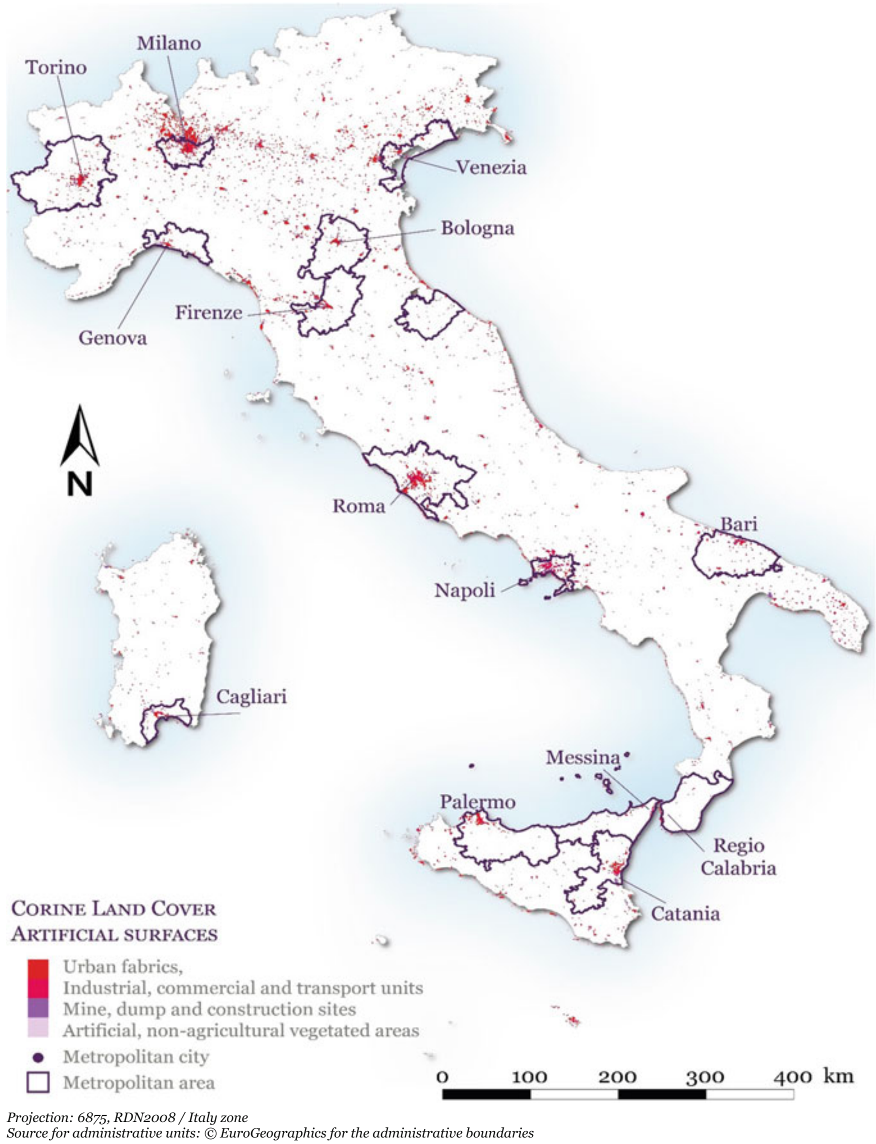

Fig. 4 Artificial surface according to the Corine Land Cover database (http://www.eea.europa.eu/data-and-maps/data/). The area pertain to CLC class 1—artificial surface. Metropolitan areas and metropolitan cities are also shown (the area of metropolitan cities is delineated by the province area)

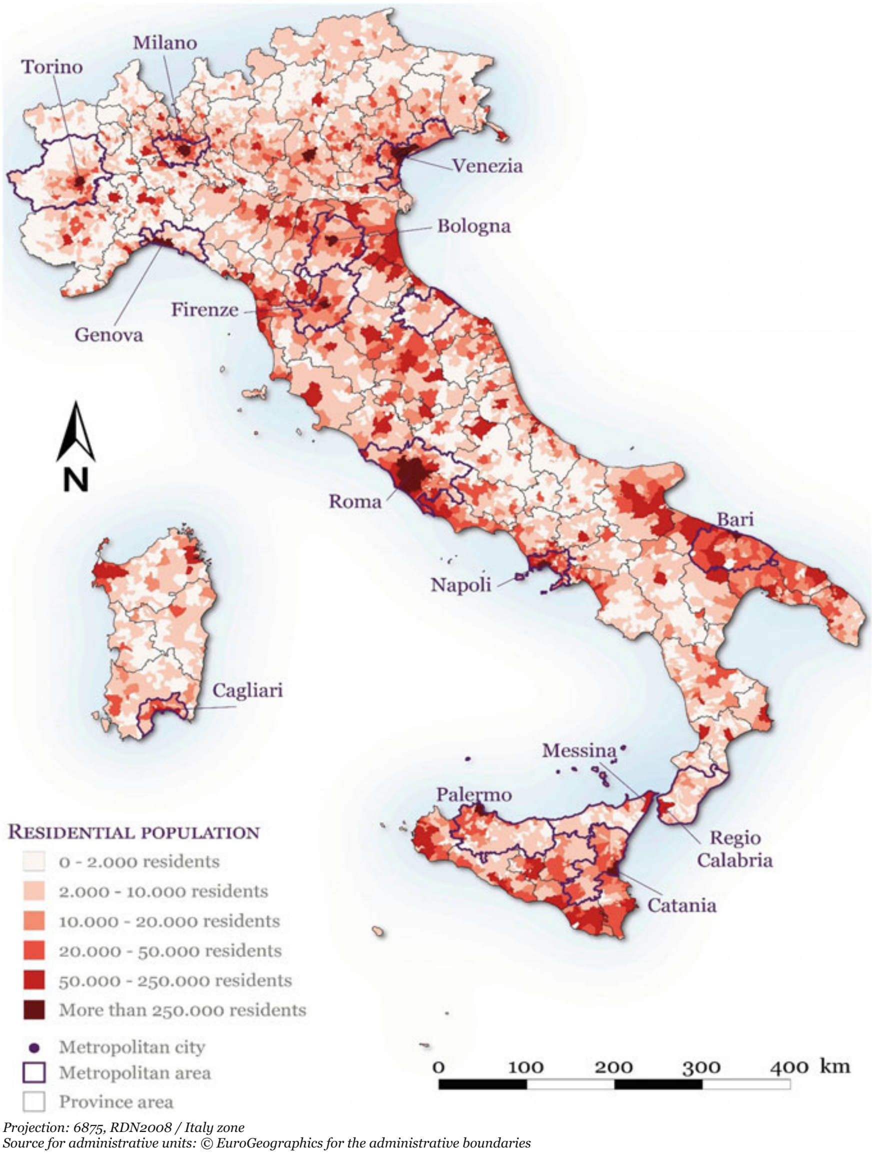

Fig. 5 Inhabitants at municipality level. *Source* Elaboration on ISTAT (National Institute of Statistic) data for the year 2016

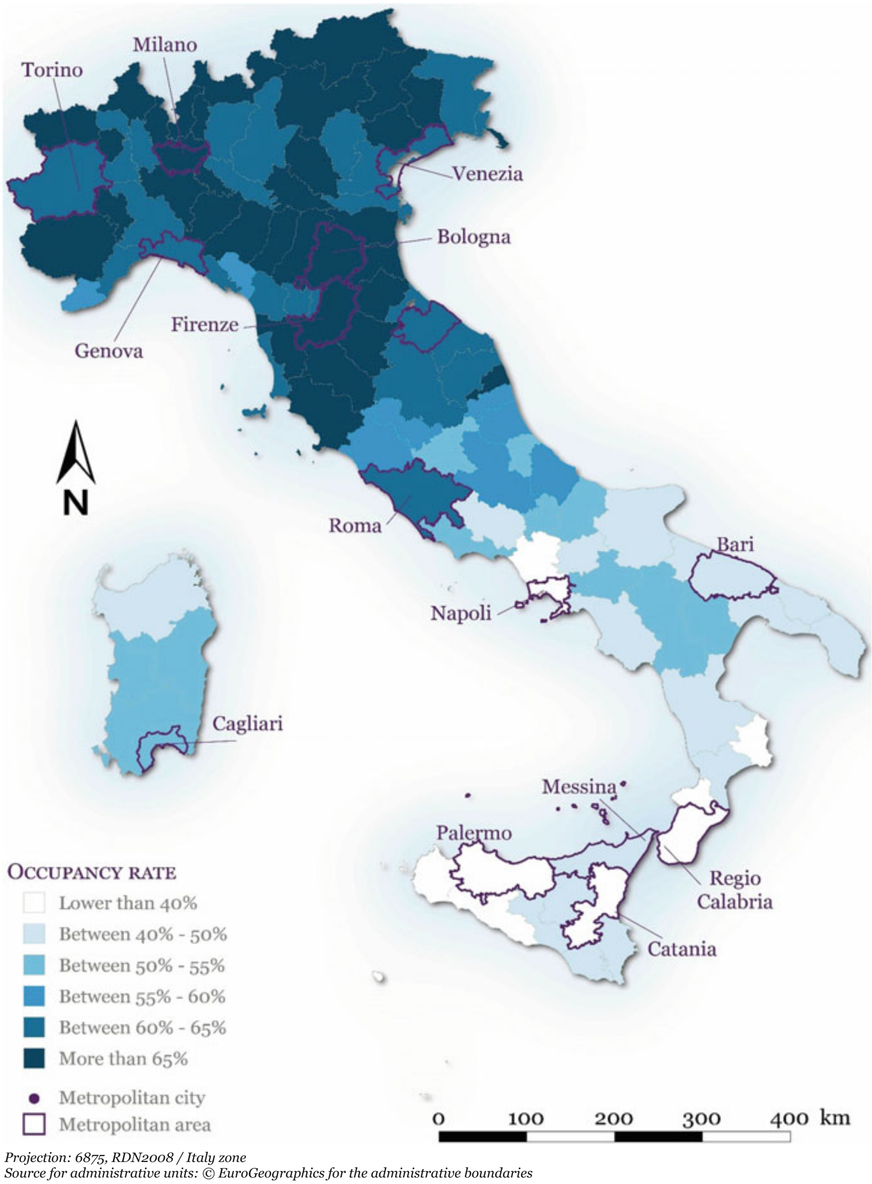

Fig. 6 Occupancy rate per province. *Source* Elaboration on ISTAT (National Institute of Statistic) data for the year 2016

Fig. 7 Foreign residents per municipality. *Source* Elaboration on ISTAT (National Institute of Statistic) data for the year 2016

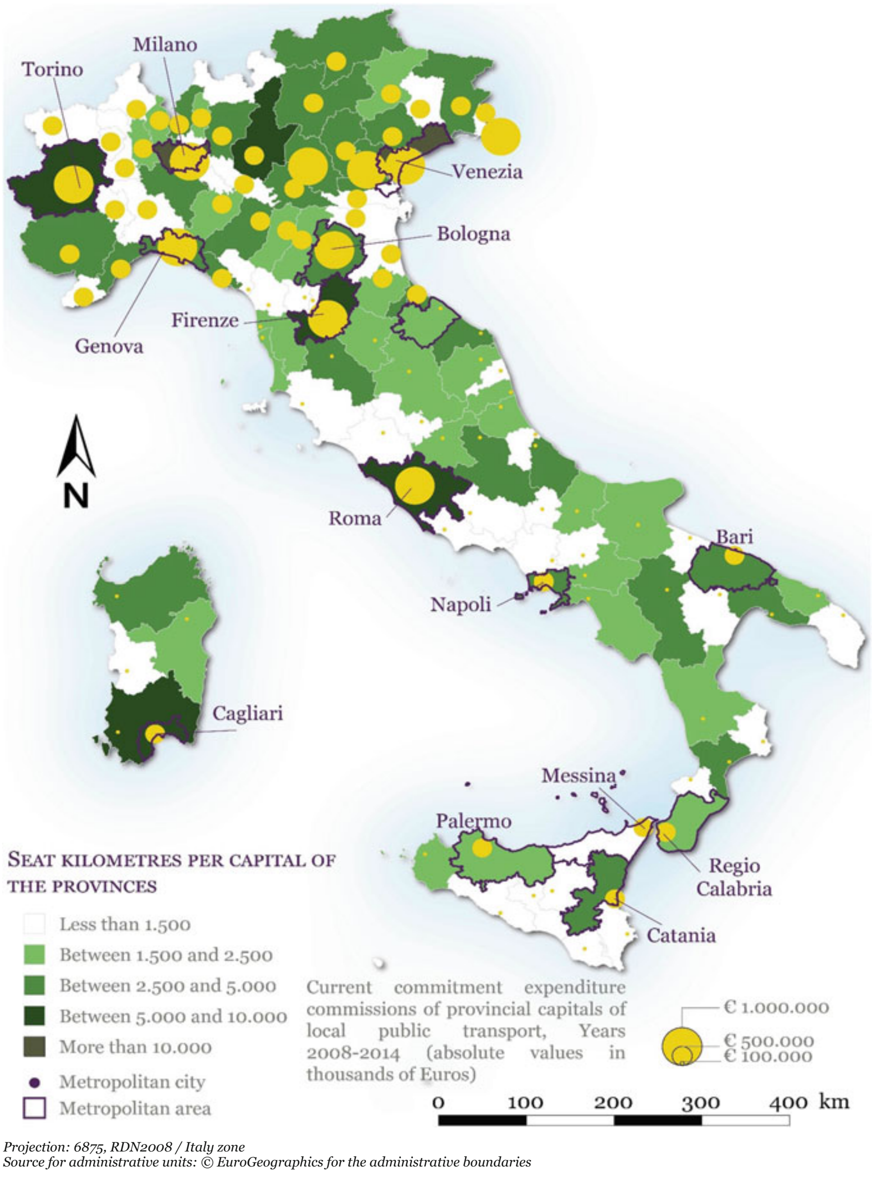

Fig. 8 Seat kilometers per capita and expenditure for local public transport at province level. *Source* Elaboration on ISTAT (National Institute of Statistic) data for the year 2014

References

Arce, R., & Gullón, N. (2000). The application of strategic environmental assessment to sustainability assessment of infrastructure development. *Environmental Impact Assessment Review, 20*(3), 393–402.

European Commission. (2014). Accordo di partenariato—CCI2014IT16M8PA001. Decision C (2014) 8021 final.

European Environment Agency. (2006). Corinne land Cover database.

European Union. (2013). Regulation No 1301/2013 of the European Parliament and of the Council of 17 December 2013, on the European Regional Development Fund and on specific provisions concerning the Investment for growth and jobs goal and repealing Regulation (EC) No 1080/2006.

European Union. (2014). Commission Implementing Regulation (EU) No 184/2014.

Haughton, G. (1999). Environmental justice and the sustainable city. *Journal of Planning Education and Research, 18*(3), 233–243.

He, J., Bao, C. K., Shu, T. F., Yun, X. X., Jiang, D., & Brown, L. (2011). Framework for integration of urban planning, strategic environmental assessment and ecological planning for urban sustainability within the context of China. *Environmental Impact Assessment Review, 31*(6), 549–560.

Shepherd, A., & Ortolano, L. (1996). Strategic environmental assessment for sustainable urban development. *Environmental Impact Assessment Review, 16*(4), 321–335.

While, A., Jonas, A. E. G., & Gibbs, D. (2004). The environment and the entrepreneurial city: Searching for the urban 'sustainability; fix' in Manchester and Leeds. *International Journal of Urban and Regional Research, 28*(3), 549–569.

Wu, J. J. (2008). Making the case for landscape ecology an effective approach to urban sustainability. *Landscape Journal, 27*(1), 41–50.

Wu, J. J. (2010). Urban sustainability: An inevitable goal of landscape research. *Landscape Ecology, 25,* 1–4.

Barriers to Switching in Retail Electricity Markets: A Regional Analysis of the Italian Market

Magda Fontana, Martina Iori and Consuelo Rubina Nava

Abstract The paper analyzes the determinants of switching barriers in a sample of Italian households. Inertia, while depressing consumer engagement and the associated benefits, also reduces competitive pressure in the energy retail free market. After the liberalization of the energy retail market in the European Union, the observed switching rates are relatively low: Identifying the causes of consumer inertia is therefore crucial to achieve the goals set by the European Union in the Three Energy Packages. We use a logistic regression model to discover the causes of consumer inertia as listed in the Aspect of Daily Life Survey (ISTAT 2014). Namely, we take into account: (i) loyalty, (ii) lack of information, (iii) difficulties in evaluating the economic benefits deriving from switching, (iv) perception of small savings from switching and (v) concerns for a worsening of the quality of service in case of switching. The main findings relate awareness—knowledge of the possibility to change the retailer—to the level of education and to the frequency of internet use. In addition, we find that households that are different in numerosity, geographical and urban location and in economic resources tend to attribute inertia to different causes. Among these, the most frequently reported are alleged difficulties in comparing offers and concerns about lower quality of service.

Keywords Consumers empowerment and action · Switching rates and consumer inertia · Informational problems · Retail strategies · Energy policy

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1 Introduction

The switching rate is a good indicator for both consumer information-based empowerment and market competitiveness. More informed consumers are more prone to benefit from better offers and, in turn, more reactive consumers foster competition among retailers. In the EU countries, the process of liberalization has generated upward trending switching rates, although their values remain well below the expected ones. Indeed, the market for electricity exhibits distinctive features. On the consumer side, electricity is a necessary good, but its cost has little impact on a typical household's income and the perspective of limited savings hampers active behavior. Additionally, inactive behavior has no consequence for the provision of service: the household will continue to receive electricity through the default, obligatory electricity-supplier scheme. After liberalization, competitors face other critical issues. First, price competition has little scope because about 75% of an energy price consists of taxes and transmission costs. Second, electricity is an undifferentiated good and competition among retailers takes place mainly through innovation in services that are added to the provision of electricity. This might result in increased difficulty for consumers to compare offers and, therefore, might further depress switching.

The paper identifies the determinants of the barriers that hamper consumers' active behavior, thereby giving insights for policy implementation at the national and regional levels. The study adds to the extant literature by providing a thorough study of switching barriers in the Italian market that, in spite of its importance in terms of volumes—it stands fourth in the European ranking after Germany, France and United Kingdom—remains largely underexplored. The analysis also contributes to knowledge of consumer behavior by applying advanced econometric techniques.

2 Literature

In the literature, inertia is explained according to three broad categories of causes. The first one is strictly connected with economic motives. Since electricity is a homogeneous good, households might consider information search costs to be too high to engage in comparisons between offers (Waterson 2003). In addition, in the presence of numerous offers, consumers might find it exceedingly difficult to identify the correct information about prices and provision terms. Finally, savings from switching are very low in comparison with an average household income and might not offset search costs and uncertainties. It follows that traditional cost-benefit logic often favors inertia over switching (Gamble et al. 2009; Littlechild 2005).

The second cause of inertia pertains to psychological attitudes. Long-term relationships generate loyalty and trust towards the current (often formerly monopolistic) electricity provider and discourage churning. Finally, inertia is associated with satisfaction with the current service.

The paper adds to the debate about consumer inertia by identifying the determinants of the above listed barriers to switching.

3 Data and Method

The analysis is based on the Aspect of Daily Life (ADL) Italian survey for 2014. We observe 42,492 individuals and 17,940 households. We use demographic, attitudinal and social information (see Tables 1 and 2) to estimate the determinants

Table 1 Descriptive statistics: individual and household variables

Individual characteristics	N	%	Household characteristics	N	%
Sex			*Number of members*		
Male	20,589	48.45	1	5541	30.89
Female	21,905	51.55	2	5101	28.43
			3	3525	19.65
Age			4	2893	16.13
Not in working age (<16)	6188	14.56	5+	880	4.91
In working age (16–64)	26,585	62.56			
Retired (>64)	9721	22.88	*Size of municipality*		
			Metropolitan area	3690	20.57
Education (over 16)			More than 10,000 inhab.	7994	44.56
University	4538	12.50	Less than 10,000 inhab.	6256	34.87
High school	13,011	35.84			
Secondary school	11,154	30.72	*Geographical area (NUTS1)*		
Primary school	6183	17.03	North-western Italy	4046	22.55
No education	1420	3.91	North-eastern Italy	3879	21.62
			Central Italy	3204	17.86
Employment status (over 16)			Southern Italy	4970	27.70
Employed	14,808	40.79	Insular Italy	1841	10.26
Jobseeker	4322	11.90			
Housewife	5295	14.58	*Economic resources*		
Student	2659	7.32	Excellent	154	0.86
Retired	8163	22.48	Good	9575	53.37
Other	1059	2.92	Insufficient	6998	39.01
			Absolutely insufficient	1213	6.76
Use of the Internet (over 16)					
Frequent	18,741	51.62			
Occasional	17,565	48.38			

Table 2 Descriptive statistics: electricity variables and switching barriers

Electricity characteristics	N	%	Inertia characteristics	N	%
Satisfaction on provided information			*Switching barriers*		
Very satisfied	1798	10.02	Loyalty (1)	7361	61.19
Quite satisfied	9099	50.72	Lack of info (2)	528	4.39
Unsatisfied	5204	29.01	Difficulties in comparisons (3)	3782	31.44
Very unsatisfied	1839	10.25	Small savings (4)	1215	10.10
			Quality loss (5)	3097	25.74
Knowledge of switching possibility					
Yes	15,185	84.64	*Number of choices*		
No	2755	15.36	1	8999	74.80
			2	2281	18.96
Supplier switch			3+	750	6.24
Electricity	1365	7.61			
Electricity and gas	1331	7.42	*Most common pairs*		
Gas	385	2.15	(3)–(5)	1166	9.69
None	14,859	82.83	(1)–(5)	1077	8.95
			(1)–(3)	892	7.41
			(3)–(4)	456	3.79
			(4)–(5)	436	3.62
			(1)–(4)	422	3.51
			(2)–(3)	249	2.07

of five broad categories of elements causing inertia in households that are aware of the possibility to switch their electricity retailer. They correspond to the answers that respondents to the survey have given to the question “You do not switch due to …”. Namely, we take into consideration: (i) loyalty toward the current retailer, (ii) the lack of information, (iii) the difficulties in evaluating the economic benefits deriving from switching, (iv) the perception of small savings from switching and (v) concerns for a worsening of the quality of service in case of switching.

We treat each of these elements as a dependent variable explained by household features. Household information is summarized in Table 1, while electricity related information and switching barriers are listed in Table 2. The geographical distribution of variables is plotted in Figs. 1 and 2. Finally, Table 3 describes the variables used in the estimation.

First, we investigate the determinants of the variable *awareness* with a logistic analysis. This variable represents the household knowledge of the switching possibility. Second, among aware households, we evaluate the reasons leading to inertia, i.e., not to change electricity retailer. It is worth noting that inertia reasons are not mutually exclusive (the most recurring pairs are shown Table 2), and therefore the application of a multinomial logit model for discrete choices is precluded. Then, we use a logistic regression model to investigate the determinants of these reasons, taken singularly.

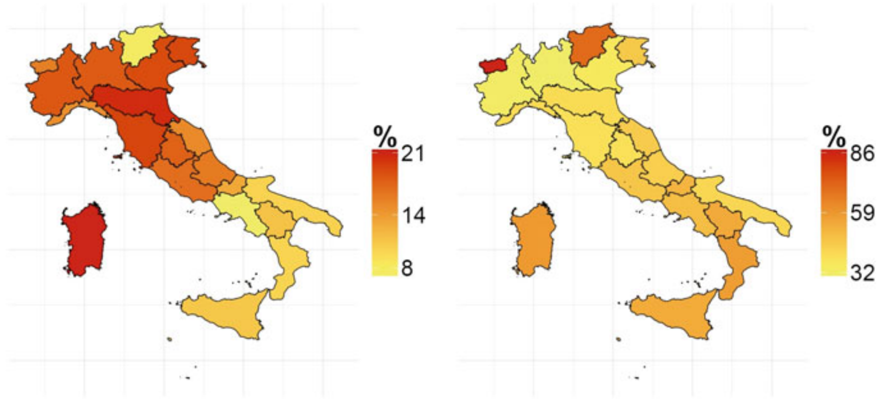

Fig. 1 Electricity retailer-switching rate (left) and index of electricity-market C3 concentration (right)

4 Results

Logistic point estimates of *awareness* are reported in Table 4. Estimates suggest that high levels of education (university and high school) and income (economic resource) result in a greater awareness of the possibility to switch. This is probably due to education providing better skills for gathering and interpreting (market) information. On the same line, a frequent use of the internet (more than once a week) strongly explains awareness.

From the geographical perspective, households in the center and in the south of Italy are less aware than those living in the north. This finding corroborates the well-known stylized fact of the social and the cultural Italian context. A minor but still positive effect is due to the high level of satisfaction on the available information.

On the market side, high concentration, expressed by the W_C3 variable, negatively affects the dependent variable. We suppose that, when the number of competitors is relatively low, marketing campaigns tend to be less frequent and aggressive.

Finally, the number of members and the age of the contact person (i.e., the head of the household) positively affect awareness, even if with a lower magnitude than the other determinants. On the one hand, older heads of the family are more aware, probably reflecting a greater interest in the search for information and in its interpretation and a greater propensity to be thrifty. On the other hand, the electricity costs weigh more on large households, inducing more intense market search motivated by higher electricity expenses.

The second step of the analysis investigated inertia in aware households. The estimated model parameters are summarized in Table 5.

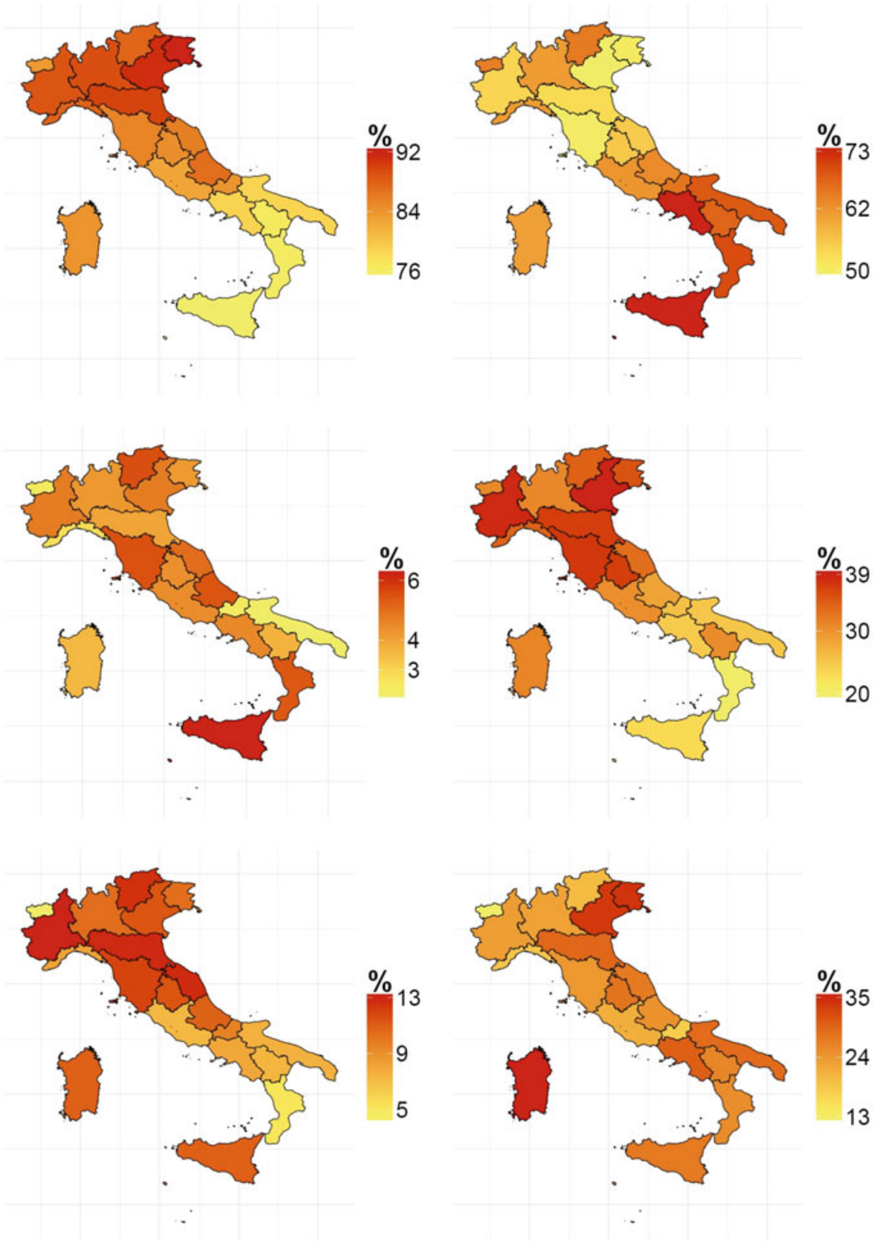

Fig. 2 Awareness (top left); loyalty (top right); lack of information (middle left); difficulties in comparisons (middle right); small savings (bottom left) and quality loss (bottom right)

Table 3 Variable description

Dependent variables	
Awareness	Dummy variable: 1 for families that are aware of the possibility to switch electricity retailer
NS_reason	Categorical variable: switching barriers, with levels 1, 2, 3, 4, 5
Explanatory variables	
Over65_CP	Dummy variable: 1 for contact person with age >65
Degree	Dummy variable: 1 for households with a university degree as higher educational level
Diploma	Dummy variable: 1 for households with a diploma as higher educational level
Nb_members	Number of family members
Inhab	Categorical variable: municipality size, with levels Metropolitan Area, <10,000 inhabitants, >10,000 inhabitants
Geo	Categorical variable: geographical distribution (NUTS1), with levels North-west, North-east, Center, South, Islands
Econ_resources	Dummy variable: 1 for satisfactory level of economic resources
Frequent_Internet_users	Rate of family members that navigate the Internet more than once per week
Gas_retailer_switch	Dummy variable: 1 for families that have switched gas retailer between July 2007—end of Jan 2014
Sat_info_level	Dummy variable: 1 for contact person that reports having satisfactory information on electricity service and provision
W_C3	Dummy variable: 1 for regional market concentration (C3) > national weighted average (weights = regional populations). C3 computed as the sum of the market shares of the three main firms in the relevant market

Starting from household information, a family with high education level perceives that it is difficult to evaluate the switching profitability, as well as to achieve substantial savings. With a lower frequency, satisfaction with the current retailer is the declared as the rationale behind the non-switching choice.

Moreover, the number of family components only marginally and positively affects the probability to select *difficulties in comparisons* and *quality loss*, while it negatively impacts *loyalty*.

The geographical dimension is still a crucial determinant. Living outside metropolitan areas has a negative impact on *loyalty*. Those who live in the south of Italy have a higher probability to select reasons *loyalty* and q*uality loss* and a lower probability to select reasons d*ifficulties in comparisons* and *small savings.*

The effect induced by a switch of gas provider is particularly interesting. A household that has already changed gas retailer has acquired a rich set of information during the evaluation and the procedure conducted about the gas market. It follows that inertia cannot be imputed to scarcity of information and

Table 4 Logit model for switching awareness

	Dependent variable
	Awareness
Over65_CP	0.106**
	(0.053)
Degree	0.864***
	(0.085)
Diploma	0.528***
	(0.056)
Nb_members	0.189***
	(0.021)
Inhab <10,000	0.024
	(0.063)
Inhab >10,000	0.005
	(0.061)
North-east	0.194**
	(0.079)
Center	−0.320***
	(0.077)
South	−0.481***
	(0.075)
Islands	−0.503***
	(0.094)
Econ_resources	0.192***
	(0.045)
Frequent_internet_users	1.081***
	(0.071)
Sat_info_level	0.122***
	(0.045)
W_C3	−0.135**
	(0.056)
Constant	0.660***
	(0.093)
Observations	17,948
Log likelihood	−6898.437
Akaike Inf. Crit.	13,826.870

Note $*p < 0.1$; $**p < 0.05$; $***p < 0.01$

difficulties in elaborating it. Rather, inertia is grounded in satisfaction with the current electricity retailer.

As for household information, a crucial determinant is the use of the internet. In particular, households that frequently access the internet attribute inertia to the difficulty to compare offers and to small savings. These elements confirm Grubb

Table 5 Logit model for switching barriers

	Dependent variable				
	Loyalty	Lack of info	Difficulties in comparisons	Small savings	Quality loss
Degree	−0.396***	0.107	0.337***	0.371***	0.070
	(0.064)	(0.144)	(0.065)	(0.099)	(0.068)
Diploma	−0.234***	0.021	0.179***	0.318***	0.013
	(0.051)	(0.116)	(0.053)	(0.082)	(0.055)
Nb_members	−0.042**	0.052	0.039**	0.004	0.058***
	(0.017)	(0.038)	(0.017)	(0.026)	(0.018)
Inhab <10,000	−0.318***	0.129	0.088	−0.061	−0.012
	(0.058)	(0.139)	(0.059)	(0.089)	(0.062)
Inhab >10,000	−0.226***	0.372***	0.080	0.060	0.100*
	(0.055)	(0.129)	(0.055)	(0.083)	(0.058)
North-east	−0.208***	0.026	0.135**	0.202**	0.451***
	(0.061)	(0.143)	(0.062)	(0.093)	(0.068)
Center	−0.133**	0.018	−0.035	0.011	0.194***
	(0.066)	(0.153)	(0.068)	(0.103)	(0.075)
South	0.458***	−0.296*	−0.458***	−0.227**	0.327***
	(0.067)	(0.158)	(0.069)	(0.107)	(0.073)
Islands	0.378***	−0.030	−0.365***	0.165	0.587***
	(0.090)	(0.195)	(0.093)	(0.135)	(0.094)
Econ_resources	0.206***	−0.036	−0.097**	−0.098	0.152***
	(0.041)	(0.094)	(0.042)	(0.064)	(0.044)
Frequent_Internet_users	−0.230***	−0.151	0.126**	0.289***	0.054
	(0.054)	(0.125)	(0.056)	(0.084)	(0.058)

(continued)

Table 5 (continued)

	Dependent variable				
	Loyalty	Lack of info	Difficulties in comparisons	Small savings	Quality loss
Gas_retailer_switch	0.720***	−0.883	−0.648***	0.219	−0.612**
	(0.230)	(0.716)	(0.244)	(0.351)	(0.260)
Sat_info_level	1.132***	−0.762***	−0.820***	−0.407***	−0.576***
	(0.041)	(0.091)	(0.041)	(0.062)	(0.043)
W_C3	0.273***	0.181	−0.143***	−0.152**	−0.216***
	(0.049)	(0.111)	(0.050)	(0.075)	(0.052)
Constant	0.038	−2.975***	−0.407***	−2.225***	−1.030***
	(0.074)	(0.174)	(0.076)	(0.117)	(0.081)
Observations	12,035	12,035	12,035	12,035	12,035
Log Likelihood	−7440.052	−2119.350	−7181.214	−3864.520	−6709.989
Akaike Inf. Crit.	14,910.100	4268.700	14,392.430	7759.039	13,449.980

Note $^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

(2015) concerns about a proliferation of offers: gathering information makes decision making more costly relatively to the respective benefits.

Households that declare "sufficient" economic resources are more affected by loyalty to and/or trust in the retailer.

Finally, highly concentrated markets result in inertia expressed as loyalty to the retailer. It is worth noting that, under this circumstance, loyalty might be induced by the presence of few competitors, i.e., by low competitiveness.

5 Discussion and Conclusion

We interpret results according to the "Three-Pillar Strategy To Deliver A New Deal For Energy Consumers" suggested by the European Commission (2015). While easily accessible and comparable, information is seen by the EU as promoting active behavior, we find that better information introduces more inertia. The data suggests that further investigation should be conducted into the benefits that household have been receiving from liberalization. Many studies and reports (AEEG 2017; Concettini and Crèti 2013) claim that, due to the imperfect realization of competition, only industrial customers have appropriated gains from competition. In this line, non-switching could be thought of as the best strategy given the prevalent conditions in the market. In addition, inertia is also related to satisfaction and savings from other markets (e.g., gas). Differentiation of behavior across Italian regions (see Fig. 1) highlights that different local market structures have an impact on consumer engagement.

References

AEEGSI. (2017). *Monitoraggio Retail. Aggiornamento del rapporto per gli anni 2014 e 2015*.

Concettini, S., & Créti A. (2013). Liberalization of electricity retailing in Europe: Coming back or going forth? *Cahier de Recherche*, 2013–2029.

European Commission. (2015). *Best practices on renewable energy self-consumption*. SWD (2015) 141 final.

Gamble, A., Juliusson, E. A., & Gärling, T. (2009). Consumer attitudes towards switching supplier in three deregulated markets. *The Journal of Socio-Economics, 38*(5), 814–819.

Grubb, M. D. (2015). Failing to choose the best price: Theory, evidence, and policy. *Review of Industrial Organization, 47*(3), 303–340.

Littlechild, S. (2005). *Smaller suppliers in the UK domestic electricity market: Experience, concerns and policy recommendations*. London: OGFEM.

Waterson, M. (2003). The role of consumer in competition and competition policy. *International Journal of Industrial Organization, 21*(2), 129–150.

Public Space and Vibrant Ground-Floor Zones in Sustainable City-Quarter Development: Learning from the Smart-City Graz

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Abstract The present paper builds upon the basis that a sustainable city is fundamentally determined by its built structure. Attractive public space contributes decisively to the quality of life, which is the overall goal of sustainable development. This paper focuses specifically on the role of the ground-floor zone as a factor for a lively public space and points out the importance of the interrelationship between the public space and the ground floors of the adjacent buildings, while also discussing the necessary qualities and strategies to be achieved. The paper briefly presents the research and realization project Smart City Graz, which is seeking to develop new knowledge and models of integrated and holistic city planning and development processes. An urban-framework plan and demonstration projects are developed in a comprehensive stakeholder process to initiate the development of Waagner Biro, the quarter Smart City Graz. Informal instruments completing the traditional planning instruments were introduced in the development process to meet these challenges: the framework plan, town planning, architecture and public-space competitions, accompanied by private-law contracts, and the development of a monitoring concept. Particular emphasis is put on the functional and spatial requirements for buildings' ground-floor zones to prepare the way for a successful intertwining of the exterior and the interior as the basis for a vibrant public space—and through this, for a lively city quarter. Furthermore, the question of the programming of the ground-floor uses on the scale of a city quarter or street

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is addressed. The municipality as the representative of the public must protect common interests and guarantee public benefits that go beyond the individual economic interests of the various stakeholders.

Keywords Sustainable city development · Compact city · Public space
Ground floor zone

1 Introduction

Even more so today, the terms sustainability and smartness are very often reduced to technological solutions and innovations. We need to remind ourselves constantly, however, that both concepts evolved from the goal to improve the lives of people. Technology is an important tool within this responsibility, but should never become more than that. On the other hand, it is obvious that the built space of a city has a direct impact on the quality of everyday life.

In the lifetime context—a fundamental factor for sustainability—of the three layers, i.e., *built environment*, *functional assignment* and *technology,* we learn that the spatial structure of a city is the most constant basis that determines space and society for decades and even centuries. If the built structure is smart—well-planned and flexible—several changes of function are possible during its life span. The technological equipment of the buildings and the city itself is finally the most short-term layer of change. A comprehensive and flexible planning of the city space is thus crucial for the success of every city-quarter or district development.

The compactness of a city and the multifunctionality of its quarters and spaces are the fundamentals for ensuring it will be sustainable. By minimizing the necessity for long- and medium-distance transport, while at the same time maximizing the opportunities for communication, the city will be made more efficient, without imposing direct pressures for efficiency on the people in it: reducing the distances people must travel in their everyday lives, the distances all kinds of goods need to travel, and the distance infrastructure networks have to cover to delivering energy, water and information.

A compact city—or *city of short distances*—does not mean an increase of built density alone, but, far more, a higher degree of intensity. Urban intensity is created by adjusting the balance and complementing the increasing number of people with appropriate areas of high-quality public space. A compact city with an elaborate network of attractive public spaces is a people-centered city of efficacy. A technology-centered city can only offer efficiency.

Fig. 1 Smart City Graz Waagner Biro project area (Google, Institute of Urbanism/URBA Graz, TU Graz)

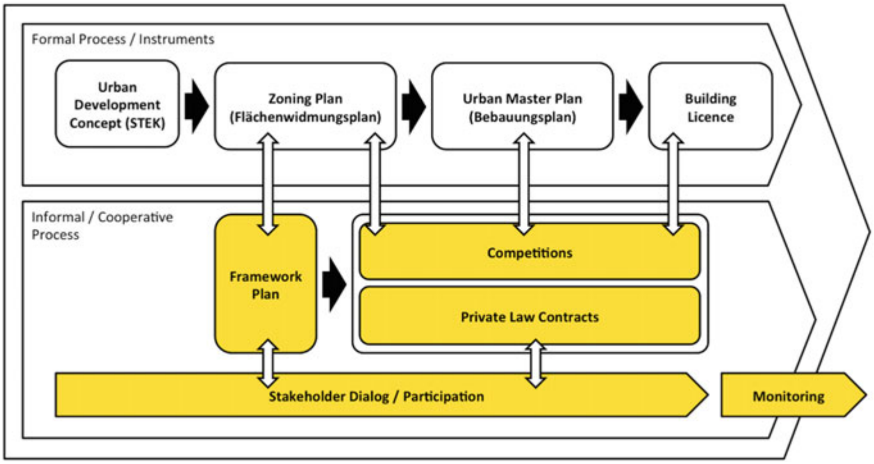

Fig. 2 Formal and informal city-development instruments (Institute of Urbanism/URBA Graz, TU Graz)

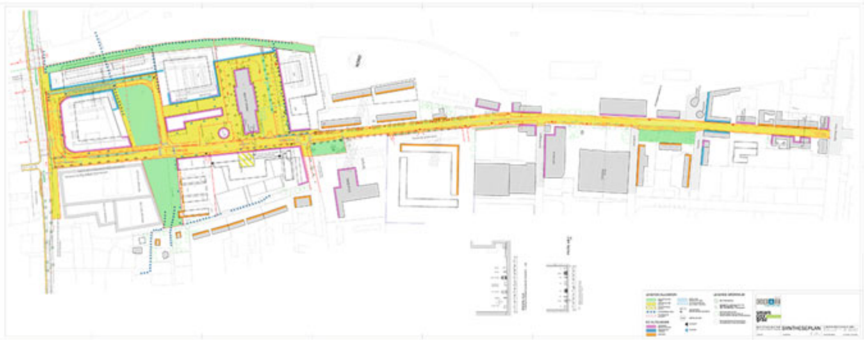

Fig. 3 Plan from the competition brief for the public space competition including ground floor uses (City of Graz, Town Planning Department)

2 Public Space and the Ground-Floor Zone

Among the fundamental conditions for a compact city (or city quarter) are the functional and social mixture and the attractiveness of urban spaces. One important, yet rarely researched, topic is that of the building ground-floor zones and their relationship to public space. The public sphere is not only constituted by streets, squares and parks, but also by the interaction of public spaces and buildings. Their manifold functional and spatial intertwining is a crucial factor for a city district or quarter. "If the edge fails, the space never becomes lively" (Alexander 1977: 600), Christopher Alexander pointed out the importance of the edges of squares and, already around 1900 in his masterpiece "*Der Städtebau nach seinen künstlerischen Grundsätzen* [*City Planning According to Artistic Principles*]" (Sitte 1983), Camillo Sitte mentioned the fact that most activities in public squares take place near their edges. In recent years, this knowledge has been increasingly rediscovered and considered at various stages of planning, as for instance in the *Masterplan Flugfeld Aspern* in Vienna:

> A city is perceived and experienced via its public spaces. Hence the focus must be put on the design of the city's spaces. From the private door to the street, to the square, to the park, etc., a hierarchy of public spaces needs to be created that is in close relation to the buildings, their entrances and windows.[1] (Stadt Wien, Tovatt 2008: 28)

Being the element defining the edge between public space and the building, the ground-floor façade is the border, transition area and buffer zone between the public and the private and requires special attention in the planning process. The exterior

[1]Translation by the author, original text in German: Eine Stadt wird über ihre öffentlichen Räume wahrgenommen. Daher muß die Priorität auf die Gestaltung des Stadtraumes gelegt werden. Von der Eingangstüre bis zur Straße, zum Platz, dem Park und weiter, soll eine Hierarchie von öffentlichen Räumen geschaffen werden, "die mit den Gebäuden und ihren Eingängen und Fenstern in Beziehung stehen."

and the interior have to work together spatially and functionally. Guidelines on how to achieve this—mainly in the spatial context—are given, for example, by the Danish architect and town planner Jan Gehl in his book *Cities for People* (Gehl 2010) and, among others, in the study *Partitur des öffentlichen Raums. Planungshandbuch [Score for Public Space. Planning Guideline]* (Stadt Wien/Gehl Architects 2009) conducted for the city development project Seestadt Aspern. Based on Gehl, the basic requirements that are necessary for and support the establishment of a functional and spatial interrelationship between the public space and the ground floor can be defined as listed below:

Functional requirements:

- Commercial uses mixed with cultural functions and uses for public benefit
- Suppliers for local daily needs
- Offices frequented by the public
- Overlapping of functions in the public space
- Mix of functions within every building
- Active uses generating communication between inside and outside
- Active uses 24/7.

Spatial requirements:

- Small-scaled shop units and façades
- Shops and offices oriented directly to the street
- Transparent ground-floor façades
- Large number of openings, views, etc.—avoid long, closed or undifferentiated façades
- Large number of entrances (maximum of 20–30 units per door)
- Clearly distinguishable entrances: "personal addressing"
- Clear headroom of over 4 m
- Flexibly structured space
- Spaces with social value positioned along the transparent façade
- Public space extends directly up to the façade
- Three-dimensional building edges, activation of recesses etc.
- Windows and balconies oriented to the street to show the life inside and provide social control.

While it is relatively easy to define these lists, when it comes to realization of all the requirements in the complexity of the development of a city quarter, three basic questions arise: *Who* decides *what* and *when*? Thus the definition of a comprehensive development process is crucial for the successful implementation of a sustainable city quarter.

3 Smart-City Graz

Graz is Austria's second biggest city with 287,000 residents and more than 320,000 people permanently present, among them a large number of students (Stadt Graz 2017: 7–8). The metropolitan region of Graz includes more than 600,000 people. Over the past two decades, Graz has been one the fastest growing cities in Austria, and this trend is expected to continue through the next decades (DerStandard 2017). Consequently there is a permanent need for new housing and workplaces.

3.1 The Smart City Graz Project

For these developments in 2011, the City of Graz, together with partners from science and industry and partly funded by the national Climate and Energy Fund, initiated the project *I LIVE GRAZ—smart people create their smart city* (Hoffer et al. 2013) that creates a vision and a roadmap for the *Smart City Graz* in the year 2050.

Based on the smart-city strategy developed in *I LIVE GRAZ*, from 2012 until 2017 the demonstration project *Smart City Graz* (Smart Future Graz Team 2014) was established, which concentrates on the development of the city quarter *Waagner Biro*, a former industrial area isolated from the city center by the railroad tracks north of Graz Central Station. Once completed, the functionally mixed and compact smart city quarter will accommodate 3500 residents and provide 1000 workplaces on a 127,000 m^2 area. A consortium of 13 partners from administration, science and industry in the associated research project is seeking to generate new knowledge and models of integrated and holistic city planning and development processes that will be applied to future smart-city developments in Graz. In a comprehensive stakeholder process, demonstration projects are worked through and compiled as an initiation for the development of the quarter. The overall aim is the "innovative realization […] to achieve a future compliant, livable and intelligent city district […] with lowest emissions (goal is zero emission) and low resource consumption that not only uses sustainable energies, but also focuses on sustainable mobility and social mixture." (Smart Future Graz Team 2014: 9)

The development process is a central issue of the project that targets integrated city development comprising comprehensive stakeholder and resident integration, interdisciplinary expert groups in the city administration and the integration of external experts.

During the project, it was observed that the formal instruments of spatial and land-use planning in Austria are not sufficient for the smart development of city districts or quarters. Thus, the formal instruments of spatial planning were combined with informal instruments. The perspective is to further improve and regularly apply them and finally integrate them as standards into the city development process. An intention of particular importance here is to use all that is learned from the *Smart City Graz Waagner Biro* prototype project for the ten-times larger city-development area *Graz Reininghaus* that is to be developed with only a short time-shift to the Waagner Biro project.

3.2 Smart City Graz Development Process and Implementation

The formal planning process in Austria comprises the *Urban Development Concept* [in German *Stadtentwicklungskonzept/STEK*], the *Zoning Plan* [*Flächenwidmungsplan*], the *Urban Master Plan* [*Bebauungsplan*] and finally the *Building License*. In practice, a process of this kind is regularly supplemented by town planning or architecture competitions. These instruments, however, do not offer enough flexibility for long-term projects, and nor do they provide sufficient possibilities for coordinating parallel ongoing developments. In Smart City Graz, a bundle of informal instruments are introduced and coordinated that complement and complete the formal process:

- a framework plan,
- private law contracts (between the city and the property owner/developer),
- a participation process,
- competitions (architecture and town planning), based on the framework plan,
- and a monitoring concept.

The central instrument is the framework plan that is defined in coordination with the zoning plans and a structural stakeholder dialog. Taking the framework plan as a fundament, competitions are held for all parts of the development area. These include additional stakeholder and participation processes. The development process also contains a monitoring coverage (at best) for the construction and moving-in phase.

A framework plan (Stadt Graz, kleboth lindinger dolling 2013) has been defined in a cooperative stakeholder process for Smart City Graz Waagner Biro, which is and has been the basis for several competitions since 2014. The competition results, together with the accompanying private law contracts between the City of Graz and the individual property owners and developers, form the basis for the subsequent urban master plan.

The private law contracts close the gap between the city's means to directly define requirements and restrictions within the formal planning instruments and the requirements necessary to realize a sustainable city quarter. They address qualities such as social sustainability, neighborhood management, soft mobility, sustainable energy, public space and building culture, which are defined on the two levels *General Agreements* and *Implementation Agreements*. This construction is essential since the City of Graz does not own the land and has to undertake negotiations and agreements with the private developers to guarantee various measures aiming at the achievement of public benefit with the development.

One finding in analyzing the process of Smart City Graz is the important role played by the competition briefs. The selection, which requirements are explicitly defined and who can contribute to the definition of the brief influence not only the results of the competition but also point out the responsibility of the developers to implement the qualities in the realization project.

3.3 Ground-Floor Zone in Smart City Graz Waagner Biro

The multifunctionality of Smart City Graz Waagner Biro was a basic topic from the beginning of the project and several definitions were thus established with the aim of preparing the way for differentiated ground-floor use on the spatial level. Awareness increased as the project progressed, however, concerning the steps that are essential to ensure a successful and sustainable programming of the significant amount of space dedicated to non-residential use.

3.3.1 Framework Plan

Various requirements for the ground floor have already been defined in the framework plan:

- The obligation to carry out a competition for the buildings *and* the public space in the quarter
- A mainly commercial use of the ground-floor zone in large parts of the quarter
- A minimum clear room height of 3.2 m
- The consequent accessibility for handicapped persons
- The general aim to achieve a small-scale and diverse structure of property and functions.

3.3.2 Competitions and Competition Briefs

In the competition brief for the public-space competition, a strategy paper on sustainable and qualitative public space was included that also covered the relationship between the public space and the buildings.

Once the architecture competitions for the majority of the sites based on the winning results and the urban master plan had been defined, the basic volumes were determined on a legally binding basis. The following were defined for the ground-floor zone:

- the height of street-side-oriented ground floors must be a minimum of 4.5 m,
- the floor at ground level must be not more than 30 cm higher than the exterior ground,
- no residential use is planned for the ground floors except along inner courtyards, and
- no commercial use is to be made of floors other than the ground floor.

3.3.3 Concept for the Use of Ground Floors

In Smart City Graz Waagner Biro, 80,000 m^2 of residential space, 30,000 m^2 commercial space and 30,000 m^2 of ancillary space will be built. The large share of commercial spaces comprises shops, services, offices (with a relevance to the public) and "alternative uses". In 2014 the City of Graz initiated a concept for the ground-floor use and agreed with the private property owners on:

- regulations for the ground-floor functional and spatial level (in the private law contracts),
- the cooperative development of the ground-floor zone,
- development according to the themes education, innovation, culture and sustainable local retailers,
- including the analysis and assessment of economic viability,
- and incentives for co-working spaces, collaborative work shops, local start-ups, sustainable or socioeconomically ambitious projects like repair-cafes, food coops, more-in-one businesses, services with long opening hours and initiatives and entrepreneurs generating a public benefit,
- and the coordination and support provided by the existing neighborhood office, which is financed half by the municipality and half by the private developers.

Furthermore, at the time of the writing this paper, the City of Graz is working on more detailed binding agreements with the private developers addressing specific uses and the financial incentives, which comprise subsidized rents for the specified target groups of entrepreneurs and initiatives, plus support for start-ups, with both of these initiatives financed by the City's Department of Economics. Moreover, the municipality is establishing and financing public services on the ground floors of the quarter, which comprise schools, a kindergarten, a youth center, childcare and the neighborhood office.

3.3.4 Cooperative Process and Coordination

The framework plan provides a fundament for the coordination of parallel, ongoing competitions on urban structure and the scale of buildings by the specifications and requirements formulated in the competition briefs. However, this issue will require further refinement in synchronizing the results prior to realization. This will apply in particular to the edges—or seams—of the individual planning areas, such as the façade of the ground floor. The architecture competitions for two large plots adjacent to the main public park and square are tendered as *Cooperative Competitions* and based upon the results of the town-planning competition for the area *and* on the outcome of the public-space competition as a means of coordinating the development of the buildings and their ground floors with the planning of the public space. The latter resulted in two winners, who are now working on the final realization project together with the town-planning department of the municipality. Specific requirements for the ground floors are developed so as to be part of the brief for the two architecture competitions and are supplemented by a participation and stakeholder process.

4 Managed Shopping Street

To discuss the process of Smart City Graz with respect to the programming of the ground-floor zone, a similar but different approach is briefly introduced:

4.1 Seestadt Aspern Vienna

The city development project Seestadt Aspern in Vienna—with a total area of 240,000 ha and intended to accommodate 20,000 residents and provide 20,000 workplaces by 2030—has basically similar principles and goals as Smart City Graz, although it differs in three main points: It is about 20 times larger than Waagner Biro, despite a subway connection; it is spatially more autonomous; and the City of Vienna owns most of the land, a fact that provides the city with a much stronger position. As a result, it is significantly easier to define the requirements for the city-owned *Wien 3420 Aspern Development AG*.

The development of a former airfield, which this Vienna project involves, started with a participation process in 2004 and a master plan by Tovatt Architects & Planners (Stadt Wien/Tovatt 2008), followed by the study "*Partitur des öffentlichen Raums. Planungshandbuch*" by Gehl Architects (Stadt Wien/Gehl Architects 2009) and developer competitions. Since 2011 the first phase is now in construction with currently about 6000 people living in Seestadt Aspern.

While the spatial and functional requirements in the various steps are basically similar to Smart City Graz, Seestadt Aspern has chosen a different approach to the issue of the management for the district ground floors. Together with the private partner *SES—Spar European Shopping Centres GmbH* the Aspern Development AG established *aspern Seestadt Einkaufsstraßen GmbH* to centrally develop and manage the ground-floor zone. In the most important and crucial locations, the *aspern Seestadt Einkaufsstraßen GmbH* is leasing the privately financed and built ground floors for twelve years. A concept for a customized and balanced mix of commercial uses and public-service (e.g., medical services and education) uses for these zones has been developed and influenced by experiences from mall and shopping-center development. The shop and office units are then sublet to various large and small businesses. The lease cost is not primarily defined by the free market, but is graduated and depends on what shops of a specific sector both fit the concept and are able to pay their way. The focus for the first phase is on local, everyday supply, and the already finished part effectively provides a mix of various functions in the ground-floor zone. In the remaining parts of the ground-floor zone, the commercial mix is not centrally managed.

4.2 Discussion

While the necessity of spatial definitions for the ground floors to enable various different uses is broadly undisputed and there is also a general agreement on functional requirements, we see two different approaches for the conception and management of the ground-floor zone going beyond the scale of individual buildings.

In general terms, there are two options for cities: either to rely on the free market or to actively influence the conception and functional mix of a street or city quarter. Leaving the development to the free market, one has to face the consequences of a functional mix with some shops that come in any case, leading to the same situation as in every city and denying any sense of locality, and with a high risk of vacancy and fluctuation. And the developers are usually more driven by generating profit for their shareholders than by generating a common benefit for the whole quarter.

If the city decides to control the compilation of shops, services and offices situated on the ground floors of a certain area, there is a spectrum of cooperative and legal strategies and instruments, depending on the ownership and legal context. Smart City Graz relies on a cooperative process including the private developers, trying to agree with them on the main aspects of the ground-floor development that covers financial and organizational support to prepare the way for the emergence of a vibrant mix of uses. In particular, if the property owners are housing companies (which is a common case in Austria) the involvement of independent economic experts to program and manage the ground-floor zone is necessary because most housing companies are specialized in their core-business housing. In contrast, Seestadt Aspern decided to be more rigorous in its influence on the conception of the functional mix and to cooperate with a professional private partner. The dominant, monopoly-like position of SES in Seestadt Aspern, however, includes the risk of misuse to the disadvantage of competing companies or defiant entrepreneurs, factors that could undermine fair competition.

In the context of shopping-center characteristics, one has furthermore to be aware of the increasing commercialization and privatization of public space that tends to transform it to an exclusive space—by indirect means—that is only accessible for those who can afford it. To guarantee fairness and openness, an active role and a strong position of the city are crucial.

5 Conclusion

For the development of a sustainable city quarter, the interrelationship between public space and the ground floor is a crucial factor to achieve a vibrant public space. The two parts—exterior and interior, public and (semi-) private—need to be intertwined on the spatial and the functional levels.

On the functional level, the municipality as the major representative of the public interest must clearly articulate the intended character of the quarter to be developed and define a concept, requirements and a process for how to achieve this. It is important to develop a coordinated concept for a street, square or quarter, instead of leaving the mix of uses to the individual developers or owners. The requirement here is for a cooperative process with intensive stakeholder integration to achieve a financially stable and socially balanced mix of commercial uses, community services and offices, of anchor tenants, small and local entrepreneurs and alternative uses. The financial incentives to support desired businesses and initiatives that are unable to afford the market-based price are thus essential, together with support in coordination and management for all the stakeholders involved.

On the spatial level, the introduction of framework plans and the consequent application of competitions have proved to be good and necessary supplements to the traditional town-planning instruments. These will need to be extended, however, so as to include more functional and procedural aspects, and it must be ensured that they focus on the conceptual level to establish a high degree of flexibility. Moreover, it should be ensured that increasing advantage is taken of the potential to include both quantitative and "soft" qualitative criteria on spatial and social sustainability in the competition briefs.

In general, a strong position of the municipality is essential to ensure emphasis is placed on communal benefit rather than primarily on profit and economic benefits. A city quarter is more than a development project, shopping street or center. It is a place for people.

References

Alexander, C. H. (1977). *A pattern language. Towns, buildings, construction*. New York: Oxford University Press.

DerStandard. (2017). Welche Gemeinden wachsen, welche schrumpfen. http://derstandard.at/2000055821519/Welche-Gemeinden-wachsen-welche-schrumpfen. Accessed 14 April 2017.

Gehl, J. (2010). *Cities for people*. Washington: Island Press.

Hoffer, K.-U. et al. (2013). *I live Graz—Smart people create their smart city. Endbericht Smart Energy Demo FIT for SET 1. Ausschreibung*. Wien: Climate and Energy Fund.
Sitte, C. (1983 [1909]). *Der Städtebau nach seinen künstlerischen Grundsätzen*. (Reprint of the 4th edn). Braunschweig: Vieweg.
Smart Future Graz Team. (2014). *Smart city project Graz Mitte. Projektbeschreibung*. *Einreichung Smart energy demo—FIT for SET 2*. Wien: Climate and Energy Fund.
Stadt Graz (Ed.), kleboth lindinger dolling. (2013). Rahmenplan Smart City Graz Waagner Biro. Graz: Stadtbaudirektion.
Stadt Graz—Präsidialabteilung, Referat für Statistik. (2017). Bevölkerungsstatistik der Landeshauptstadt Graz. Stand 1.1.2017. http://www1.graz.at/Statistik/Bevölkerung/Bevoelkerung_2016_final.pdf. Accessed 11 April 2017.
Stadt Wien—MA 18 Stadtentwicklung und Stadtplanung (Ed.), Wien 3420 Aspern Development AG (Ed.), Gehl Architects ApS (2009). Partitur des öffentlichen Raums. Planungshandbuch. Wien: Wien 3420 Aspern Development AG.
Stadt Wien—MA 18 Stadtentwicklung und Stadtplanung (Ed.), Tovatt Architects & Planners AB. (2008). Masterplan Flugfeld Aspern. Wien: Magistrat der Stadt Wien.

Governance and Urban Development Processes: Evaluating the Influence of Stakeholders Through a Multi-criteria Approach—The Case Study of Trieste

Mauro Crescenzo, Marta Bottero, Mauro Berta and Valentina Ferretti

Abstract The proposed study focuses on the investigation of the role of evaluation approaches in the governance of urban-regeneration operations with particular reference to the Multicriteria Analysis methods (Figueira et al. in Multiple criteria decision analysis: state of the art surveys. Springer, New York, 2005). There is, in fact, a strong need to take into account the various aspects involved in regeneration processes and programs, in order to contrast social decline, increase the inhabitants' quality of life, enhance the cultural resources, valorize buildings and public spaces, protect the environmental system, stimulate economic development and so on. In particular, this paper considers the case of Cittavecchia, the historic centre of Trieste, where new investments are required due to several past recovery plans that left various problems unsolved, causing identity and trust issues. This study shares the framework with a wider research project where three regeneration scenarios for Cittavecchia have been evaluated and compared through a multicriteria approach (Crescenzo and De Matteis in Ri-centro: valutazione di scenari di riqualificazione urbana per il centro storico di Trieste attraverso l'Analisi Multicriteri. MS thesis, Politecnico di Torino, 2016) based on the Multi-Attribute Value Theory (MAVT) (Keeney and Raiffa in Decisions with multiple objectives: preferences and values trade-offs. Wiley, New York, 1976). MAVT enables the evaluation of the proposed

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alternatives and the identification of a successful network of planning and design strategies, thanks to its flexible framework that better simplifies, structures and sorts the existing fragmentation. MAVT is useful to support complex development processes because it considers multiple points of view, from the local communities' needs, to governance and political ones. In particular, this paper is focused on the examination of the influence of socio-political aspects on decision-making processes, illustrating the calculation of the Coalition Index: an indicator that has been developed through the application of the NAIADE technique (Munda in Eur J Oper Res 158:662–677, 2004). This index makes it possible to consider the various actors' opinions and to investigate the strength of the coalitions among the stakeholders involved in the transformation. Furthermore this method enables, with the contribution of local experts, the identification of the influence of stakeholders on the performance of the results and on the overall procedure, aiding decision makers to properly evaluate consequences and priorities, thus enhancing the transparency of the whole procedure. This study is a starting point for the evaluation of complex urban regeneration processes thanks to the ability of the proposed method to influence governance and urban planning procedures and even to adapt its framework to changes of conditions, objectives, criteria and needs.

Keywords Stakeholders analysis · NAIADE · Urban planning
Weight assessment · MAVT

1 Introduction and Overview

Evaluation and planning increasingly require innovative methods that are able to better manage and organize the system of relations and data to achieve a more resilient and successful result for the governance of complex development processes. The deep complexity existing today (Munda 2004: 2) is related to the various values, stakeholders' needs, opinions and contributions involved within decision-making procedures for urban regeneration proposals. In this sense, the present paper investigates the influence of stakeholder's perspectives on these processes, starting from the particular case study of Trieste, a city with ancient Roman origins located in the northern part of Italy. Cittavecchia, the historic center of Trieste, is in fact deeply marked by its complex development process because major depopulations occurred in the late 18th century and in the 1950s, and several demolition plans were proposed in the 1920s. Sanitary problems (Maggi et al. 2009), collapses and abandonment of the area led to the first masterplan proposed in the 1980s and the walling up of the area that lasted until the early 1990s. The extensive renovation of Cittavecchia started thanks to the European funds obtained in 1998 for the Urban Programme. However, portions of the area and part of the archeological remains discovered during the intervention (Morselli 2007) were left incomplete. This situation, after several years, increased the existing fragmentation of the urban environment and of its identity. The paper aims at investigating the social aspects related to the regeneration of Trieste historic center, further developing the proposals of a wider research study[1] that focuses on the evaluation of various scenarios for the case under examination and permits other analysis and aspects to be investigated (Crescenzo et al. 2017). The article is organized as follows: Sect. 1 presents the methodological background of the study clarifying the phases of the evaluation model; Sect. 2 illustrates the application of the research to the historic center of Trieste with the extensive stakeholder analyses that have been developed to better frame the decision problem and the proposal of the innovative *Coalition Index*; Sect. 3 illustrates the results and discusses the findings, drawing the conclusions and presenting the future perspectives of the research for the study and the regeneration of historic city centers.

1.1 The Appraisal Framework of the Evaluation

The integrated evaluation framework investigated in the research is based upon an Embedded Mixed Method Design (Creswell 2003) application of the Multi Attribute Value Theory (MAVT) proposed by Keeney and Raiffa (1976) useful to simplify the process considering various qualitative and quantitative data (Bottero and Mondini 2009). Decision problems have been thus structured (Table 1) thanks to the promising multiple-criteria decision method, which is able to simplify the existing complexity (Ferretti 2012) and objectives involved.

Various stakeholders take part in this evaluation methodology: institutions set objectives and support designers in defining possible scenarios and criteria, while experts contribute to other phases of the process that are fundamental to properly identifying the best performing scenario among the proposals.

1.2 The Proposed Alternative Regeneration Scenarios

Various scenarios have been envisaged for the regeneration of the historic center of Trieste. In fact, each alternative enhances different vocations of the area: a working setting, a touristic environment and a residential location, as described in Table 2.

[1]Master thesis developed by Mauro Crescenzo and Sara De Matteis in the Master Programme in Architecture Construction City at Politecnico di Torino under the supervision of professors Marta Carla Bottero, Mauro Berta and Valentina Ferretti (Crescenzo and De Matteis 2016).

Table 1 Aspects under consideration in the MAVT model for the case study under analysis

Economic aspects	Functional aspects	Social aspects	Political aspects
#1 Public convenience	#1 Residential spaces	#1 Social mix	#1 Planning feasibility
#2 Private convenience	#2 Work spaces	#2 New job opportunities	#2 Coalition index
#3 Real estate market variation	#3 Cultural-research spaces	#3 Public space quality index	#3 Public-Private ratio
#4 Risk	#4 Urban regeneration index	#4 Tourism development	#4 Institutions approval

Table 2 Main interventions proposed for the three regeneration scenarios

Scenario	Description
Working setting	This scenario is designed to host traditional and innovative work activities and a large neighborhood market, thanks to the proximity to the institutional buildings and presence of various existing work realities
Touristic environment	The historic traces, cultural identity and other attractions are enhanced and systematized in this scenario with a new tourist office, archaeological museum and various paths between the archeological areas
Residential location	This scenario aims at creating a more livable environment by converting significant spaces into residential buildings and enhancing the cooperative uses of spaces with a neighborhood community house

2 Evaluating the Influence of Stakeholders on the Regeneration Process

The maximization of social objectives is becoming an increasingly important aspect related to urban development sustainability (Barbier 1987: 103). Proper innovative tools to facilitate the process and to understand the social and institutional context of the intervention are thus required because sometimes this goal is difficult to achieve due to the community dimension of the problem. Community is in fact a complex entity characterized by various needs, opinions and objectives (Robinson et al. 2005). Regional and local governance policies are thus facing the challenge to extend decision-making procedures to include more actors (Stratigea and Papadopoulou 2013: 87) as proposed solutions and contributions increasingly refer to the whole community. Thanks to the consideration of the broader spectrum of points of view, cooperation between institutional and non-institutional stakeholders can in fact be enhanced (Arienzo 2013: 22), thus supporting the process.

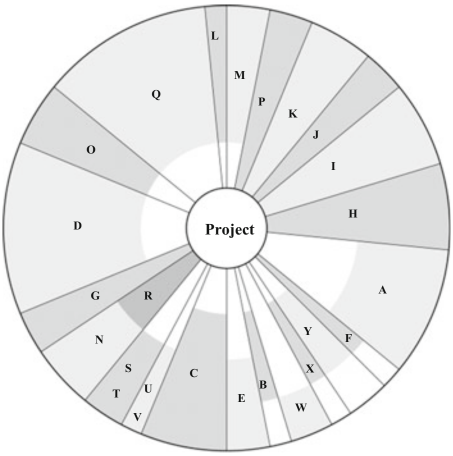
2.1 The Stakeholders Analysis

A Stakeholders Analysis (SA) (Dente 2014) has been developed for the case study of Trieste (Table 6 in Appendix 1) to consider stakeholders'—which are individuals or organizations interested in or capable of influencing the proposed decision-making process—positions and conflicting interests (Gill et al. 2013). The analysis thus identifies objectives, levels of action, roles and resources of every type of actor involved within the proposed regeneration of Cittavecchia (Berta et al. 2016).

Moreover, data obtained by the Stakeholder Analysis have been integrated using the Stakeholders Circle methodology proposed by Bourne and Walke (2008), which is useful to better consider the complex existing network of social relationships (Bottero et al. 2016), thanks to a graphical representation of the data, as Fig. 1 illustrates. The interested reader can refer to Yang (2014) for other approaches to stakeholders' analysis. The influence of stakeholders on the project—the center of the circle—corresponds in fact to the dimension of the related area, while the power of control over the project is represented by the distance of the pattern from the center of the circle.

2.2 The Coalition Index

This paper focuses on the proposal and examination of the *Coalition Index* criterion: a numerical value that represents for each scenario the stakeholders' perspective and is obtained through an original application of the NAIADE methodology and of its *Equity Matrix*. The integration of this criterion within the



Key Decision Makers
Q - Municipality
O - A.T.E.R. (Agency for Social Housing)
D - Private investors
G - Designers
N - A.R.Di.S.S. (Agency for the Right to Education)
R - University
S+T - New residents and workers
U+V - Existing residents and workers
Major external influences
C - Tourists and visitors
E - Environmentalists
B - Media and public opinion
W - Music school (Casa della Musica)
X - Coworking associations
Y - Trade associations
F - Temporary economic activities
Power to kill the project
A - International institutions
H - State government
I - Ministry of Cultural Heritage, Activities and Tourism
J - Ministry of Environment and Territory Protection
K - Ministry of Economy and Finance
P – Local council
M - Region
L - Superintendence for Architectural Heritage and Landscape

Fig. 1 Stakeholders circle method developed for the case study of Trieste

MAVT evaluation permits the influence of stakeholders involved within a complex decision-making process to be considered and the strength of the coalitions among the actors to be investigated.

2.2.1 Multi Criteria Evaluation and NAIADE Methodology

NAIADE stands for “Novel Approach to Imprecise Assessment and Decision Environments” and is a methodology developed by Munda (1995) for a European research promoted by JRC of Ispra (1996). It is based on the Social Multicriteria Evaluation (SMCE) proposed by Munda (2004), which has been used on several occasions in the context of urban and territorial transformations (Scuderi and Sturiale 2016: 207). SMCE is social multicriteria policy assessment (Fig. 2) that considers various opinions, values, alternatives and political constraints to avoid a technocratic approach to the policy-making process and possible collusion by interest groups. Problems, hypotheses and interested actors are defined within the initial Institutional analysis for identifying their relationships and influences.

NAIADE methodology is based on a fuzzy technical evaluation that identifies the results thanks to matrix calculations, the pairwise comparison of the inputs (i.e., either alternatives or opinions) and the use of s*emantic distance*, which measures the distance among the functions that represent and define the considered inputs. The interested reader can refer to JRC (1996). In particular, a technical analysis permits the performances of alternatives over a set of criteria to be identified thanks to an *Impact Matrix,* while a conflict analysis permits the consensus among various stakeholders for each scenario to be assessed thanks to the *Equity Matrix* (Fig. 3). Through research studies, inquiries, interviews and discussions, the interest groups judge the alternatives with linguistic indicators that are then translated into a scale of values that goes from 1 to 9 (for the less and most desirable alternative, respectively) and are collected in an *Equity Matrix*. A *Similarity Matrix* and a *dendrogram of coalitions,* derived from the calculation of the probability of coalition between two groups of interest and that allows the level of conflict between stakeholders to be assessed, are thus calculated with a sequence of mathematical reductions.

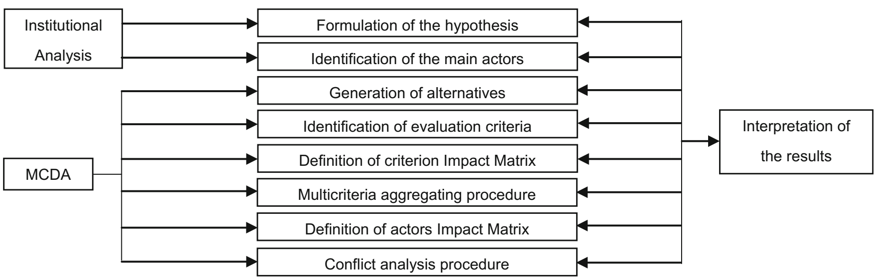


Fig. 2 Graphical elaboration of the social multicriteria evaluation phases (Wenzel 2004: 9)

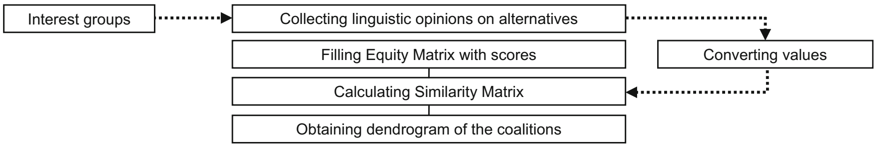


Fig. 3 Phases of the evaluation related to the NAIADE equity matrix

2.2.2 An Evaluation Methodology Proposal

This paper proposes an innovative application of the NAIADE *Equity Matrix* that is useful to quantify the proposed *Coalition Index* and consider the influence of stakeholders. In the light of the results obtained in the Stakeholders Analysis (see Sect. 2.1), seven interest groups have been identified for contributing to the definition of the proposed Equity Matrices, which compare each proposed scenario with the existing one (with values set equal to 1). The linguistic indications, which are translated into a scale that goes from 1 to 9 (Table 3), make it possible to identify the preference of each social actor (Table 4).

Table 3 Equity Matrix for each scenario of the seven interest groups (stakeholders' capital letters refer to Fig. 1)

Stakeholders	Working scenario		Touristic scenario		Residential scenario	
	Opinion	Existing	Opinion	Existing	Opinion	Existing
a—Local government (M + O) and A.T.E.R. (Q)	6	1	7	1	8	1
b—Superintendence for Architectural Heritage and Landscape (W)	4	1	8	1	5	1
c—A.R.Di.S.S. (N) and University (R)	7	1	6	1	8	1
d—Private investors (D)	6	1	7	1	9	1
e—Media and Public Opinion (B)	5	1	9	1	6	1
f—Residents (S + T)	7	1	5	1	9	1
g—Workers (U + V)	8	1	8	1	5	1

Table 4 Scenario preferences for each interest group (letters refer to interest groups identified in Table 3)

a	b	c	d	e	f	g
Residential	Touristic	Residential	Residential	Touristic	Residential	Working
Touristic	Residential	Working	Touristic	Residential	Working	Touristic
Working	Working	Touristic	Working	Working	Touristic	Residential

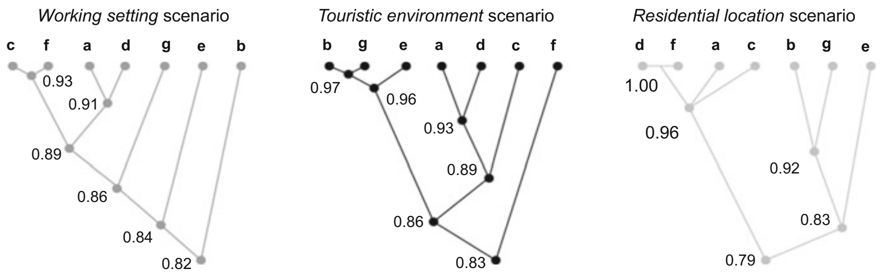


Fig. 4 Dendrograms of coalitions with some level of consensus (letters refer to the interest groups of Table 3)

A Similarity Matrix for each scenario (Tables 7, 8 and 9 in Appendix 2) have then been calculated through matrix-based operations, which are useful to obtain the overall overview on the results. These matrices quantify the *level of consensus* among each pair of interest groups (in a range of values that goes from 0 to 1 for the weakest and the strongest coalition, respectively) and permit dendrograms of the possible coalitions to be defined (Fig. 4). *Total level of consensus* for each scenario are obtained summing the matrix values related to each pair of actors: results are higher for the touristic scenario (17.5), followed by the residential (16.9) and the working one (16.8).

2.2.3 The Coalition Index

Values related to the *level of consensus*, which identify the strength of the various coalitions thanks to the NAIADE Similarity Matrices (Tables 7, 8 and 9 in Appendix 2) and the opinions collected in the Equity Matrices (Table 3), are both relevant data. They are indeed useful to evaluate which alternative is more likely to be accepted and to identify the desirability and the effective strength of each proposal from the stakeholders' perspective.

In particular, scores obtained by each scenario can be further developed to consider and assess the performance of every alternative over the attribute *Coalition Index* in the MAVT model. This indicator depends on the *Partial Coalition Indexes* that are obtained, in this application, for each pair of stakeholders in each project scenario, as is shown in Eq. 1 and detailed in Table 5:

$$PCI = \left(i_x + i_y\right) ci_{xy} \tag{1}$$

where:

PCI is the *Partial Coalition index* related to the pair of interest groups (x, y);

i_x and i_y are the numerical opinions given by stakeholders identified in the Equity matrix (Table 3);

Table 5 Sum of Partial coalition indexes to which each interest group (identified by letters that refer to Table 3) is correlated

Working setting	Touristic environment	Residential location
c (65) + f (65)	e (80)	d (81) + f (81)
g (64)	b (78) + g (78)	a (77) + c (77)
a (61) + d (61)	a (74) + d (74)	e (64)
e (53)	c (66)	b (55) + g (55)
b (43)	f (55)	

ci_{xy} is the *level of consensus* between each pair of interest groups (Tables 7, 8 and 9 in Appendix 2).

The final *Coalition Index* of every proposal is obtained summing for each scenario the *Partial Coalition Indexes* (once for each pair of interest groups and not considering pairs of same stakeholders) collected in the matrices (Tables 10, 11 and 12 in Appendix 3). The *touristic environment* scenario proves thus to obtain the highest Coalition Index (251), followed by the *residential* scenario (244) and then by the *working* alternative (207).

The obtained results can be further analyzed to identify the propensity of creating strong coalitions: *Partial Coalition Indexes* of the interest groups (Table 5) are thus converted into a range from 1 to 9 and compared. Private investors prove to obtain the highest propensity (17%), followed by A.R.Di.S.S. with university (16%), local government with A.T.E.R. (15%), residents and media and public opinion (14% both), workers (13%) and finally Superintendence for Architectural Heritage and Landscape (10%).

2.2.4 Identifying the Priorities: The Influence of the Stakeholders

The MAVT methodology, thanks to a multidisciplinary approach and the contribution of experts, enables that heterogeneous criteria and their respective weights are taken into account in a transparent way (De Montis et al. 2005: 105). In order to integrate the *Coalition Index* within the methodology, the values obtained for each scenario are then normalized considering a maximum *Coalition Index* (378) that is obtained supposing a scenario evaluated with a score of 9 by all the stakeholders (the *level of consensus* in that case is always 1). Therefore, the normalization procedure allows the index of each scenario to be assigned as follows: 0.7 for the *touristic environment* alternative, 0.6 for the *residential location* alternative and 0.5 for the *working setting* alternative.

As already mentioned, the obtained results have been included in the MAVT model, allowing the three considered scenarios to be ranked considering their global performance on a multidimensional family of criteria (Table 1). A fundamental step in the MAVT evaluation is then related to the weight-assessment procedure that, in this case, has been developed with a panel of experts. In particular, results of the weighting procedure show that *political aspects* proved to be the most influential

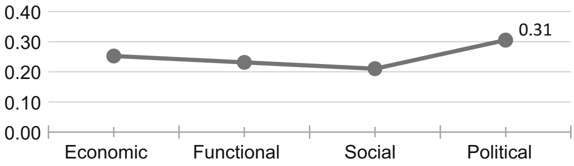


Fig. 5 Influence of the main criteria on the proposed urban development resulting from MAVT development

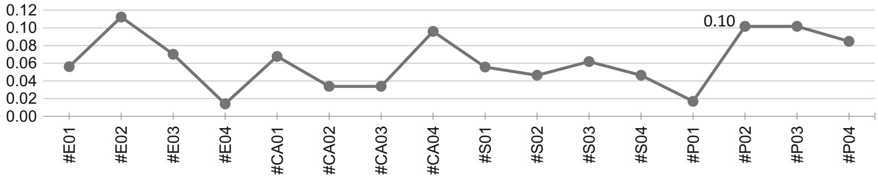


Fig. 6 Influence on proposed urban development of criteria resulting from MAVT (criteria codices refer to Table 1)

criterion on the evaluation of complex development and decision-making processes with an overall importance of 31% (Fig. 5). Moreover, an analysis of the importance of the single attributes resulting from the weighing procedure enables us to say that the *private convenience* criterion (E02) is the most important criterion with a weight of 11%, immediately followed by *coalition index* (P02) and *institutions approval* (P04) criteria, both weighted at 10% (Fig. 6).

Since NAIADE equalitarian approach considers every stakeholder as equally powerful, a Sensitivity analysis is required to evaluate the robustness of the results (Gerber et al. 2012: 16). In this case, the stability of the results has been studied with reference to the variation of the weights of the criteria. As it is illustrated in Fig. 7, the *Touristic scenario* proves to be the best performing scenario in all the considered sets of weights.

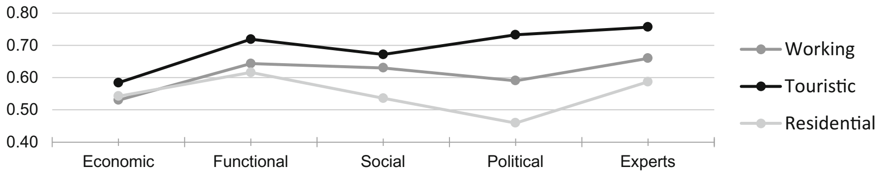


Fig. 7 Sensitivity analysis of main criteria developed on the MAVT results

3 Discussion of the Results and Conclusions

Today, governance is increasingly facing the need to achieve shared solutions and a high degree of cooperation between the multiplicities of actors involved within urban development issues. The interaction between scientists and the rest of society is in fact unavoidable and the dialogue between stakeholders is essential to the management of policy processes (Munda 2004: 7). Participatory activities are thus fundamental for complex decision-making procedures and for assessing their quality (Funtowicz and Ravetz 1992: 7). Community involvement related to governance in regeneration policies is far from easy because it may generate various challenges and problems: local interests may conflict with each other (Robinson et al. 2005); democratic legitimacy issues may arise; and limitations of methodology, data, participatory processes (is diversity of local community represented?) or asymmetries of information may influence the result (Kallis et al. 2006: 230–232). Moreover, it is difficult to guarantee the success of these kinds of processes due to the existence of complex relationships (Ombuen 2006: 41) and unavoidable subjectivity in certain steps of the evaluation (Munda 2004: 10). Proper evaluation methodologies can thus aid decision makers to facilitate the whole process. In particular, the proposed combination of social researches (Stakeholders Analyses and Stakeholders Circle Method) and participatory activities (NAIADE) with a multicriteria evaluation methodology (MAVT) proved to be a useful tool for identifying a more sustainable development strategy, increasing the legitimacy of the decision process (Kallis et al. 2006: 232). Both methodologies are in fact suited for solving and easing the governance of problems and urban development processes characterized by high complexity and uncertainty (Munda 2004; Ferretti 2012). In particular, the MAVT flexible framework and multidisciplinary approach aids the achievement of a successful regeneration by clarifying and pinpointing consequences, priorities (Mondini et al. 2014: 228) and the influence on the overall procedure of the various aspects under consideration. Objectives, criteria and the broad spectrum of judging elements are in fact simplified, structured and compared.

The NAIADE methodology makes possible, instead, comparison between various opinions and identification of the possible coalitions between interest groups, reducing conflicts over the results and enhancing inclusive perspectives in a transparent and deliberative way (Etxano et al. 2012: 4).

The joint application permits problems, data and stakeholders to be framed and structured, quality of the process to be enhanced and technocratic approach to the evaluation to be reduced (Salgado et al. 2009: 992) and leads to a shared result where the greatest benefits for the whole community are achieved. Participatory activities, thanks to the acquisition of more information (Stratigea and Papadopoulou 2013: 97), are in fact useful to combine input from various points of view, leading to increased credibility, successful results, better awareness about objectives, enhanced mutual understanding, shared knowledge (Salgado et al. 2009: 1002) and, finally, better refinement of actions and proposals. In particular, opinions and aspects are integrated within the evaluation (Fig. 8) thanks to institutional

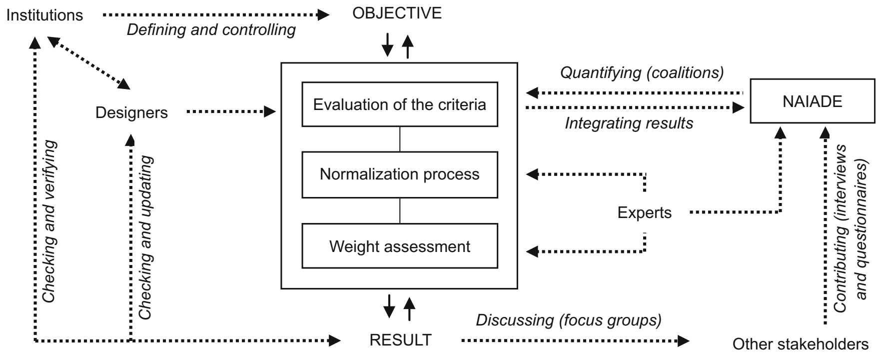


Fig. 8 Social-learning process resulting from the proposed evaluation

analyses, questionnaires, interviews and surveys that are useful to collect data for social research and NAIADE. Moreover, Institutions define objectives and control the process, while designers propose alternatives and experts contribute to the method with their knowledge, assessing value functions, weights and checking results. Furthermore, the methodology proposed in this paper allows compromises to be encouraged, differences between stakeholders to be reduced or even removed (Wenzel 2004) and dialogue between actors to be promoted thanks to negotiations and focus groups about the results. Focus groups, in particular, are a promising social-research method based on deep interaction between various participants during guided discussions that permit rich databases (Wenzel 2004), information, stakeholders' opinions and suggestions to be acquired by decision makers, and even conflictual behaviors to be studied (Stratigea and Papadopoulou 2013: 90). The evaluation becomes thus a collaborative social learning process that is able to improve policy-making quality (Etxano et al. 2012: 5–28) and contribute to the identification of conflicting values or evaluation criteria.

Further development of the research can be related to a more extensive use of participatory activities: the proposed alternatives for the Trieste historic center enhance, in fact, the existing vocations of the area, which have been investigated and proposed thanks to several researches, interviews and surveys. However, if vocations are less identifiable or the evaluation process and expected objectives are more uncertain, participatory activities can also be developed from the very start of the process, enabling the evaluation to focus more on the process than on the results (Munda 2008). Problems, criteria and even the various scenarios are thus proposed, discussed, identified, verified and updated with the interest groups during multiple phases of the method. In this perspective, urban development better reflects the various hierarchies, relations, interactions and combinations existing between the stakeholders and networks of interest groups (Mayntz 1999: 16), proving to be more responsive and suitable to the high number of concerns and needs. Moreover, the framework can be easily improved, revised and adapted if modified conditions, values, stakeholders involved, problems and possible solutions occur.

Acknowledgements The present paper, for which is responsible Mauro Crescenzo with the contribution of Marta Bottero, Mauro Berta and Valentina Ferretti, is the result of further research and developments of the methods that have been proposed in the master's thesis of Mauro Crescenzo and Sara De Matteis at Politecnico di Torino, supervised by Marta Carla Bottero, Mauro Berta and Valentina Ferretti.

Appendix 1: Analysis of the Relevant Stakeholders for the Decision Problem

See Table 6.

In particular, actors that contribute with their knowledge and experiences can be (Dente 2014):

- **Political actors**, as politicians or associations that represent citizens thanks to the popular consent or spokespersons of committees and professionals;
- **Bureaucratic actors**, contribute, on the basis of legal rules, with formal competence;
- **Actors with special interests**, contribute with utilitarian vision due to costs and benefits that have to be borne (companies, individuals, organizations that represent categories affected by the intervention);
- **Actors with general interests**, represent, without political or legal legitimacy, entities or interests that are not able to act or defend themselves;
- **Experts**, contribute to the intervention with their knowledge (deriving from their experiences in related fields), structuring and collecting relevant empirical data with a scientific method.

Resources instead can be:

- **Political**, if related to the consensus that an actor can achieve;
- **Economical**, if related to money and other types of wealth;
- **Legal**, if they depend on decisions of the legislative and/or administrative authorities;
- **Cognitive**, if they are related to the ability to contribute with information or conceptual models.

Table 6 Stakeholder analysis developed for the case study of Trieste

No	Stakeholders	Level of action	Type of actor	Type of resources	Objective
A	International Institutions (Europe)	I + N + Lo	Gi	L + P + S + E	Managing the interventions; ensuring greatest benefits with the lowest impact
B	Media and Public opinion	I + N + Lo	Gi	P + S	Promoting and influencing decision-making process
C	Users: tourists and visitors	I + N + Lo	Gi	S + C	Creating a well-being place with recreational spaces; promoting local culture; promoting accommodation facilities
D	Private investors	I + N + Lo	Gi	E	Maximizing profits
E	Environmentalists	I + N + Lo	Gi	S + C	Protecting the environment; promoting sustainable development projects
F	Temporary economic activities	I + N + Lo	Si	E + S	Profits; promoting public participation
G	Designers	I + N + Lo	Ex	S + C	Satisfy the customers and users' needs
H	State Government	N	Pl + B	P + E + L	Attracting political consensus; paying attention to the public interest
I	Ministry of Cultural Heritage, Activities and Tourism	N	B	P + E + L	Attracting political consensus; promoting the local culture
J	Ministry of Environment and Territory Protection	N	B	P + E + L	Attracting political consensus; promoting the sustainable development; protecting the environment
K	Ministry for Economy and Finance	N	B	P + E + L	Managing profits; searching for economic resources; searching for political-economic strategy
L	Superintendence for Architectural Heritage and Landscape	R	B	P + E + L	Promoting local culture; defending protected resources, properties and goods
M	Local council	R	Pl + B	P + E + L	Attracting political consensus; paying attention to the public interest
N	A.R.Di.S.S.	R + Lo	Si	E + S	Creating new spaces for students; creating new job opportunities

(continued)

Table 6 (continued)

No	Stakeholders	Level of action	Type of actor	Type of resources	Objective
O	A.T.E.R.	R + Lo	Si	E + S	Creating new social housing solutions
P	Province	Lo	Pl + B	P + L	Attracting political consensus; managing efficiently the interventions
Q	Municipality	Lo	Pl + B	P + L	Attracting political consensus; managing efficiently the interventions
R	University	Lo	Ex	C + S	Creating and valorising the archaeological areas; creating new research spaces
S	Users: future residents	Lo	Si	S	Creating residential services and recreational areas; Improving the infrastructures; creating new job opportunities
T	Users: future workers	Lo	Si	S	Creating residential services and recreational areas; Improving the infrastructures; creating new job opportunities
U	Users: residents	Lo	Si	S	Maintaining residence in the area; improving the quality of life and services
V	Users: workers	Lo	Si	S	Maintaining residence in the area; improving the quality of life and services
W	Casa della Musica	Lo	Ex	C + S	Creating new research spaces
X	Co-working associations	Lo	Si	C + S	Creating new work spaces; creating new job opportunities
Y	Traders association	Lo	Si	E	Promoting the market competition; creating new services

I International, *R* Regional *Gi* General interest, *Ex* Expert, *B* Bureaucratic, *P* Political, *E* Economical, *N* National, *Lo* Local, *Si* Special interest, *P* Politic, *L* Legal, *S* Social, *C* Cognitiv

Appendix 2: Similarity Matrices for the NAIADE Evaluation

See Tables 7, 8 and 9.

Table 7 *Working setting* scenario Similarity Matrix that collects the level of consensus of pair-wise alliances

Stakeholders	a	b	c	d	e	f	g
a—Local government (M + O) and A.T.E.R. (Q)	1.000	0.7126	0.8794	0.9124	0.8456	0.8794	0.7872
b—Superintendence for Architectural Heritage and Landscape (W)	0.7126	1.000	0.6577	0.7160	0.8188	0.6577	0.5987
c—A.R.Di.S.S. (N) and University (R)	0.8794	0.6577	1.000	0.8842	0.7800	0.9280	0.8621
d—Private investors (D)	0.9124	0.7160	0.8842	1.000	0.8456	0.8794	0.7872
e—Media and Public Opinion (B)	0.8456	0.8188	0.7800	0.8456	1.000	0.7587	0.6849
f—Residents (S + T)	0.8794	0.6577	0.9280	0.8794	0.7587	1.000	0.8621
g—Workers (U + V)	0.7872	0.5987	0.8621	0.7872	0.6849	0.8621	1.000

Table 8 *Touristic environment* scenario Similarity Matrix that collects the level of consensus of pair-wise alliances

Stakeholders	a	b	c	d	e	f	g
a—Local government (M + O) and A.T.E.R. (Q)	1.000	0.8633	0.8936	0.9331	0.8333	0.7648	0.8633
b—Superintendence for Architectural Heritage and Landscape (W)	0.8633	1.000	0.7887	0.8619	0.9558	0.6857	0.9656
c—A.R.Di.S.S. (N) and University (R)	0.8936	0.7887	1.000	0.8919	0.7692	0.8338	0.7890
d—Private investors (D)	0.9331	0.8619	0.8919	1.000	0.8333	0.7648	0.8633
e—Media and Public Opinion (B)	0.8633	0.9558	0.7692	0.8333	1.000	0.6667	0.9558
f—Residents (S + T)	0.7648	0.6857	0.8338	0.7648	0.6667	1.000	0.6857
g—Workers (U + V)	0.8633	0.9656	0.7890	0.8633	0.9558	0.6857	1.000

Table 9 Residential location scenario Similarity Matrix that collects the level of consensus of pair-wise alliances

Stakeholders	a	b	c	d	e	f	g
a—Local government (M + O) and A.T.E.R. (Q)	1.000	0.6889	0.9625	0.9558	0.7941	0.9558	0.6889
b—Superintendence for Architectural Heritage and Landscape (W)	0.6889	1.000	0.6887	0.6667	0.8285	0.6667	0.9163
c—A.R.Di.S.S. (N) and University (R)	0.9625	0.6885	1.000	0.9558	0.7941	0.9558	0.6889
d—Private investors (D)	0.9558	0.6667	0.9558	1.000	0.7692	1. 000	0.6667
e—Media and Public Opinion (B)	0.7941	0.8285	0.7941	0.7692	1.000	0.7692	0.8304
f—Residents (S + T)	0.9558	0.6667	0.9558	1.000	0.7692	1.000	0.6667
g—Workers (U + V)	0.6889	0.9163	0.6889	0.6667	0.8304	0.6667	1.000

Appendix 3: Partial Coalition Indexes

See Tables 10, 11 and 12.

Table 10 *Working setting* scenario matrix that collects the *Partial Coalition Inde*x for every pair of interest groups

Stakeholders	a	b	c	d	e	f	g
a—Local government (M + O) and A.T.E.R. (Q)	-	7.13	11.44	10.92	9.24	11.44	11.17
b—Superintendence for Architectural Heritage and Landscape (W)	7.13	-	7.25	7.15	7.39	7.25	7.26
c—A.R.Di.S.S. (N) and University (R)	11.44	7.25	-	11.49	9.07	12.97	12.93
d—Private investors (D)	10.92	7.15	11.49	-	9.24	11.44	11.17
e—Media and public opinion (B)	9.24	7.39	9.07	9.24	-	9.40	8.90
f—Residents (S + T)	11.44	7.25	12.97	11.44	9.40	-	12.93
g—Workers (U + V)	11.17	7.26	12.93	11.17	8.90	12.93	-

Table 11 *Touristic environment* scenario Matrix that collects the *Partial Coalition Inde*x for every pair of interest groups

Stakeholders	a	b	c	d	e	f	g
a—Local government (M + O) and A.T.E.R. (Q)	-	12.95	11.62	13.06	13.33	9.18	12.95
b—Superintendence for Architectural Heritage and Landscape (W)	12.95	-	11.04	12.93	16.25	8.91	15.45
c—A.R.Di.S.S. (N) and University (R)	11.62	11.04	-	11.59	11.54	9.17	11.05
d—Private investors (D)	13.06	12.93	11.59	-	13.33	9.18	12.95
e—Media and Public Opinion (B)	13.81	16.25	11.54	13.33	-	9.33	16.25
f—Residents (S + T)	9.18	8.91	9.17	9.18	9.33	-	8.91
g—Workers (U + V)	12.95	15.45	11.05	12.95	16.25	8.91	-

Table 12 *Residential location* scenario Matrix that collects the *Partial Coalition Inde*x for every pair of interest groups

Stakeholders	a	b	c	d	e	f	g
a—Local government (M + O) and A.T.E.R. (Q)	-	8.96	15.40	16.25	11.12	16.25	8.96
b—Superintendence for Architectural Heritage and Landscape (W)	8.96	-	8.95	9.33	9.11	9.33	9.16
c—A.R.Di.S.S. (N) and University (R)	15.40	8.95	-	16.25	11.12	16.25	8.96
d—Private investors (D)	16.25	9.33	16.25	-	11. 54	18.00	9.33
e—Media and Public Opinion (B)	11.12	9.11	11.12	11.54	-	11.54	9.13
f—Residents (S + T)	16.25	9.33	16.25	18.00	11.54	-	9.33
g—Workers (U + V)	8.96	9.16	8.96	9.33	9.13	9.33	-

References

Arienzo, A. (2013). *La governance*. Roma: Ediesse.

Barbier, E. B. (1987). The concept of sustainable economic development. *Environmental Conservation, 14*(2), 101–110.

Berta, M., Bottero, M., & Ferretti, V. (2016). A mixed methods approach for the integration of urban design and economic evaluation: Industrial heritage and urban regeneration in China. *Environment and Planning B-Planning & Design, 23,* 1–25.

Bottero, M., Armando, A., Bonino, V., Frassoldati, F., Bruno, E., & Federighi, V. (2016). A Hybrid evaluation approach for designing complex urban scenarios: Application for the T.I.T. area (China). *Procedia—Social and Behavioral Sciences, 23,* 931–935.

Bottero, M., & Mondini, G. (Eds.). (2009). *Valutazione e sostenibilità. Piani, programmi, progetti* (p. 29). Turin: Celid.

Bourne, L., & Walke, D. (2008). Project relationship management and the stakeholder circle. *International Journal of Managing Projects in Business, 1,* 125–130.
Crescenzo, M., Bottero, M., & Buzzacchi, L. (2017). Public and private interests in urban regeneration programs: The case study of Trieste historic centre. In G. Osvaldo (Ed.), *Computational science and its applications—ICCSA 2017. Lecture Notes in Computer Science* (Vol. 10406). Heidelberg: Springer.
Crescenzo, M., & De Matteis, S. (2016). *Ri-centro: valutazione di scenari di riqualificazione urbana per il centro storico di Trieste attraverso l'Analisi Multicriteri.* MS thesis, Politecnico di Torino.
Creswell, J. W. (2003). *Research design: Qualitative, quantitative and mixed methods approaches*. London: Sage.
De Montis, A., De Toro, P., Droste-Franke, B., Omann, I., & Stagl, S. (2005). Assessing the quality of different MCDA methods. In G. Michael, L. Spash Clive, & S. Sigrid (Eds.), *Alternatives for Environmental Valuation* (pp. 99–133). Abingdon, Oxon: Routledge.
Dente, B. (2014). *Understanding policy decisions*. New York: Springer, Polimi Springer Briefs.
Etxano, I., Garmendia, E., Pascual, U., Hoyos, D., Díez, M. A., Cadiñanos, J. A., et al. (2012). *Towards an integrated and participatory assessment approach for European Natura 2000 sites*. BC3 Working paper series. Accessed at: October 21, 2016, from http://www.bc3research.org/lits_publications.html.
Ferretti, V. (2012). *Verso la valutazione integrata di scenari strategici in ambito spaziale. I modelli MC-SDSS* (p. 65). Turin: Celid.
Figueira, J., et al. (Eds.). (2005). *Multiple criteria decision analysis: State of the art surveys*. New York: Springer.
Funtowicz, S. O., & Ravetz, J. R. (1992). The good, the true and the post-modern. *Futures, 24*(10), 963–976.
Gerber, J.-F., Rodríguez-Labajos, B., Yánez, I., Branco, V., & Roman, P. (2012). *Guide to multicriteria evaluation for environmental justice organisations*. EJOLT Report No. 8.
Gill, L., Lange, E., Morgan, E., & Romano, D. (2013). An analysis of usage of different types of visualisation media within a collaborative planning workshop environment. *Environment and Planning B: Planning and Design, 40*(4), 742–754.
JRC—Ispra site. (1996). *NAIADE manual and tutorial, version 1.0. ENG*. Ispra: Joint Research Centre of the European Commission—Ispra site.
Kallis, G., et al. (2006). Participatory methods for water resource planning. *Environment Planning Part C, 24*(2), 235–256.
Keeney, R. L., & Raiffa, H. (1976). *Decisions with multiple objectives: Preferences and values trade-offs*. New York: Wiley.
Maggi, P., Merlatti, R., & Petrucci, G. (Eds.). (2009). *Sotto Trieste. Percorsi nella città tra storia e archeologia*. Opicina, Trieste: Tipografia Villaggio del Fanciullo.
Mayntz, R. (1999). La teoria della governance: sfide e prospettive. *Rivista Italiana di Scienza Politica, 29*(1), 3–22.
Morselli, C. (Ed.). (2007). *Trieste antica. Lo scavo di Crosada*. Editreg: Trieste.
Munda, G. (1995). *Multicriteria evaluation in a fuzzy environment: Theory and applications in ecological economics*. Heidelberg: Physica-Verlag.
Munda, G. (2004). Social multi-criteria evaluation: Methodological foundations and operational consequences. *European Journal of Operational Research, 158,* 662–677.
Munda, G. (2008). *Social multi-criteria evaluation for a sustainable economy*. Berlin, Heidelberg: Springer.
Mondini, G., Bottero, M., & Ferretti, V. (2014). Tecniche valutative di supporto alla decisione: le Analisi Multicriteri. In R. Riccardo (Ed.), *Manuale di Estimo. Valutazioni Economiche ed esercizio della professione* (pp. 227–266). Novara: De Agostini—UTET.
Ombuen, S. (2006). Governance e Government. In P. Stanghellini, V. Stefano, & P. Donatella (Eds.), *Rapporto Dal Territorio 2005* (pp. 41–43). Roma: Inu Edizioni.
Robinson, F., Shaw, K., & Davidson, G. (2005). On the side of the angels: Community involvement in the governance of neighbourhood renewal. *Local Economy, 20*(1), 13–26.

Salgado, P., Quintana, C. S., Pereira, A. G., del Moral Ituarte, L., & Mateos, B. P. (2009). Participative multi-criteria analysis for the evaluation of water governance alternatives: A case in the Costa del Sol (Malaga). *Ecological Economics, 68,* 990–1005.

Scuderi, A., & Sturiale, L. (2016). Multi-criteria evaluation model to face phytosanitary emergencies: The case of citrus fruits farming in Italy. *Agricultural Economics—Czech, 62,* 205–214.

Stratigea, A., & Papadopoulou, C. A. (2013). Multicriteria evaluation in spatial planning: A participatory methodological approach. Accessed at: October 10, 2015, from http://www.agenziaentrate.gov.it.

Wenzel, V. (2004). An epistemic approach applied for integrated water quantity and quality problems—Case study of Berlin. *Bridging Scales and Epistemologies: Proceedings of Linking Local Knowledge and Global Science in Multi-Scale Assessments, 17–20 March 2004*. Alexandria, Millennium Ecosystem Assessment.

Yang, X. (2014). An investigation of stakeholder analysis in urban development projects: Empirical or rationalistic perspectives. *International Journal of Project Management, 32*(5), 838–849.

Informal Planning: Towards Promoting Resilient Governance in Greece

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Abstract Due to a controversial historical and political background and the prolonged socioeconomic crisis, the culture of collaboration and dialogue is not cultivated at any governance level in Greece. On the contrary, the conventional self-financed real-estate development model is deeply rooted within Greek society—planning regulation supports greenfield development instead of implementing urban renewal or compact-city policies. As a result, Greek cities are affected by sprawl and, often, illegitimate development tendencies. In order to effectively cope with such urban problems, there is an idea of introducing a communicative rationality approach—a tool towards promoting a resilient governance system. However, since collaborative dialogue, networks and trustful relationships among the relevant players build the core of communicative rationality, it is rather challenging to implement an approach in Greece such as a fuzzy-governance context. The paper revolves around two main questions: How can tailor-made initiatives transcend the current sociopolitical obstacles in Greece and contribute to resilient spatial development? How could the country absorb the social, political and intellectual capital in practice that is produced by collaborative initiatives? The central part of the research is the case study presenting the informal planning method (called the Test Planning Process), applied for the first time in the Greek planning context in the city of Patras. Elucidating the role of various actors involved in the process, the paper shows how collaboration in consecutive steps, based on expertise and impartial participation, may reverse irrational decisions, thus promoting the gradual development of an informal approach to spatial planning.

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1 Introduction

In recent years, global socioeconomic transformations have strongly challenged the spatial planning practice. The countries of Eastern and Southern Europe in particular have experienced a prolonged economic crisis with tremendous impact on numerous facilities, services, and infrastructures. Some of the specific reasons for the deep crisis in the spatial planning domain appear due to increasing demand for housing, the provision of low-interest mortgages, and the significant, but not sustainable investments in major urban projects. Combined with the unregulated method of decision making in the spatial planning field, all of these have caused massive urban sprawl and excessive economic dependence upon the construction sector (Knieling and Othengrafen 2016; Romero et al. 2012). Greek cities comprise a good basis for exploring the above phenomena through the lens of spatial planning decision-making procedures (Giannakourou 2011; Getimis and Giannakourou 2014; Papaioannou and Nikolakopoulou 2016).

The fragmented decision-making that takes place between various planning levels and actors strongly affects the current spatial development of Greek cities. First, the spatial planning lacks a vision due to the recent privatization of planning powers and services, outsourcing and pro-growth planning (Reimer et al. 2014; Getimis and Giannakourou 2014). Second, the cooperation model among the state, various administrative bodies and public organizations for common, strategic spatial planning is missing, thus causing the conflicts and delays for the vital strategic projects (Papamichail 2015; Pappas et al. 2013). Hence, an alternative model of governance and planning aiming at the public benefit of Greek cities and regions is required. Having this in mind, the example of Patras was selected as the first city in Greece to adopt the informal planning procedure, known as the Test Planning Process (TPP), due to an extensive spatial conflict. Briefly put, the Patras problem concerns the fragmented and non-integral city development scenarios and actors' conflicts revolving around the integration of a railway line in the city's waterfront area.

The paper is structured as follows. After a short introduction, the second section presents a brief critical overview of the Greek decision-making context observed through the lens of collaboration, which leads us to identifying the main shortcomings related to Greek institutional dynamics. Subsequently, the next section elucidates the notion of resilient governance as a system based on the basic principles of communicative rationality. This section briefly explores the components of resilient governance that has been recently broadly used for understanding the complex decision-making contexts. In order to illustrate how communicative rationality has been applied at the planning-process level, the central part lays out the test planning method and its implementation in the case of Patras, focusing on an overview of the actors involved in this step-wise procedure. The discussion section compares the resilient governance principles with those of the TPP implemented in Patras. Such a relationship between the conceptual and empirical part of the paper stresses the importance of using the informal planning procedures in a fuzzy governance context.

2 Spatial Planning in Greece

Due to the late emergence of Greek independence in the early 19th century, the Germanic legal family[1] influenced the nature of the Greek legal code, while the administrative planning framework was clearly modelled after the Napoleonic system, characterized by a fused administrative structure—underlining the importance of both the local and national levels (Newman and Thornley 1996). Moreover, Greece belongs to the planning family based on the tradition of urbanism, which focuses on structural planning and urban design through rigid building regulations, zoning and codes. Briefly put, planning is translated into the design and creation of places and is mainly carried out at the local level. Due to the institutional transformation during the 1990s, the decentralization of the planning responsibilities toward the regional administrations and local authorities was enforced, while there has been an attempt to install new mechanisms of actor involvement concerning the Europeanization of Greek planning (Giannakourou 2011). However, nowadays all the planning decisions still have to be in line with the national spatial planning perspectives. The planning system itself is not well-established and deals with the limited mechanisms for citizens' involvement, as well as poor management of the conflict between various planning levels and actors (Knieling and Othengrafen 2009).

The spatial planning system in Greece operates at three administrative levels: national, regional and local. The interrelationships among the main planning levels, as well as the features of spatial policies, relevant for each level are provided in Fig. 1.

Such an administrative framework implies that the final decisions and approval of various plans and programs are carried out in a top-down manner, thus creating an inflexible environment for participation and collaboration. The development of planning policies and instruments has been proved to be non-intersectoral and non-interdisciplinary, while overlapping responsibilities and interests at all administrative levels prevent any collaborative approach (Pappas 2017). Hence, the

[1]According to the classification by Newman and Thornley (1996), there are five legal and administrative families in Europe: British, Napoleonic, Germanic, Scandinavian and East European.

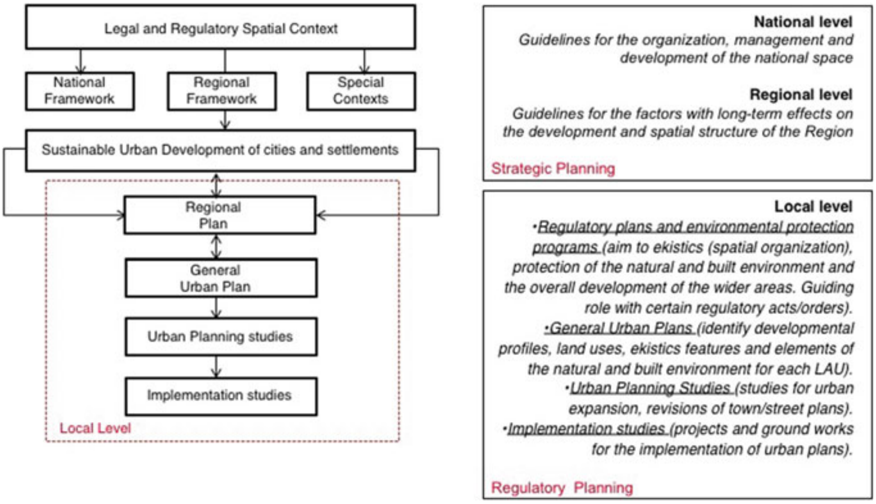

Fig. 1 General framework of spatial planning in Greece *Source* Pappas (2017)

prolonged planning deficiencies and problems necessitate alternative concepts and approaches in practice toward flexible decision-making and resilient governance (Scholl et al. 2015; Pappas 2017).

3 Resilient Governance Systems: Conceptual Overview

The examples of the traditional (top-down) government can be witnessed in various environments and are numerous. Just to name a few: planning agency neglects the approach defined through a consensus-building process because it is assumed that the agency should develop its own solution; agency leaders reject the proposal for collaborative processes because they are afraid of losing control or being criticized for not being able to invent their own approach; public agencies prefer to work behind the scenes to get their views accepted and refuse to consider conflicting perspectives (Innes and Booher 2010: 199–200). Although the 'shift from government to governance' has been strongly promoted for a few decades now (Davoudi and Strange 2009), thus redirecting the power from institutional and administrative bodies to non-governmental organizations and the private sector as well, democratic processes and traditional government are still in the center of the debate.

For more than 30 years, scholars have been arguing over the 'crisis in democracy', outlining the evidence that new practices for decision making are needed, which allow our societies to be resilient and adaptive (Innes and Booher 2010). The theory of communicative action (Habermas 1984) served as a fruitful ground for many similar planning approaches based on the notion of communicative rationality, i.e., the power of arguments. The ‘communicative-argumentative turn in planning’ (Forester 1989), also known as ‘planning through discussion and cooperation’ (Healey 1992), ‘communicative planning’ (Sager 1994), ‘inclusive discourse’ (Healey 1995), ‘communicative action and interactive practice’ (Innes 1995), ‘planning through consensus building’ (Innes 1996), ‘collaborative planning’ (Healey 1997), ‘discursive practice’ (Sandercock 1998), ‘deliberative planning’ (Forester 1999) etc., involves about the same strategy: obtaining valid information, making informed choices, and assuring internal commitment to the choices (Innes and Booher 2010: 200). However, Innes and Booher (2010) claim the need to move beyond collaboration towards defining the basic components of resilient governance as a context within which collaborative practices emerge. Some of the most important components include the following (Innes and Booher 2010: 209–211):

- **Diversity and interdependence**. This component relates to the actors who are supposed to jointly participate in the planning process in which all have a certain interest. The final outcome of such a joint action is achievement of mutual gains, instead of zero-sum negotiations.
- **Collaborative dialogue and collaborative development of knowledge**. Collaborative dialogues are the ones in which all stakeholders are heard and their interests are respected. Such a situation also creates social capital among previously competing interest groups. Moreover, when explaining the current problem through various lenses, there is a high possibility of building mutual trust between the stakeholders.
- **Networks**. Networks among the stakeholders include a wide variety of possible interrelationships. This may include interdisciplinary cooperation, i.e., cooperation among various sectors within administrative structure, but also intersectoral cooperation, which includes mutual activities between public, private and civil sectors.
- **Monitoring and feedback**. This component stresses the necessity of creating certain indicators for following the changes in various domains. Their main contribution is the joint analysis of data and choosing the appropriate responses.
- **Small, diverse working groups**. Such working parties are crucial for dealing with complex problems in uncertain contexts. Through specific tasks, there is a great chance for building mutual trust, joint learning and knowledge transfer.

The next section illustrates the operationalization of these principles within the concrete case study of the TPP in Patras.

4 The Test Planning Process in Patras: Methodological and Practical Issues

4.1 The Method of Test Planning

The TPP is in fact an informal method for creating concrete and feasible proposals and solving the challenging tasks in spatial planning. It stimulates a critical discourse about implementing the solutions for complex and long-term spatial problems (Scholl et al. 2013; Scholl 2017). Instead of traditional and formal spatial planning methods, the TPP implies a collaborative process among numerous stakeholders with different interests that combines top-down with bottom-up approaches. More than a common competition, the TPP gathers competitive ideas from various planning teams coordinated by an interdisciplinary steering committee. The resulting contributions are presented, discussed and, after a close evaluation, passed on to an executive committee for further elaboration and implementation (Papamichail 2015; Scholl et al. 2015). Many cities were pioneers in implementing the TPP, such as: Vienna's need for the Danube River flood protection (Vienna Model); Frankfurt's regeneration of the urban area along the Main River waterfront (*Stadtraum Main*); or Swiss cases of Solothurn's revitalization of one of the largest brownfields and the transformation of the abandoned military airport Dübendorf (Scholl 2017).

According to Scholl et al. (2013), there are seven key principles immanent to test planning as a method:

- **Concurrence of ideas**. The core of test planning is the competition between various ideas. As a result, the most efficient solution is given to the contractor within the framework of the given conditions.
- **Rhythm**. Ideas and solutions mature due to repeated discussions and continuous testing throughout regularly scheduled meetings.
- **No 'winner'**. Unlike a traditional competition, there are no unique winning proposals. Since complex tasks often do not have ideal solutions, this method examines the different ideas of the teams and selects those that are most appropriate.
- **Ad hoc organization**. Test planning is an independent process and even the contributions of local and regional officials are considered according to the TPP rules. As a result, alternative, impartial solutions can emerge.
- **Communication**. Test-planning cases are usually about areas whose future has a strong public interest. To gain public support for the results and attract various actors, communication and marketing of the various different steps and solutions is important from the beginning.
- **Finding problems and solutions**. Apart from the final solutions, a redefinition or identification of new problems, in addition to the given ones, often takes place. This turns test planning into a dynamic process.

- **'Protected' process**. Ideas and solutions are first discussed and tested in closed meetings between the teams and the steering committee before any public announcements in order to develop strong argumentation for the solution, which allows for a fruitful dialogue with various actors and the public to follow.

4.2 The Implementation of Test Planning in Patras

There is a strong debate today on how to proceed with the large-scale infrastructural projects when the decisions are made not only by formal authorities. The case study elucidating such a problem is the medium-sized Greek city of Patras, with the tradition of a rational planning model and fuzzy decision-making procedures, as was described earlier. In the 19th and early 20th centuries, the city was a main trading and cultural hub, and the role of the railway was remarkably decisive. Nowadays, a direct connection between Athens and Patras is a strategic project of high priority because it contributes to bridging the East-West division of high-performance transport infrastructure that has existed in Greece for a long time through the national strategic corridor of PATHE (Patras-Athens-Thessaloniki-Eidomeni). At the international level, this section is part of the Orient/East-Mediterranean) TEN-T (Transnational European Transport Network) Corridor connecting Hamburg to Athens and further to Patras (EC 2011).

However, in the recent two decades, an endless discussion and unfeasible studies about the integration of the rail tracks into the urban pattern have been undertaken without concrete results. This stems mainly from an administrative fragmentation of the waterfront areas along the existing railway alignment that leads to inconsistent decision making, generated mainly by the indisposition of the local government, the OSE (Hellenic Railways Organization) and the ERGOSE[2] (the OSE subsidiary company in charge of real estate) to collaborate. The initiative for an alternative scenario for sustainable development through the implementation of a new planning method was made possible due to the engagement of three universities (ETH Zurich, University of Patras—UP, and National Technical University of Athens—NTUA), whose representatives created the basis for an open and transparent dialogue. The TPP comprises various stages—initiation, preliminary assessment, discussing the solutions, and monitoring and feedback—which last from six months up to one year. In the case of Patras, several steps preceded and followed the TPP itself, thus leading to a conducive environment for substantial knowledge transfer and trust building among all the involved actors. These are briefly explained in the following sections.

[2]The ERGOSE undertakes the management of OSE's Investment Program projects and in particular those co-funded by the EU Programs. The ERGOSE's tasks include planning, development, support, management, design, supervision, and construction of all types of projects for third parties in Greece and abroad, as well as land acquisition for the state or other public bodies.

4.2.1 Preliminary Steps: 2012–2014

The three main preliminary steps were undertaken before the official start of the TPP. First, in 2012, the preparatory meeting (including the representatives of the OSE, ERGOSE, Patras municipality, academics and professionals from various domains) took place in Zurich in order to elucidate the problems relevant to the railway and spatial development of Greece and the region of Patras. In 2013, a Joint Seminar Week (a workshop gathering the students from three universities—ETH, UP, and NTUA—followed in the city of Patras. Mixed groups of Swiss and Greek students coordinated by interdisciplinary experts produced promising alternative ideas ready to be implemented in a stepwise manner. At the final presentation of the students' work, the Municipality of Patras, the OSE, the ERGOSE, the Patras port authority and citizens were in the audience in order to jointly exchange ideas and comment on the various solutions. In February 2014, a Swiss-Greek Mobile Seminar was held in eastern Switzerland in order to explore the Swiss railway network in an area topographically similar to the Peloponnese region to which Patras belongs.

In order to better understand the key steps of the TPP, it is necessary to briefly explain the main organizational structure of the stakeholders involved (Fig. 2):

Commissioner. The commissioner is the main party responsible for such a procedure and usually finances the project. In the concrete case, the project was commissioned by ETH Zurich under the Chair of Spatial Planning and Development.

Stakeholders instead of an Executive Committee. Usually an Executive Committee consists of two to nine persons, representatives of the decision-making authorities of the contracting political authorities and companies. However, in the case of Patras, the Executive Committee did not exist even though its role in the

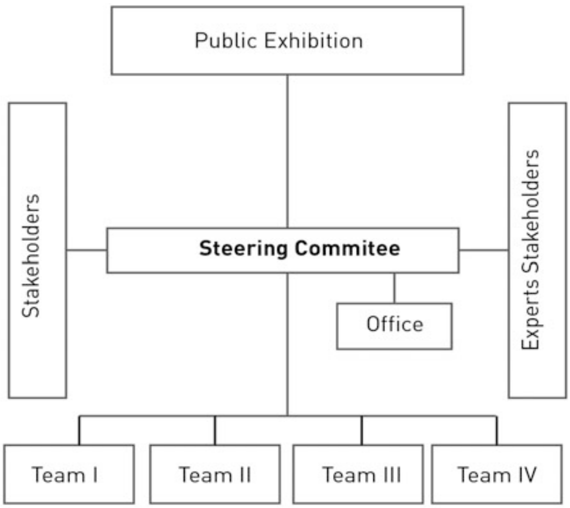

Fig. 2 Organizational structure for the TPP in Patras *Source* Scholl et al. (2015)

process was crucial. Instead, other stakeholders like the OSE and the Municipality of Patras, participated occasionally at the beginning of the process.

Steering Committee. It usually consists of seven to eleven interdisciplinary experts, leading the TPP, examining the content and being responsible for the final recommendations and the attention of the Executive Committee.

Planning Teams. In the Patras project, four planning teams (mainly academics from ETH, UP, and NTUA) participated. The different backgrounds and experiences of each team offered various insights into the task at the macro-scale and for in-depth studies, supported by the experts in economics, transport and landscape architecture.

Office. The office consists usually of three to four people, responsible for the preparation and the fundamentals of the TPP, pretesting the project and taking operative leadership of the process.

4.2.2 Test Planning Process: 2014/2015

The TPP itself lasted six months and included the following key stages (Fig. 3):

- **12.12.2014**: Constitution of the Steering Committee. First discussion and improvement of the task mission for the planning teams.
- **06.02.2015**: The kick-off event in Patras. Presentation of the task. Visit of the most critical spots along the existing railway line by the Steering Committee together with external experts and planning teams. The relevant stakeholders, the OSE, the ERGOSE and the municipality representatives were invited even though only the support of the OSE was obtained.
- **27.02.2015**: A workshop discussion between the Steering Committee and each team separately. The idea behind the closed meetings was for each team to keep its own direction in order to achieve various final solutions in the end, even with some common points.
- **27.03.2015**: The joint interim presentation. Discussing each solution and highlighting the main points by both the Steering Committee and the teams.
- **29.05.2015**: The final presentation of the complete proposals by each team, followed by a constructive critique.

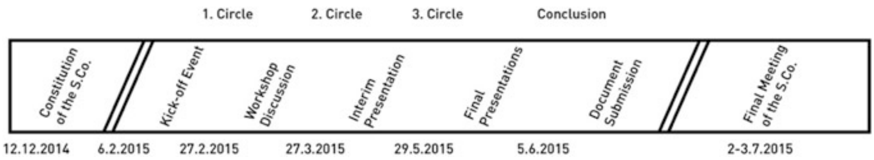

Fig. 3 Timeline of the TPP in Patras *Source* Scholl et al. (2015)

- **05.06.2015**: Submission of the final reports and the posters. The Steering Committee compiled them in the form of an overview for a comprehensive presentation. The final session of the Steering Committee aimed at developing further recommendations to gain the attention of the Executive Committee.
- **02-03.07.2015**: Final recommendations of the Steering Committee after a careful examination of all four planning proposals.

4.2.3 Public Involvement and the Following Steps: 2015–2017

Since the future changes impact mostly the citizens, the results of the TPP were presented to the public through two events: an exhibition (November 2015) and a Workshop of Ideas (February 2016), which brought stakeholders and citizens to a common discourse ground. The exhibition presented the results and offered a first incentive to initiate a public discussion, while the workshop focused on citizens' information, discussion and contribution for a new culture of public transportation (Scholl et al. 2016). In June 2017, a Joint Seminar Week took place in Patras with mixed working groups of Swiss and Greek students from three universities (ETH, UP and NTUA) supported by high-qualified experts. As recommended in the final results of the TPP, the future railway station of Agios Dionyssios should be the focus of the spatial intervention. Therefore, the students provided various solutions for the further development of the catchment area of the station, mainly exploring the potential impact of the new urban centrality of the future railway station.[3]

5 Results and Discussion

The paper documented how an informal planning procedure had been implemented in a country without a tradition of collaborative planning. In order to elucidate the interrelationship between the planning context and the planning process (necessarily embedded into the certain context), the comparison between the components of resilient governance and the main features of the TPP was presented first, followed by the impact of TPP on various scenarios of integrated railway and urban development. For this reason, the various phases have been analyzed through an actor-centered approach, by pointing out the role of actors and the impact on drafting sustainable planning studies and promoting resilient governance. In particular, the various initiatives for actors' involvement taken during the TPP, the outcome and the future potential of such a constellation in the Greek reality were developed in contrast to the current managerial planning environment. The components of resilient governance and the main features of the TPP are compared next.

[3]A publication on the results of the Joint Seminar Week 2017 will follow in autumn 2018.

- Through **diversity and interdependence**, the mutual gain among the various stakeholders in Patras is achieved based on an holistic planning approach. For example, the railway company decided to opt for an aboveground railway line, which is significantly cheaper solution than the previously considered underground one, while the municipality will obtain an economic profit from railway development that can be further invested in the regeneration of the waterfront area or for other urban projects.
- **Collaborative dialogues and development of knowledge** as a main tool for trust building was produced through a strong and tested argumentation discourse between the planning teams, steering committee, and citizens, while a plurality of not only local information and knowledge, but also dissemination of international experiences was a chief determinant for the logical and sound final recommendations. For example, the location of the future railway station in Agios Dionyssios area, as well as the continuing operation of suburban train, are part of the final recommendations of the TPP and are respected by all actors.[4]
- New **networks** of collaboration between various stakeholders were particularly experienced in the case of Patras. Here, we can refer to the improved cooperation between the OSE and the ERGOSE, who at the very beginning of the TPP held opposing positions. Furthermore, through the experts acting as mediators of the entire process, the voices of citizens were made heard and further accepted by the city officials, which, up to the moment of initiating the TPP, were 'deaf' to the citizens' demands.
- **Monitoring and feedback** of the entire TPP was provided by the experts via a certain rhythm of discussions. This proved to be a sound base for future undertakings of joint activities.
- **Small and diverse working groups** in the case of Patras were recognized in the role of four international planning teams. Specifically chosen to deal with the complex issue of integrated railway and spatial development in Patras with no tradition of such an integrative approach, the planning teams were able to propose alternative scenarios of railway and city development and argue with the various actors. Such a joint approach of extensive commenting on the proposed solutions secured the knowledge and experiences dissemination as well as later adoption of the joint solution based on various approaches of the planning teams.

From such a comparison, it seems that the informal planning procedure of the TPP has spawned a fruitful arena even in the non-transparent and non-collaborative planning context of Patras. However, as the consistent analysis of the resilient governance cannot be conducted without considering the role of various public bodies, and since the Greek planning context is based on a top-down planning approach, it turns out that the real effect of the TPP in Patras is limited. More precisely, what is evidently missing is not only the active participation of local

[4]A more detailed and complete overview of the recommendations can be found at www.code-patras.ethz.ch.

governance, but also an absolute absence of national administration (i.e., responsible ministries and national agencies). The following illustration clarifies the limited impact of the TPP in Patras on proactive scenarios of integrated development: in February 2017, almost one year after the Workshop of Ideas as a follow-up event of the TPP, the Greek Ministry of Transportation initiated a discussion about three scenarios of railway development in Patras (the by-pass, the underground and the ground-level solution), in an effort to meet the political interests of the municipality leading to generalizations and pharaonic plans, i.e., the by-pass solution, an unsustainable project of €700 million with no provisions in accordance with the integral model of city development.

Nevertheless, in July 2017, the public discussion continued with the presence of all responsive actors (OSE and ERGOSE, the municipality, the Ministry of Transportation, the port authorities, the ecologists, the University of Patras etc.). The involvement of other actors (transportation companies, experts, academia) was a significant step towards overcoming the tense relationship between local and national government. Therefore, we may assume that the TPP needs more time to be implemented in a planning environment that does not recognize the need for collaboration. The next important step is the preparation of a common ground for embedding the informal planning processes into a fuzzy governmental context. This would actually mean the transformation of the planning culture, an extremely long and demanding process. Nevertheless, the implementation of the TPP in Patras can be considered a small step in bridging this gap.

6 Conclusion

The transformation of the top-down decision-making environment to the resilient governance system is a long process. Probably, it would need decades to change not only the institutional system, but more importantly and thus more difficult, the mental models or the so-called soft infrastructure within a certain institutional framework (Healey 1997). The case of Greece belongs to this group (Knieling and Othengrafen 2016; Papaioannou and Nikolakopoulou 2016; Scholl et al. 2016). However, it is important that some crucial steps have been already undertaken. Now, we have to wait and see in which ways and forms that collaborative practices as a tool for resilient governance are going to find their way in the city of Patras.

Therefore, the value of the TPP cannot be disregarded (Scholl et al. 2015, 2016). To sum up:

- Step-wise development, including the strategic role of Patras in its future and an integrated approach to railway and spatial development, was proposed for the first time based on concrete arguments.
- Moreover, the TPP can provide the common foundation for later discussions, especially in the future application for the EU funding package (2020–2024) about the final railway section in the city of Patras.

- In broader terms, supporting Patras to serve as a multi-modal and touristic hub for the regions of Western Greece and Peloponnese, an identity that few cities can obtain, a strategy and specific goals have to be established to reach this goal.

It is a chance for the city of Patras, as for other cities in crisis, to proceed with sustainable territorial management against privatization policies and a prolonged phase of underdevelopment. This can certainly be done through the substantial transformation of spatial planning, based on an interactive reciprocity between formal and informal planning procedures. Reinforcing strategic decision making and a step-wise development are the tools for paving the way towards the new planning culture.

References

Davoudi, S., & Strange, I. (2009). *Conceptions of space and place in strategic spatial planning*. Abingdon, Oxon, GBR: Routledge.

EC (European Commission). (2011). *TEN-T Core network including core network corridors*. Brussels: European Commission.

Forester, J. (1989). *Planning in the face of power*. Berkeley, CA: University of California Press.

Forester, J. (1999). *The deliberative practitioner: Encouraging participatory planning processes*. Cambridge, MA: MIT Press.

Getimis, P., & Giannakourou, G. (2014). The evolution of spatial planning in Greece after the 1990s: drivers, directions and agents of change. In M. Reimer, P. Getimis, & H. H. Blotevogel (Eds.), *Spatial planning systems and practices in Europe* (pp. 149–168). New York: Routledge.

Giannakourou, G. (2011). Europeanization, Actor constellations and Spatial Policy in Greece. *disP—The Planning Review, 47,* 32–41.

Habermas, J. (1984). *The theory of communicative—Volume 1: Action, reason and the rationalization of society*. Boston: Beacon Press.

Healey, P. (1992). An institutional model of the development process. *Journal of Property Research, 9,* 33–44.

Healey, P. (1995). The institutional challenge for sustainable urban regeneration. *Cities, 12,* 221–230.

Healey, P. (1997). *Collaborative planning—shaping places in fragmented societies*. London: MacMillan Press.

Innes, J. (1995). Planning theory's emerging paradigm: communicative action and interactive practice. *Journal of Planning Education and Research, 14,* 183–189.

Innes, J. (1996). Planning through consensus building: A new view of the comprehensive planning ideal. *Journal of American Planning Association, 62,* 460–472.

Innes, J., & Booher, D. (2010). *Planning with complexity: An introduction to collaborative rationality for public policy*. New York: Routledge.

Knieling, J., & Othengrafen, F. (2009). *Planning cultures in Europe: Decoding cultural phenomena in urban and regional planning*. Surrey: Ashgate.

Knieling, J., & Othengrafen, F. (Eds.). (2016). *Cities in Crisis: Socio-spatial impacts of the economic crisis in Southern European cities*. New York: Routledge.

Newman, P., & Thornley, A. (1996). *Urban planning in Europe: International competition, national systems & planning projects*. New York: Routledge.

Papaioannou, A., & Nikolakopoulou, Ch. (2016). Greek cities in crisis: Context, evidence, response. In J. Knieling & F. Othengrafen (Eds.), *Cities in Crisis: Socio-spatial impacts of the economic crisis in Southern European cities* (pp. 172–189). New York: Routledge.

Papamichail, T. (2015). Railway and urban development in Patras: Towards the improved participation of local governance in complex planning problems. *Serbian Architectural Journal, 7*(3), 365–380.

Pappas, V. (2017). *Spatial planning in Greece*, Lecture, MAS program in spatial planning, European aspects of spatial planning, symposium Part III, Zurich: ETH Zurich, February 7, 2017.

Pappas, V., Kalamiotis, I., & Karidi, A. (Eds.). (2013). *CODE PATRAS Joint seminar week, urban and railway development in Patras: Report*. Patras: University of Patras.

Reimer, M., Getimis, P., & Blotevogel, H. H. (Eds.). (2014). *Spatial planning systems and practices in Europe*. New York: Routledge.

Romero, J., Jiménez, F., & Viloria, M. (2012). (Un)sustainable territories: Causes of the speculative bubble in Spain (1996–2010) and its territorial environmental and sociopolitical consequences. *Environment and Planning C: Government and Policy, 30,* 467–486.

Sager, T. (1994). *Communicative planning theory*. Aldershot: Averbury.

Sandercock, L. (1998). *Towards cosmopolis: Planning for multicultural cities* (p. 1998). Chichester: John Wiley and Sons.

Scholl, B. (2017). Building actor relationships and alliances for complex problem solving in spatial planning: The test planning method. *disP—The Planning Review, 53*(1), 46–56.

Scholl, B., Frezadou, I., Milionis, N., Moraitis, K., Noser, P., Papamichail, T., et al. (2015). *Code patras—rail & city—A test planning process for patras*. Zurich: ETH Zurich, Institute for Spatial and Landscape Development.

Scholl, B., Frezadou, I., Papamichail, T., & Signer, R. (2016). *Code patras—rail & city, a test planning process for patras. Exhibition of the results 2015/workshop of ideas 2016*. Zurich: ETH Zurich, Institute for Spatial and Landscape Development.

Scholl, B., Staub, B., & Vinzens, M. (Eds.). (2013). *Test planning—A method with a future*. Zurich: vdf Verlag.

Part V
Urban-Rural Innovation

Urban-Rural Bioenergy Planning as a Strategy for the Sustainable Development of Inner Areas: A GIS-Based Method to Chance the Forest Chain

Francesco Geri, Sandro Sacchelli, Iacopo Bernetti and Marco Ciolli

Abstract We describe the application of the spatial-based r.green.biomassfor Decision Support System (DSS), which is able to calculate the energy available from forest biomass residues, in a case study in an inner area of Italy, the Union of Pistoia Apennines Municipalities. Inner areas need strategies to counteract demographic abandonment as well as to improve socioeconomic conditions. This work considers the suitability of urban buildings to be served by biomass-energy plants as well as the supply/demand balance at the basin level. The suitability of the implementation of district-heating plants (DHP) was computed by means of a multicriteria analysis (MCA) model able to combine the following parameters: (i) yearly energy needs at the building level, (ii) building density, (iii) distance from the gas network and (iv) accessibility of the buildings/urban context. The MCA involved various experts and stakeholders to choose the parameters and to assess the weight to be assigned. A participative approach based on the Analytic Hierarchy Process (AHP) was carried out. Once DHP suitability and potential energy demand had been calculated, the basin energy density was computed. The optimal localization of DHP was then determined at the geographic level to analyze the technical and economic availability of the bioenergy supply. The new DHP implementation was analyzed for basins with both a high supply/demand ratio and high building suitability. Using the r.green.biomassfor software, the bioenergy availability was estimated from both ecological and economic points of view, while taking into account several environmental, technical, normative and financial variables. A series of scenarios have been analyzed using sensitivity analysis. The absence/ presence of bioenergy production, as well as the variability of woodchip prices,

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stressed the high importance of wood-residue valorization for the improvement of the forest chain. The approach we tested allows for better understanding and valuation of marginal areas in which planning is more difficult because resources are unevenly distributed. By highlighting suitable basins, energy planning is focused where it is advisable. The DSS is an effective tool for planning and communicating spatially explicit results to stakeholders. Although forest biomass covers a limited amount of energy demand and must be integrated with other renewable sources, forest-biomass valorization has huge positive side effects on the energy-supply production chain and can be a driving force to revive local economies. Our spatial results confirm the validity of a holistic strategy for local development.

Keywords Inner areas · Wood energy · Supply/demand ratio · Suitability model Multicriteria analysis

1 Introduction

Inner areas (*Aree Interne*) represent a large portion of Italian territory (about three-fifths of Italy's land) although only a quarter of Italy's population resides in these areas. According to Barca et al. (2014), inner areas are characterized by inadequate access to the essential services needed to maintain a certain level of quality of life. Moreover, they are far from large- and medium-sized urban centers that can supply adequate health, educational and transport services. These areas are quite diversified within themselves and are characterized by unstable development trajectories. Although they can provide resources that are lacking in the central areas and, due to their polycentric structure, they may have a potential appeal, inner areas can suffer from demographic challenges (Carrosio 2015).

Inner areas are considered strategically relevant to foster a more sustainable and inclusive national growth (Frappi and Varvelli 2010; Barca et al. 2014); therefore, the Italian government has adopted a strategy that is outlined in the PNR (*Piano Nazionale di Riforma*—National Reform Plan) to counteract demographic abandonment and to relaunch development and services in these areas through the funding of *Legge di Stabilità* (Stability Law) and EU funds (Mantino 2013). This strategy envisions the search for and the realization of the so-called "gentle activities", eco-sustainable activities learned by experience, and aims to revive typical local products and short supply chains sustained by public institutions and private urban organizations. In fact, the focus of area-based projects should concentrate on the following selected fields (development factors): land management and forests, local food products, renewable energy, natural and cultural heritage, traditional handicraft and SMEs (local knowledge). The management of supply chains represents one of the major components within the requalification strategy of disadvantaged areas, and the energy supply chain plays a leading role among supply chains (Barca et al. 2014).

Promoting a strategy that integrates and manages renewable energies in the territory through small, distributed plants taking advantage of all available resources (sun, wind, water and biomass) cannot only improve the efficiency of the energy supply, increasing local communities' autonomy from fossil fuels, but may also revive local activities, including the manufacture of typical local products.

Energy policy is gaining attention in the European context. In particular, forest biomass could represent a main resource that may help to reduce CO_2 emissions and address environmental issues. Moreover, during the last ten years, an increase of forest-biomass demand has been observed. This increase can be due to the following two main factors:

(i) The availability of a large amount of forest biomass for energy production: The depopulation of mountain areas and the abandonment of traditional activities have triggered a natural reforestation process that is occurring in Italy, both in the Apennines and in the Alps (Tattoni et al. 2017).
(ii) The rising price of traditional fossil fuels coupled with the clear intention of European policy to foster renewable energy.

Therefore, forest biomass for energy production is strongly connected with the rehabilitation of marginal areas because it may promote the intrinsic development of typical local products and typical timber assortments; this connection indicates that the development of short supply-chain technologies in internal areas is a determining factor in marginal area rehabilitation. However, an excessive use of local forest biomass could cause an overexploitation of forest resources, affecting biodiversity and ecosystem services. Therefore, to manage forest resources in a sustainable and integrated way, it is necessary to understand both how much forest biomass can be sustainably extracted and the real energy demand that can be satisfied through plant biomass. To obtain this information, planners, forest professionals and technicians need complex and structured analysis tools, such as the DSS, that are based on a holistic approach. These types of tools have already been proven effective in these types of planning procedures (Grilli et al. 2017).

As part of the Alpine Space European project, recharge.green, EURAC, DICAM and CREA-MPF have developed software called r.green, which is divided into different submodules (Garegnani et al. 2015). The submodule r.green.biomassfor evaluates the ecological, technical and economic suitability of various exploitation strategies employing forest biomass for energy production.

The purpose of this work is to apply r.green.biomassfor to an inner area of Tuscany called "*Unione dei Comuni dell'Appennino Pistoiese*" (Union of the Pistoia Apennines Municipalities).

The research considers the viability of existing urban residential buildings to be served by forest biomass-energy plants, and it calculates the supply/demand equilibrium at the basin level. The study followed a multi-criteria approach.

2 Methods

2.1 Study Area

The *Unione dei Comuni dell'Appennino Pistoiese* includes the following five municipalities: Abetone, Cutigliano, San Marcello Pistoiese, Sambuca Pistoiese and Piteglio (Fig. 1), and the total size of the area is 28,726 ha.

The landscape is mainly covered by mountains characterized by many powerful torrents with a mean elevation of approximately 1,000 m. Abetone Municipality is located at the highest mean elevation, 1,390 m, and the nearby area also features some well-frequented winter ski slopes that host tourists coming from the nearby towns. The land use of the territory is mostly characterized by forests (90%), while less than 2% is classified as an urban area. Beech (*Fagus sylvatica*) and chestnut (*Castanea sativa*) predominate in the broadleaf forests, while spruce (*Picea abies*), fir (*Abies alba*), Douglas fir (*Pseudotsuga menziesii*) and black pine (*Pinus nigra*) are the most common species in the conifer forests.

The study area has many environmentally critical issues, such as the homogenization of the natural landscape due to the loss of semi-natural and agriculture areas, resulting in secondary forest recolonization with a decrease in biological diversity. These environmental issues are accompanied by a series of economic and

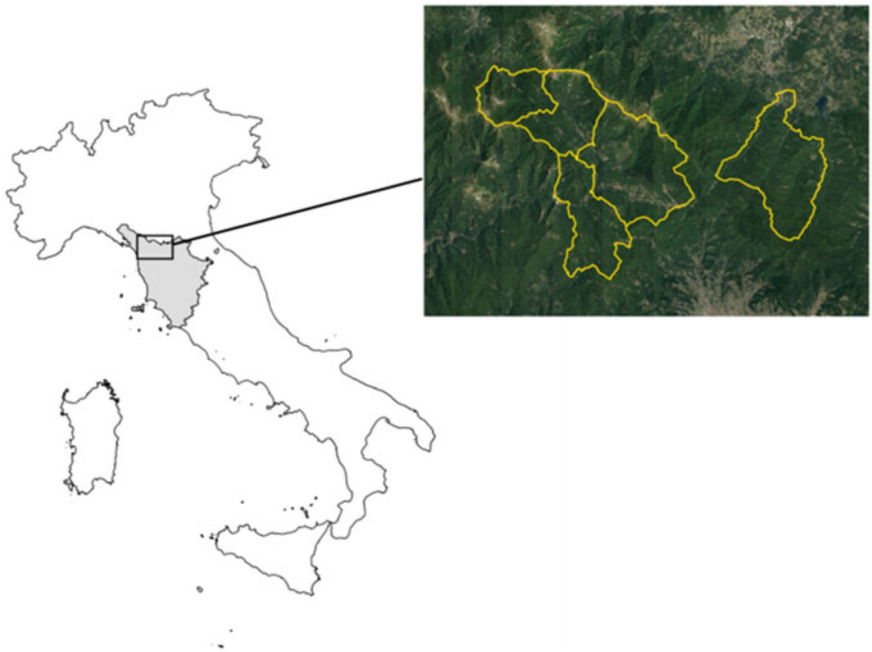

Fig. 1 Study area

social difficulties that also affect the natural and territorial aspects of the area. In particular, the recently ISTAT (Italian National Institute of Statistics) data show a decline in the resident population, mainly due to the active population, with an old-age index and an unemployment rate higher than regional averages. A further significant detail is the population decrease, by about 72%, during the period 2000–2010.The introduction of an energy and economic-regeneration strategy would reduce the incidence of such negative drivers.

2.2 DSS

The r.green.biomassfor model is a spatially explicit holistic model able to calculate the amount of forest biomass for bioenergy production that can be sustainably extracted from forests. The model was developed in the recharge.green Alpine space project as an evolution of the Biomasfor model (Zambelli et al. 2012, 2013; Sacchelli et al. 2013, 2014) and is available as add-ons of GRASS GIS (Neteler et al. 2012), with functions of GUI auto-generation that make it available also in the QGIS environment (www.qgis.org). The model was conceived as a framework based on a series of steps representing the logical implementation of scenarios that consider environmental, technical and economic variables and constraints (Garegnani et al. 2015). The model calculates forest biomass-energy potential in an area in MWh/y by performing a multi-step analysis and estimates energy potential levels in the five main submodels, which include theoretical, legal, technical, financial and recommended submodels:

- r.green.biomassfor.theoretical calculates the potential energy available from forest biomass in an area using the periodic (annual) forest yield.
- r.green.biomassfor.legal estimates the energy available from forest biomass using the prescribed yield, which in general is a percentage of the total yield.
- r.green.biomassfor.technical calculates the energy available from forest biomass that is actually exploitable from a forest area, depending on various mechanization levels.
- r.green.biomass.recommended introduces bonds and biomass-production limits.
- r.green.biomassfor.financial calculates the energy that can be produced with a positive net revenue (i.e., positive stumpage value) of all the production chain.

The model r.green.biomassfor enabled us to estimate energy availability from woodchips by taking into account variables tied to landscape morphology, extraction methods, roads infrastructures, production costs, costs for transport and wood sales.

2.3 Bioenergy Demand Localization

The suitability for district heating plant (DHP) implementation in residential buildings was defined by means of a spatial multicriteria analysis model (S-MCA) (Kühmaier et al. 2014). Following the methodology proposed in Nibbi et al. (2012), the criteria and indicators showed in Table 1 have been used. Yearly energy requirements consider the volume of the building, as well as the average thermal energy needed for a specific localization and building typology, according to national norms. Building density was computed through a kernel analysis (low-pass filter). Eventually, two distance-based operations were processed to quantify the distance from both the gas network and main roads. To aggregate resulting maps in an MCA, model normalization in the range 0–1 was performed by means of the fuzzy-logic technique and linear functions (Chen and Hwang 1992). To assess the weight to be assigned to each criterion, a participative approach involving experts and local stakeholders and based on the Analytic Hierarchy Process (AHP) was carried out (Saaty 1980). The main objective of the model was to rank the buildings according to their suitability to have biomass plants installed. The result was a raster suitability map, in which the value of the map was influenced by the buildings.

2.4 Data Analysis

The study area was divided into territorial units that are considered homogeneous from the point of view of available tree biomass, transport infrastructures and the conservation of local resources. For this purpose, the study area was divided into watershed basins, identified through the r.watershed function of GRASS GIS. The potential forest biomass-energy availability for each basin was calculated with the submodule, r.green.biomassfor.theoretical. A zonal statistic of the basin was calculated by overlaying the potential energy availability with energy demand, calculated by a multicriteria evaluation. Only the basins characterized by a supply/demand rate greater than one were selected. Within each basin, the DHP were manually positioned inside the buildings that were classified as highly suitable. After DHP positioning, the module r.green.biomassfor.technical identified the areas that could be exploited using available extraction technologies. Finally, the module r.green.biomassfor.financial estimated the energy that could be produced with a positive economic revenue.

Table 1 Framework criteria and indicators

Criteria	Indicators	Unit of measures
Bioenergy demand	Energy needs	MWh/mc $year^{-1}$
Suitability for pipelines implementation	Building density	m^2/ha
Gas competition	Distance from gas network	m
Accessibility	Distance from roads	m

3 Results

The basin analysis identified nine suitable basins with a supply/demand rate greater than one (Fig. 2).

Within each suitable basin, a DHP was positioned, taking into account the analysis of the building's features (Fig. 3).

In Fig. 4, the maps produced by r.green.biomassfor are reported. The three maps correspond respectively to theoretical, technical and financial analysis. The color gradient corresponds to different levels of estimated energy. It is possible to note that the potential energy that is available decreases from the theoretical level (Fig. 4a, energy available on the basis of biomass) to the technical level (Fig. 4b, actual exploitable energy with the available mechanization level) and finally to the financial level (Fig. 4c, available energy with a positive net revenue).The stumpage value considers revenues coming from the selling of woodchips and traditional wood products, as well as all the costs throughout the production chain. As specified in the methods, this calculation also accounts for the constraints related to extraction methods (ground skidding and forwarder or aerial logging).

Four different scenarios were considered in the final analysis. The scenario "no chip" excludes the production of chips, while in the other three scenarios, the chip production is considered with different market prices (20, 25 and 30€/Mwh) for selling the energy. We considered a sensitivity analysis based on the input parameter variation, in our case the chip price, to verify the variation of the output parameters.

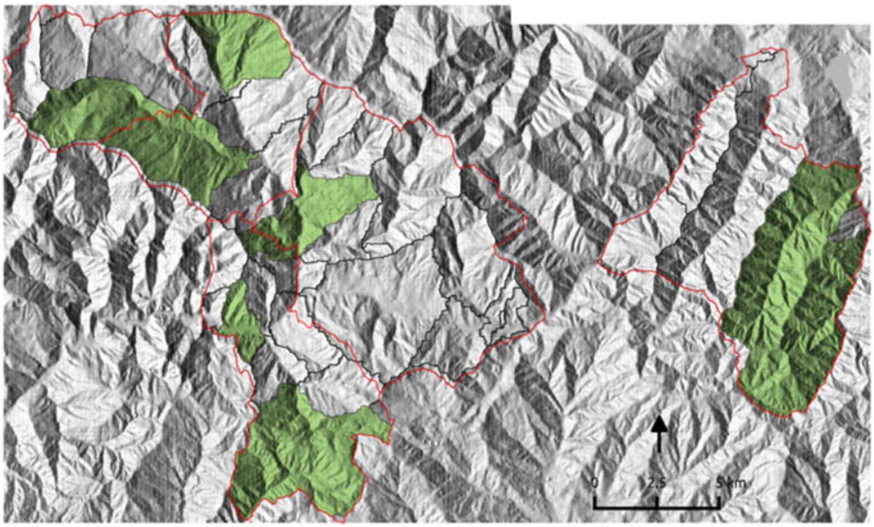

Fig. 2 The suitable basins characterized by a positive supply/demand rate are highlighted in green

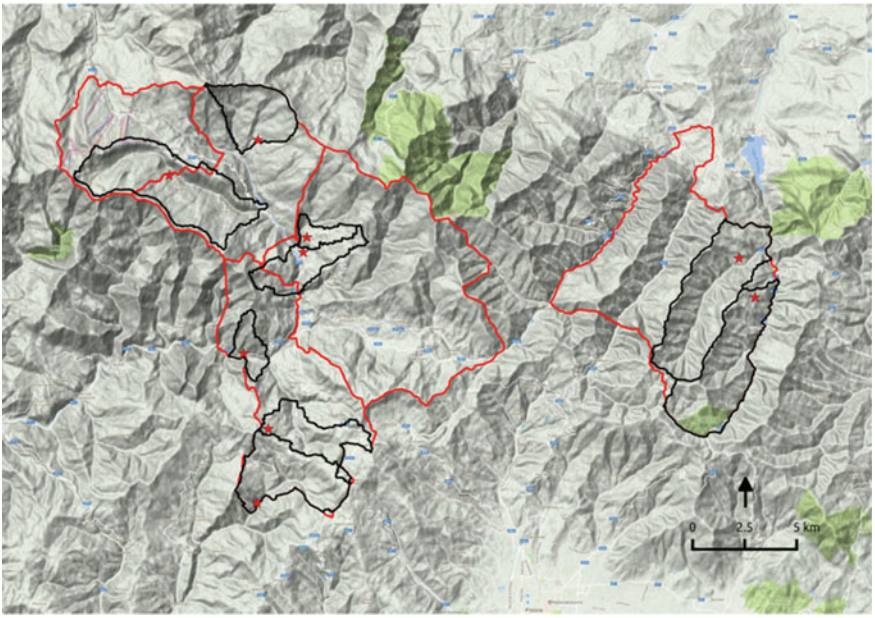

Fig. 3 Red stars identify DHP position in the study area within the suitable basins

Table 2 reports the yearly total net revenues. The total net revenues per each of the four scenarios are reported in the penultimate row, while the rightmost row represents the chip added value of the whole forest-wood-energy supply chain; in other words, it indicates how much the net revenue would increase by performing chip production compared to the present state.

Table 3 focuses on the energy that can be produced using woodchips. The "total" line is the estimated total for all the municipalities, while the bottom line reports the percent of energy demand in highly suitable buildings that can be satisfied with plants using woodchips. Highly suitable buildings are defined, among other factors, as buildings with a suitability score higher than the 80th percentile. The rate does not vary significantly in the scenarios and is between 17 and 20%.

These findings indicate that, to improve self-sufficiency in terms of energy planning, forest biomass must be integrated with other forms of renewable-energy production.

Table 4 reports, according to the same previous four scenarios, the volume of each type of traditional wood assortment (roundwood, wood pole, timber for wood packaging, small wood pole and firewood) that can be produced yearly in each municipality, expressed in m^3/year. Comparing the four scenarios, it is clear that

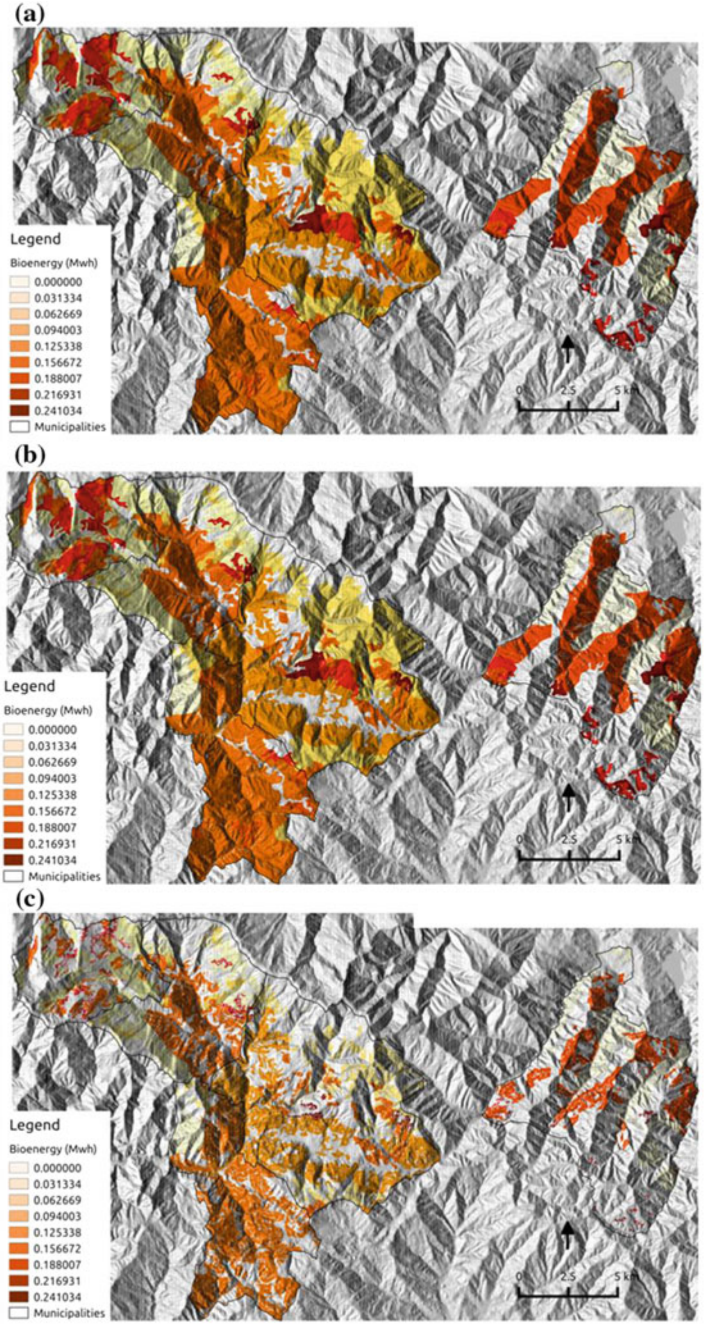

Fig. 4 Bioenergy results: **a** theoretical level, **b** technical level, **c** financial level

Table 2 Total yearly net revenues (€/year) obtained from the difference between the sale of main assortments (roundwood, poles, firewood, etc.), and production costs in four scenarios: no-chip, and sale at 20, 25 and 30 €/Mwh

Woodchip price (€/MWh)				
	No chip	20	25	30
Abetone	144,752	184,291	202,245	221,481
Cutigliano	139,230	199,565	228,028	258,616
San marcello P.se	319,296	434,939	487,229	542,954
Piteglio	339,981	451,180	498,921	549,107
Sambuca P.se	205,676	280,761	315,792	353,876
Total	1,148,935	1,550,736	1,732,215	1,926,034
%	0.00	35.00	51.00	68.00

Table 3 Energy produced in each municipality in sale scenarios (20, 25 and 30 €/Mwh)

Woodchip price (€/MWh)			
	20	25	30
Abetone	3,337	3,844	4,155
Cutigliano	5,581	6,103	6,558
San marcello P.se	10,286	11,062	11,840
Piteglio	9,583	10,171	10,721
Sambuca P.se	6,569	7,259	7,973
Total	35,356	38,439	41,247
% of high suitabilty demand (%)	17.00	19.00	20.00

The “total” line is the estimated total for all the municipalities, while the last line reports the % of energy demand in highly suitable buildings that can be satisfied with plants using woodchips. The maximum rate is 17–20%

chip extraction strongly fosters the production of the main timber assortments because the co-product improves the efficiency of the supply chain, creating a cascade effect. Therefore, traditional timber assortments and, hence, the local timber sector strongly benefit from the woodchip biomass energy chain (e.g., local logging companies can work more, local sawmills can use local resources and so on).

Table 4 Scenarios of the volume of traditional assortments that can be produced yearly in each municipality (m^3/year) for each assortment

		Roundwood	Woodpole	Timber	Small woodpall	Fire wood
No chip	Abetone	426	260	447	539	2,488
	Cutigliano	1,276	1,076	184	2,806	1,239
	San marcello P.se	2,395	2,100	598	5,351	2,027
	Piteglio	2,521	2,379	9	6,294	955
	Sambuca P.se	1,341	1,232	25	3,260	2,291
Woodchip 20€/MWh	Abetone	718	293	638	613	2,756
	Cutigliano	1,614	1,269	287	3,309	1,880
	San marcello P.se	2,756	2,309	725	5,890	3,415
	Piteglio	2,893	2,730	25	7,217	1,046
	Sambuca P.se	1,713	1,476	114	3,899	2,387
Woodchip 25€/MWh	Abetone	1,125	314	900	660	2,862
	Cutigliano	1,752	1,365	317	3,559	2,163
	San marcello P.se	2,978	2,418	815	6,170	3,884
	Piteglio	3,070	2,895	41	7,649	1,115
	Sambuca P.se	1,928	1,641	164	4,324	2,561
Woodchip 30€/MWh	Abetone	1,339	335	1,042	705	2,949
	Cutigliano	1,871	1,445	346	3,770	2,418
	San marcello P.se	3,183	2,511	910	6,410	4,426
	Piteglio	3,232	3,044	65	8,036	1,203
	Sambuca P.se	2,159	1,811	220	4,765	2,729

4 Conclusion

The approach we tested allows for a better understanding and valorization of marginal areas in which planning is more difficult because resources are unevenly distributed. By highlighting suitable basins, energy planning is focused where it is advisable. Various different wood extraction techniques and economic scenarios can be simulated. Furthermore, the DSS is an effective tool for planning and communicating spatially explicit results to stakeholders. Our simulations showed that forest biomass may have a significant role in the energy policy of the area; however, because it covers a limited amount of total energy demand, it must be integrated with other renewable sources. One of the most interesting findings of our study is the positive side effect of forest biomass valorization on the energy-supply production chain: Biomass is crucial in energy strategy and can represent a driving force to revive local economies. Therefore, our spatial results confirm the validity of a holistic strategy for local development. Future research studies could involve testing the feasibility of alternative models in other territories and automatizing building suitability selection.

References

Barca, F., Casavola, P., & Lucatelli, S. (2014). A strategy for inner areas in italy: definition, objectives, tools and governance. *Materiali UVAL 31*. Rome.

Carrosio, G. (2015). Economia civile e gestione delle risorse ambientali nelle aree interne. *Territorio*.

Chen, S. J., & Hwang, C. L. (1992). *Fuzzy multiple attribute decision making: methods and applications*. Berlin: Springer-Verlag.

Frappi, C., & Varvelli, A. (2010). *Le strategie di politica energetica dell'Italia* (p. 98). Relazioni Internazionali: Criticità interne e opportunità internazionali.

Garegnani, G., Geri, F., Zambelli, P., Grilli, G., Sacchelli, S., Paletto, A., et al. (2015).A new open source DSS for assessment and planning of renewable energy: r.green. In *Proceedings of: FOSS4G Europe, Como 2015, 14–17 June 2015*. Geomatics Workbooks.

Grilli, G., Ciolli, M., Garegnani, G., Geri, F., Sacchelli, S., Poljanec, A., et al. (2017). A method to assess the economic impacts of forest biomass use on ecosystem services in a National Park. *Biomass and Bioenergy, 98,* 252–263.

Kühmaier, M., Kanzian, C., & Stampfer, K. (2014). Identification of potential energy wood terminal locations using a spatial multicriteria decision analysis. *Biomass and Bioenergy, 66,* 337–347.

Lucatelli, S., Carlucci, C., & Guerrizio, A. (2013). A strategy for 'inner areas' in Italy. In *Education, local economy and job opportunities in rural areas in the context of demographic change: Proceedings of the 2nd EURUFU scientific conference (Asti, Italy)* (pp. 69–79).

Mantino, F. (2013). La riforma delle Politiche di sviluppo rurale 2014–2020. *Rivista Agriregioni Europa*, 9(35).

Neteler, M., Bowman, M. H., Landa, M., & Metz, M. (2012). GRASS GIS: A multi-purpose open source GIS. *Environmental Modelling and Software, 31,* 124–130.

Nibbi L., Tirinnanzi A., Sacchelli S., Ciampi C., & Fagarazzi C. (2012). Planning future biomass to energy facilities on a GIS Offer/demand basis: A study for tuscany, Italy. In *Proceedings of 20th EuropeanBiomass Conference and Exhibition* (pp.14–18), Milan.

QGIS Development Team. (2017). *QGIS Geographic Information System. Open source geospatial foundation project*.

Sacchelli, S., Zambelli, P., Zatelli, P., & Ciolli, M. (2013). Biomasfor an open source holistic model for the assessment of sustainable forest bioenergy. *iForest*, *6*, 285–293.

Sacchelli, S., Bernetti, I., De Meo, I., Fiori, L., Paletto, A., Zambelli, P., et al. (2014). Matching socio-economic and environmental efficiency of wood-residues energy chain: a partial equilibrium model for a case study in Alpine area. *Journal of Cleaner Production, 66,* 431–442.

Saaty, T. L. (1980). *The analytic hierarchy process*. New York: McGraw-Hill.

Tattoni, C., Ianni, E., Geneletti, D., Zatelli, P., & Ciolli, M. (2017). Landscape changes, traditional ecological knowledge and future scenarios in the Alps: A holistic ecological approach. *Science of the Total Environment, 579,* 27–36. https://doi.org/10.1016/j.scitotenv.2016.11.075.

Tzeng, G. H., & Huang, J. J. (2011). *Multiple attribute decision making: methods and applications*. Florida: CRC press.

Zambelli, P., Lora, C., Spinelli, R., Tattoni, C., Vitti, A., Zatelli, P., et al. (2012). A GIS decision support system for regional forest management to assess biomass availability for renewable energy production. *Environmental Modelling and Software, 38,* 203–213.

Zambelli, P., Gebbert, S., & Ciolli, M. (2013). Pygrass: An object oriented python Application Programming Interface (API) for Geographic Resources Analysis Support System (GRASS) Geographic Information System (GIS). *ISPRS International Journal of Geo-Information* 2, 201–219.

Provincial but Smart—Urban-Rural Relationships in Brandenburg/Germany

Antje Matern, Carolin Schröder, J. Miller Stevens and Silke Weidner

Abstract While the idea of intelligent or smart cities started a vivid discussion and brought up a whole variety of strategies to transform urban areas into smart cities, the discussion about smart regions is less developed and rather vague. By looking into trends and strategies developed in the first implementation projects, one general lesson learned is that there is not just one approach to transforming regions into smart regions, but that innovation and smartness need to be related to their specific spatial, infrastructural and sociopolitical contexts (place-based approach). This contribution discusses existing concepts of Smart Regions and argues that peripheral regions may similarly become smart by implementing place-based approaches. In a first step, a short literature review on smart regions and challenges of the peripheral is presented. In a second step, new approaches in peripheral regions will be analyzed and discussed by providing and comparing four case studies from the Brandenburg region in Germany.

Keywords Smart regions · Urban-Rural-Relationships · Metropolization and peripherization

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1 Introduction

Spatial concepts of urban-rural relations have been scrutinized in urban-planning debates over recent decades. While discussions about globalization and the information society have brought urban research back to the agenda, spatial-planning discourses often consider the role of the countryside in the urban age. Major concerns are the challenges of polarization caused by parallel trends of growth and decline between urban and rural areas (Lang 2012; Kühn 2015). In the context of these debates, several spatial visions and strategies have been developed to deal with issues of spatial polarization and regional divides, like the concept of urban-rural partnerships (TA 2011; OECD 2013) or the RURBAN initiative (BBSR and DV 2012: 68–70).

A core element of those concepts is endogenous regional development by cooperation and networking between various actors. The aim of this urban-rural cooperation is better management of natural resources, enhanced innovation and economic spill-over effects from urban centers into their hinterlands. Therefore, networking between regional stakeholders will overcome the dichotomizing mindsets of "the urban" and "the rural", which for example are often found in funding practices. Furthermore, the cooperation in multilevel governance structures is seen as a precondition for knowledge clusters, learning in networks and the creation of innovation (Davoudi and Stead 2002) that prevents the marginalization of rural areas (Kühn 2015).

Concepts of smart regions can build upon findings of research that strive to create knowledge networks and multi-level-governance structures including cities and their neighboring areas. Due to the smartness debates, the partnership approach is now concentrated on green and knowledge-based economies/clusters, circular economies and investigations into using ICT to improve services, participation processes or resource-efficiency to create more liveable regions (Angelidou 2014).

In the spatial sphere, the debates about smart regions often concentrate on prosperous urban agglomerations. But this disregards the fact that the settlement structures in Europe are characterized by a number of small- and medium-sized cities. This is also the case in the German state of Brandenburg. The Capital Region of Berlin-Brandenburg contains, besides Berlin, a number of rural, peripheral and distressed areas and a large number of cities with less than 50,000 inhabitants. In regional planning, these cities are characterized as the backbone of rural development by providing services, economic, social and cultural functions for rural regions.

In the debates, an academic void exists regarding the role of urban-rural partnerships for creating smart regions or coherent development strategies on the scale of medium-sized metropolitan regions. Based on a competition ("*Stadt-Umland-Wettbewerb*"—SUW) initiated by the state of Brandenburg, regional stakeholders were asked to develop coherent strategies for urban-rural partnerships for regional development. The state provides the successful applicants with ERDF funding for projects named in the strategies. Our study is based on literature reviews, expert interviews and the in-depth analysis of the SUW competition program and entries. We follow up on discussions about smart regions and analyze recent achievements in transforming traditional regions. Furthermore we:

- discuss the definitions and criteria of smart regions in a literature review and focus on the understanding of urban-rural interrelations and multilevel governance for the smart regions,
- demonstrate how the SUW competition on a program level encourages regional stakeholders to develop coherent strategies for creating smarter regions,
- analyze in a case study what kind of strategies are applied to foster the energy transition on a local/regional level.

In this paper, we want to explore in which way urban-rural partnerships in rural areas can support the transition process to a smart region and a funded competition like the SUW in Brandenburg could enhance the process. We finally conclude how definitions of smart regions need to be adjusted for regions outside metropolitan areas.

2 Smart Regions

The term 'smart region' emerged some ten years ago in academic discussions. Early definitions were heavily influenced by discussions on smart cities and focused on prosperous city regions; they emphasize that "smart regions deliver prosperity and growth through the development of competitive strengths in knowledge and technology intensive sectors" (Greenfield et al. 2006: iii). Smart regions, in that conception, are based on potentials of economic growth, new technologies, knowledge creation and innovation at a larger scale (Greenfield et al. 2006: ix).

But regional smartness may also be conceived differently: in the literature, knowledge-based approaches can be found that emphasize the need to relate new technologies to local knowledge (for example, Rogerson 2001: 34; Camagni and Capello 2013) as well as society-based, participatory approaches (Roth and Hirschmann 2013; ref.) that focus on relations of technology and society under the label of 'social innovations' (Calzada 2013).

Within the scope of such a broadened perspective on smart regions in which spatial and societal context matters, involvement of a variety of actors is postulated. Following that thought, government, academia, industry and civil society—the quadruple helix—need to work together in order to develop context-related solutions for smart regions (see Fig. 1).

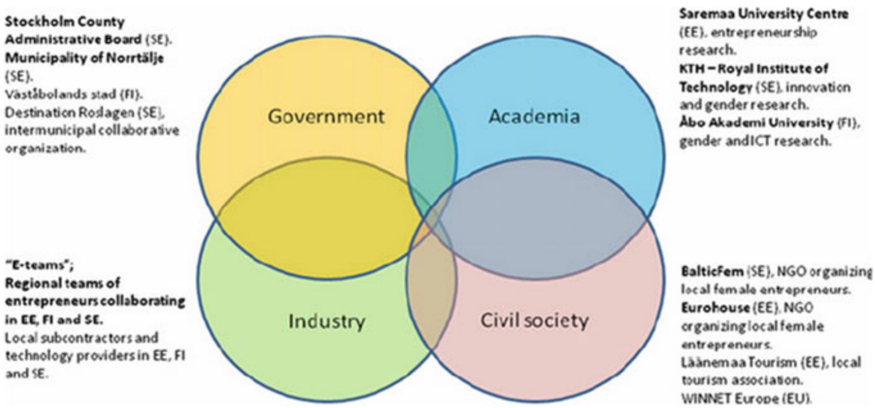

Fig. 1 Quadruple helix as a basis for smart innovations (Lindberg et al. 2014)

3 The Challenges of the Peripheral

Following the smart-region definition of Greenfield et al. (2006), it can be questioned whether peripheral or less favored regions could be considered 'smart regions' at all. Instead of being economic centers, they are characterized by specific socio-spatial challenges such as structural deficits, e.g., in infrastructure, a lack of capital, resources and skilled people; weak technological and institutional structures (Rosenfeld 2002: 9–10), as well as a concentration of poverty, shrinkage and outmigration (Kühn 2015: 367).

In search of causes of polarized structures and spatial inequalities, recent debates focus on peripheries. They argue that old industrialized regions or medium-sized cities in rural areas are more likely to be affected by socioeconomic decline. In addition, they emphasize mutual dependencies of centralization and peripheralization dynamics (Herrschel 2012). Hence the peripheralization can be understood as a product of the dynamics of:

- economic polarization, e.g., by a lack of innovation (Davoudi and Stead 2002),
- social inequality (through cultural, social or structural marginality and poverty (Wacquant 2008) and a lack of political power and participation (Kühn 2015: 368ff).
- political dependencies and exclusion from sources of power (decision-making, agenda-setting), as well as from networks (Herrschel 2012).

The process-centered approach draws attention to the fact that peripheries are products of multi-dimensional processes and not "pre-given spaces" (Fischer-Tahir and Naumann 2013). In consequence, researchers suggest developing endogenous governance networks to reduce exogenous dependency on the centers or establishing vertical networks to the centers to improve innovation capacities and to overcome disadvantages of exclusion (Kühn 2015).

With reference to this debate, *urban-rural cooperation is a precondition for any smartness of region*s. Such cooperation aims at networking, at creating partnerships and at mobilizing synergies and facilitating endogenous developments and specialization for innovation and growth (Davoudi and Stead 2002). The actors involved are both the urban and rural stakeholders from politics, administration, science, the business sector and civil society (Lindberg et al. 2014).

In European policies, these recommendations led to strategies of urban-rural partnerships (TA 2020) and programs like RURBAN (EPRS 2016: 7). They support territorial partnerships of cities and rural areas and promote the creation of structures for territorial multilevel governance to assess possible economic and social gains from enhanced cooperation and to improve regional competitiveness. Due to the fact that obstacles of cooperation are also created by EU funding policies, the RURBAN program addressed the question of how EU funding can best be used to support urban-rural cooperation. As a result, the EU recommended to the Member States supporting community-led local development (CLLD) by a multi-fund approach that finances investments by the ERDF, ESF and LEADER when the investments are embedded in a coherent regional strategy.

The multi-fund approach was applied in the program period 2014–2020 for the first time, and the state of Brandenburg followed the recommendation. The state established the "*Stadt-Umland-Wettbewerb (SUW)*" (city-region competition) and asked the municipalities for concepts of urban-rural partnerships. Before we give insights into the competition for urban-rural cooperation, we will briefly characterize our case study of the Brandenburg region.

4 New Approaches in Brandenburg

The State of Brandenburg is one of 16 states in Germany and known as the "energy state" since energy production is traditionally the main economic sector. One of the distinguishing characteristics of Brandenburg is its spatial containment of the German capital city-state of Berlin (Fig. 2).

While Berlin's current population is approximately 3.5 million (as of 12/31/2014) and has been growing steadily since about 2010, Brandenburg has a population of approximately 2.48 million. With regard to population density, Berlin has some of the highest densities in all of Germany (3891 persons/km^2 on average) while Brandenburg, like the other former East German states, possesses one of the lowest population densities (average 82.9 persons/km^2 overall). It is, however, necessary to differentiate within Brandenburg between the so-called "*Speckgürtel*" with an average of 325.42 persons/km^2 and the peripheral regions with an average of only 57.11 inhabitants/km^2.

Brandenburg is not only sparsely populated but also characterized by a socioeconomic situation outside the "*Speckgürtel*" influenced by the major structural change starting in the 1990s, which de-industrialized large parts of the state. This is also true for energy production as the major economic sector and main

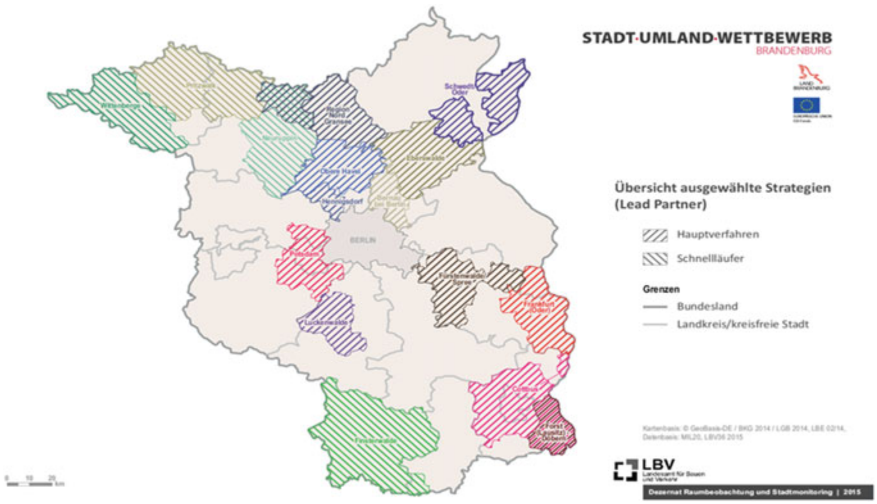

Fig. 2 Overview of the selected city-regions in the competition (LBV 2015)

employer (e.g., in the south of Brandenburg). The sector is faced with the challenge of adapting to the energy transition (with the goal of 30% renewables by 2030) and replacing existing coal mining and lignite-fired power plants by renewable energy (MWE 2012).

Given those specific conditions, it seems crucial that (further) peripheralization is to be avoided since, without a stabilization of the hinterland, it will become impossible to establish vital centers and growth centers (urban-rural interdependency) where local resources can be concentrated and exchanged. In consequence, peripheral regions may need a specific infrastructure that suits their spatial context (decentralized). Despite the fact that the conditions in Brandenburg do not fulfill the criteria proposed by Greenfield, we suggest that "smartness" is not only feasible but also crucial for the context-related, regional development of less favored regions.

The German State of Brandenburg initiated the "city-region competition" (*SUW*) among municipalities and their respective regions in 2015 to promote communal cooperation for the realization of specific projects. The competition was conducted by the Ministry of Infrastructure and Regional Planning and encompassed a total subsidization volume of 213 million Euros in a multi-fund approach, including funding from the European Structural Investment Fund (ESI), the ERDF and the EAFRD, while the ESF was optional (MIL 2015). In and of itself, the competition can be characterized as innovative and "smart" due to the concentrated, multi-fund and place-based approach. Furthermore, the competition aimed to promote strategies of innovation and networking in public-service provision, regional development and inclusion by supporting urban-rural partnerships and by enhancing towns as anchors for regional development. Prerequisites for participating in the competition were, for example, inter-communal cooperation and strategic planning. It can therefore be suggested that the competition was also “smart” with regard to its objectives, contents and its strategic approach.

Out of 34 competition entries (small- and mid-sized towns with corresponding regions), 16 city-regions were chosen for subsidization of their projects (Fig. 2). These 16 city-regions receive funding totaling about 160 million Euros (ESI-Fonds) to develop strategies for innovative relations and networking between small- and mid-sized towns in Brandenburg and their respective rural regions.

These selected entries include such aspects as inter-communal cooperation, urban-rural-linkages, food sovereignty, material flows and circulation, public and private actors, digitalization in rural areas, adaptation to climate change, division of labor between town and region (for example as culture and nature, work and recreation and the chance to generate new businesses for the rural regions) etc. In addition, the energy transition was a component in three-fourths of the competition entries, which combined innovative technologies and cooperative relationships on both local and regional levels.

In the following, we will focus on three city-regions and their cooperative activities in the decentralized production and provision of renewable energies, the energetic upgrading of existing buildings and the promotion of e-mobility. We place the emphasis on energy since the sector is a major economic factor in Brandenburg and debates about smartness of cities and regions target the improvement of resource-efficiency. In the context of the competition, the energy transition also constitutes an effort to overcome inequality in urban-rural relations.

4.1 City of Pritzwalk/East Prignitz

The city of Pritzwalk and the surrounding region of East Prignitz are located in the northwest of the State of Brandenburg, approximately halfway between Berlin and Hamburg. The competition entry was based on the long-standing and institutionalized “Workgroup Growth Region Autobahn Triangle Wittstock/Dosse” which includes four municipalities, extends across the administrative boundaries of two counties and encompasses a total of approx. 44,800 inhabitants. This collaborative group was joined by two additional municipalities and a number of private partners for the competition. As a response to the challenge of sustainable service provision in a shrinking region, the competition entry focused on a division of labor regarding public services. For the implementation of the proposed projects, Pritzwalk and the city-region of East Prignitz were granted a total of 10.3 million Euros.

With regard to energy transition, Pritzwalk et al. proposed the following projects for funding:

- new facilities of energy production/heating, e.g., a biogas facility for remote heating of public facilities in the community of Gross Pankow and a small-scale hydroelectric plant in Pritzwalk

- retrofitting of the housing stock for renewable-energy production, e.g., solar-thermal heating in the Röbeler Vorstadt in Wittstock
- provision of energy/heating to public facilities, e.g., heating of public buildings with surplus industrial heat in Heiligengrabe and the case mentioned previously in Gross Pankow.

4.2 City of Potsdam

The city of Potsdam is the capital of the State of Brandenburg and is located immediately adjacent to Berlin in the southwest. Due to its proximity to Berlin, Potsdam and the surrounding communities comprise a growing local region within the "*Speckgürtel*" around Berlin. The mutual dependency between Potsdam and Berlin is matched by an interdependency between Potsdam and the surrounding communities. This also means the Potsdam city-region is confronted with challenges such as a large amount of commuter traffic, as well as the provision of housing and services to a growing population. For the city-region competition, Potsdam created a new form of cooperation with neighboring communities with a total of 246,627 inhabitants. To prepare the competition entry, the members of the group collaborated in the planning process, e.g., in common thematic workshops. Based on, among other factors, the size of the affected population and the significance of the projects, the city-region of Potsdam was granted 21.89 million Euros for the funding of their projects.

As projects for energy transition, Potsdam and the collaborating communities proposed the following:

- investments in renewable-energy production facilities such as the local remote heating system fired by wood chips in the former Olympic Village in the community of Elstal
- construction of new energy-efficient housing, e.g., the CO_2 neutral housing development in Krampnitz, north of Potsdam, with a biogas-fired local power and heating plant, solar thermal and photovoltaic systems
- improvement of the commuting infrastructure, e.g., construction of high-speed bike paths and e-mobility infrastructure (charging stations), along with mobility management (e.g., information systems).

4.3 City of Cottbus

The city of Cottbus is located in the southeast of the State of Brandenburg at approximately the same distance as Pritzwalk from Berlin (1.5 h). Cottbus proper is a center of a higher order and has a population of roughly 100,000. For the city-region competition, Cottbus cooperated with seven additional municipalities encompassing a total of approx. 188,600 inhabitants and extending across two functional regions. This collaboration could draw upon the experience gained in over 15 years of inter-communal cooperation, e.g., on the joint Regional Development Concept Forst/Guben and in the International Building Exhibition (IBA) Fürst-Pückler-Land from 2000 to 2010 in the lignite coal-mining region. A total of 12.99 million Euros was granted for the realization of the proposed projects.

Within the scope of the competition entry, Cottbus and the collaborating municipalities within the region proposed the following projects for energy transition:

- renewal of inner-city quarters, including energetic upgrading with components such as a low-temperature remote heating system based on solar-thermal and power-to-heat systems, the integration of renewable energies into remote heating systems and a decentralized heating system
- the creation of a mobility network and infrastructure for charging stations for electric public buses
- preparatory actions for energy transition in the post-mining region including the redevelopment of former lignite coal-mining areas.

The competition entries illustrate that the municipalities in Brandenburg emphasize energy efficiency and renewable energies (production, heating) by following an incremental and place-based approach. According to various different challenges in agglomerations or rural areas, the energy pilot actions in the three cases highlight distinctive regional strategies: The case of Potsdam shows that in metropolitan areas challenges of smart mobility and solutions for the housing demand are primary while in regional growth poles like Cottbus, issues of restructuring urban infrastructures and the energetic retrofitting of housing are a main challenge. In the Prignitz, as a representative of a rural-peripheral region, the central tasks for municipalities are ensuring public services. In this case, smart cooperation is applied to strengthen the division of labor, thereby ensuring main factors of the quality of life. With regard to the smartness of regions, we interpret the pilot actions in the SUW for low-carbon development, as well as ensuring or improving (efficient) public services under difficult socioeconomic conditions, as smart strategies.

5 Conclusion

The definition of “smart” should be adapted when examining regions and furthermore should take into consideration the particular social, economic and technological conditions in the respective region. For local city-regions in Brandenburg, this means considering the spatially differentiated demographic and economic development within the overall Capital City Region, which includes the entire state of Brandenburg. Until now, most definitions of "smart" imply demographic and economic growth in cities and regions. But faced with the far-reaching structural changes such as those in Brandenburg and especially in the rural regions, it is necessary to develop a definition of "smart" that can apply to the various approaches and solutions to the myriad of problems within shrinking regions. In other words, "smart" can and should apply to the "survival strategies" in such regions. Besides the emphasis on ensuring services and qualities in regions, "smart" strategies in Brandenburg focus on resource and energy efficiency, and ICT is used as a tool for meeting the challenges of regional development.

With regard to cooperation and networking among municipalities, communities and their respective regions, the State of Brandenburg can be considered "smart": The city-region competition in Brandenburg stipulated urban-rural cooperation and joint strategic planning as requirements for competition entries. The program creates a framework for innovative urban-rural relationships in applying a multi-fund approach, permits flexibility for place-based innovation and is biased toward existing networks of municipalities. Within the various collaborative arrangements, medium-sized cities take on the role of growth poles and include neighboring functional areas. It was therefore not surprising to find various forms of cooperation within the entries and the corresponding projects. Furthermore, it appears that there is a direct positive relationship between the duration and extent of existing cooperation and the success of the entries in the city-region competition. However, the program could not achieve the objective of fostering the quadruple-helix structures since in all of the entries the involvement of private actors is very limited.

The competition aimed to systematically evaluate city-regions in order to distribute funding for projects that fulfill the requirements of the ESI Fund (ERDF). The State of Brandenburg was one of the few German states which used this instrument for preparing decisions on economic support, i.e., subsidization. That may, in and of itself, be considered "smart" on the level of state regional planning. It will, of course, be interesting to observe whether the cooperative relationships named in the individual competition entries will: (1) actually benefit the realization of the projects, and (2) continue beyond the purposes of the projects.

With regard to the federal guidelines for regional development in Germany, it appears that the results of the city-region competition deviate from the objective of "strengthening strengths" on the spatial level of the entire State of Brandenburg, in which the so-called "*Speckgürtel*" in the area surrounding Berlin reveals the greatest strengths (demographically and economically). But, on the spatial level of the counties, towns and local regions, the competition and the subsequent funding will benefit existing strengths on the local level. In future research, it would be interesting to monitor the duration and quality of cooperation and to investigate cooperative relationships that extend beyond the specific sectoral fields delineated by the city-region competition.

References

Angelidou, M. (2014). Smart city policies: A spatial approach. *Cities—The International Journal of Urban Policy and Planning, 41*(1), 3–11.

BBSR (Federal Institut for Research on Building, Urban Affairs and Spatial Development) & DV (Deutscher Verband für Wohnungswesen, Städtebau und Raumordnung e.V.). (2012). Partnership for sustainable rural-urban development: extisting evidences. http://ec.europa.eu/regional_policy/de/policy/what/territorial-cohesion/urban-rural-linkages/.

Calzada, I. (2013). *Critical social innovation in the smart city era for a city-regional European horizon 2020*. Accessed as May 4, 2017 from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2506952.

Camagni, R., & Capello, R. (2013). Regional innovation patterns and the EU regional policy reform: Toward smart innovation policies. *Growth and Change, 44*(2), 355–389. http://www-sre.wu.ac.at/ersa/ersaconfs/ersa12/e120821aFinal00190.pdf.

Davoudi, S., & Stead, D. (2002). Urban-Rural-Relationships: An introduction and a brief history. *Built environment, 28*(4), 269–277.

EPRS (European Parliamentary Research Service). (2016). Bridging the rural—urban divide. rural—urban partnerships in the EU http://www.europarl.europa.eu/RegData/etudes/BRIE/2016/573898/EPRS_BRI(2016)573898_EN.pdf.

Fischer-Tahir, A., & Naumann, M. (2013). *Peripheralization. The making of spatial dependencies and social injustice*. Wiesbaden: Springer.

Greenfield, P., Hammond, L., Milsom, N., & Rayner, M. (2006). *Smart regions: Characteristics of globally successful regions and implications for Queensland*. Accessed as May 04, 2017 from http://www.chiefscientist.qld.gov.au/images/documents/chiefscientist/pubs/reports-other/smart-regions-report.pdf.

Herrschel, T. (2012). Regionalisation and marginalisation. Bridging old and new divisions in regional governance. In Danson, M. & DeSouza, P. (Ed.) *Regional Development in Northern Europe. Peripherality, Marginality and Border Issues* (pp. 30–48). London: Routledge.

Kühn, M. (2015). Peripherization—Theoretical concepts explaining socio-spatial inequalities. *European Planning Studies, 23*(2), 367–378.

Lang, T. (2012). Shrinkage, metropolization and peripherization in East Germany. *European Planning Studies, 20*(10), 1747–1754.

LBV (Landesamt für Bauen und Verkehr). (2015). *Stadt-Umland-Wettbewerb Brandenburg, Übersicht ausgewählter Strategien*. Accessed as May 4, 2017 from http://stadt-umland-wettbewerb.brandenburg.de.

Lindberg, M., Lindgren, M., & Packendorff, J. (2014). Quadruple Helix as a way to bridge the gender gap in Entrepreneurship: The case of an innovation system project in the Baltic Sea Region. *Journal of the Knowledge Economy, 5*(1), 94–113.

MIL (Ministerium für Infrastruktur und Landesplanung des Landes Brandenburg). (2015). *Stadt-Umland-Wettbewerb Brandenburg, Wettbewerbsaufruf—Entwicklung von Stadt und Umland durch Kooperation und fondsübergreifende Förderung in der EU-Förderperiode 2014–2020 im Land Brandenburg*. Accessed as May 4, 2017 from http://stadt-umland-wettbewerb.brandenburg.de.

MWE (Ministerium für Wirtschaft und Europaangelegenheiten des Landes Brandenburg). (2012). *Energiestrategie 2030 des Landes Brandenburg*. Accessed as May 4, 2017 from http://www.energie.brandenburg.de/media/bb1.a.2865.de/Energiestrategie_2030.pdf.

OECD. (2013). *Rural-Urban Partnerships: An integrated Approach to Economic Development*. Paris: OECD Publishing. https://doi.org/10.1787/9789264204812-en.

Pezzi, M. G., & Urso, G. (2016). Peripheral areas: Conceptualizations and policies. Introduction and editorial note. *IJPP—Italian Journal of Planning Practice, 6*(1), 1–19.

Rogerson, C. M. (2001), Knowledge-based or smart regions in South Africa. *South African Geographical Journal,* 83(1), 34–47. http://www.tandfonline.com/doi/pdf/10.1080/03736245.2001.9713717.

Rosenfeld, S. (2002). *Creating smart systems: A guide to cluster strategies in less favoured regions*. Carrboro, North Carolina: Regional Technology Strategies. Accessed as May 2, 2017 from http://www.rtsinc.org/publications/pdf/less_favoured.pdf.

Roth, K. O., & Hirschmann, T. (2013). Smart regions: Two cases of crowdsourcing for regional development. *International Journal of Entrepreneurship and Small Business, 20*(3), 272–285. https://steffenroth.files.wordpress.com/2013/09/ijesb200302-roth.pdf.

TA 2020. (2011). *Territorial Agenda of the European Union 2020. Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions*. Accessed as May 4, 2017 from http://www.nweurope.eu/media/1216/territorial_agenda_2020.pdf.

Wacquant, L. (2008). *Urban Outcasts: A comparative sociology of advanced Marginality*. Cambridge: Polity Press.

The Links Between Smart Specialisation Strategy, the Quintuple Helix Model and Living Labs

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Abstract This paper analyzes how the Living Labs can be designed as tools for a more effective implementation of the Smart Specialisation Strategy (S3) within the Quintuple Helix Model. Above all, the Quintuple Helix espouses the formation of a constructive situation encompassing ecology, knowledge and innovation, and creating extensive synergy between economy, society, and democracy. In this paper, we shall be focusing on the Quintuple Helix and Living Labs geared towards creating a shared arena in which services, processes and new ways of working via technology can be developed and tested with user representatives and researchers. Since the Living Lab is a rather new research area, the number of supporting theories for understanding the concept is limited. The same is true when it comes to methodologies, methods and tools. The aim of the paper is to clarify these perspectives and to illustrate how they can enhance each other.

Keywords Smart specialisation strategy · Living labs · Quintuple helix model

1 Introduction

The Smart Specialisation Strategy (S3) has become an umbrella notion for a diverse set of innovation strategies in the European Union. The S3 was conceived on the basis of two fundamental ideas:

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(a) minimizing the risk of investment dispersion in research and innovation (such as training and R&D expenditure), by selecting those technological domains in which investments can produce higher specialisation;
(b) domains are chosen to enhance the existing knowledge and innovation potential in the region (smart).

From a theoretical point of view, these ideas are based on two assumptions (Foray et al. 2009; McCann and Ortega-Argilés 2015):

(a) achieving a critical mass of resources to achieve R&D in terms of productivity;
(b) regional specialisation has a high degree of path dependence, and successful diversification can only be achieved in areas that are closely linked to existing knowledge bases.

The S3 indicates that the innovation process is increasingly understood as an open system where various actors collaborate and interact to promote an open and inclusive governance system supporting the participation of traditional and new innovators. The realization of new innovative processes and green technology moving in the direction of sustainable development become key factors for the achievement of long-term innovative strategies and will lead to interconnections between central and peripheral regions.

Although S3 pursues a place-based setting, the concept has been criticized for its uniform potential spatial impact. Many European regions exhibit a weak correlation between regional research and development capabilities and between training specialization and industrial structure; the original concept needs to be adapted to specific features of the area in question.

In this sense, the evolution of innovative models from the Triple Helix (TH) and Quadruple Helix (QH) to the Quintuple Helix (QuiH) is especially appealing to European regions lagging behind. With particular reference to innovative models aimed at urban and rural areas, the Quintuple Helix model tries to reinforce the interaction between public institutions, private organizations, research institutes, local agencies and the general public within a single environmental system.

Therefore, the Living Lab (for example, the open innovation ecosystem) may constitute an added value to interpreting, in a positive fashion, the peculiar configuration of territorial clusters and social and relational structures in a specific area. Following an approach of shared responsibility, it becomes an instrument for interpreting the released potential of local resources, infrastructure and organization, thus improving the adaptability of the players, the attitude to collective learning and making local innovation processes easier.

The last part of the discussion is related to Living Labs. Living Labs has become an umbrella concept for a varied array of innovative milieus emerging all over Europe. Even though they may differ in many ways, both in focus and approach, there are also several common denominators drawing them together (Shami 2008). A Living Lab is an open innovation environment in a real-life setting in which user-driven innovation is the co-creation process for new services, products and societal infrastructures. Living Labs encompass societal and technological dimensions simultaneously in a business-citizen-government-academia partnership.

In the following sections, we present the aims and weaknesses of S3 and the development of innovative models up to Quintuple helix. Subsequently, we introduce the Living Lab and its key components and principles; this is followed by a brief example from a lagging area where a public and private partnership fosters urban development, pursuing a particular concept of sustainable development. Then we reflect on the key principles and key components, as well as the relationship between them, before the paper ends with a few concluding remarks.

2 The Smart Specialisation Strategy: Aims and Weaknesses

The official document of the European Union Regional Policy contributing to Smart Growth in Europe (EC 2010) introduces the Smart Specialisation Strategy.

The S3 tries to individualize and enhance the competitive potential of various areas through the identification of the characteristic assets of each region [place-based strategy (Barca 2009)]. The principle adopted by the strategy takes the shape of a concentration of resources of knowledge, linking them to a limited number of priority and economic activities (principle of concentration); this is allied to shared participation in innovation management, with the involvement of local stakeholders and lifelong learning based on the ex-ante and ex-post evaluation processes of the strategy.

In other words, Smart Specialisation entails a strategic approach to economic development through the use of bottom-up policies that involve research and innovation (Provenzano et al. 2016). The concepts expressed in Strategy S3 are implemented through regional research and innovation policies. The RIS3 (Research and Innovation Strategies for Smart Specialisations) fosters entrepreneurial discovery and the formation of territorial partnerships between various public and private stakeholders, as well as the creation of the prerequisites for long-term sustainable economic development. The key actors for promoting knowledge and innovation are local policy makers, universities and private entrepreneurs (Capello 2014).

The implementation of the strategy has highlighted certain weaknesses in its wording. The concept of smart specialisation emphasizes issues of economic potential, in an a-spatial context, driven primarily by intra-sectoral, rather than inter-sectoral spillovers. These criteria are based on two assumptions:

1. a critical mass of resources is essential to get results from R&D investment and productivity
2. regional specialisation shows a high degree of path dependency, so that successful diversification can be achieved only in the areas related to the existing knowledge base (Iacobucci and Guzzini 2016).

Regions and cities, however, are different. According to the literature on regional innovation systems (McCann and Ortega-Argilés 2013; Tödtling and Trippl 2005), the OECD classifies three types of regions, namely: knowledge regions, industrial production zones and non-science and technology (S&T)-driven regions, which typically consist of the lagging regions. Various countries and regions tend to specialise in different knowledge-related sectors depending on their capabilities. The weaker regions, in particular, do not sometimes reach the critical masses for a specific specialisation, nor do they know the potential of their territory in advance.

The application of S3 actually favored regions that were already more competitive. Therefore, the original concept of S3 should be adapted to the specific features of a region, taking into account aspects of the region's economic geography. To surmount the non-space logic of S3, the concept of domain was introduced, substituting the sectoral approach to innovation and also helping entrepreneurs to find innovation opportunities within their domains (Foray et al. 2009, 2011; David et al. 2009). The domain concept should foster cross-sector access not only within the same region, but also among the various European regions.

The concept of connectedness of domains plays a key role. Domains highly connected with other domains will offer greater opportunities for sharing knowledge, which represents an important concept for several forms of networking and clustering capacity (McCann and Ortega-Argiles 2015). At this point, the evolution of regional models of innovation will be described.

3 Evolution of Innovation Models and the S3

Progress from a knowledge economy to a knowledge society has been the milestone of The European Commission, making explicit reference to the quadruple helix (QH) model of innovation (Carayannis and Campbell 2009). More specifically, the QH model is based on the openness of innovation processes to civil society for the application of the Smart Specialisation Strategy, surpassing the TH model developed by Etzkowitz and Leydesdorff (1997), which was based on the relationships between the public system, universities and business. Pursuing the QH model, the users' orientation is expected to develop and produce, as well as to access new products, processes and industrial services. At the same time we need an additional step in order to identify a new layer of regional innovation processes.

Moreover, the QuiH stresses the importance of the natural environment as an asset for the production of knowledge and innovation. The QuiH model comprises five helices: the education system, the economic system, the natural environment, the media- and culture-based public and the political system.

The natural environment is considered a central element for the production of knowledge and innovation, being a unique source for the very survival of mankind. The creation of new green technology and innovative processes geared towards

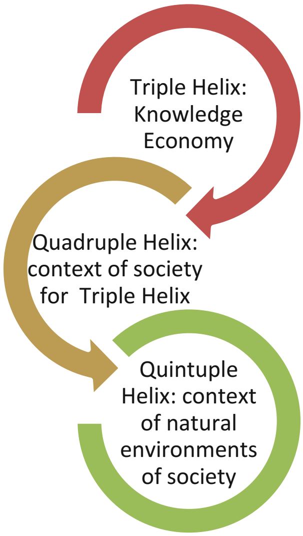

Fig. 1 The evolution of Helix innovation models

sustainable development become fundamental for fostering long-term innovative strategies. Protection of the environment and biodiversity propels knowledge and innovation in the direction of a sustainable and social economy where all the actors are involved and responsible for the formulation of strategies for local development.

The QuiH model is a framework for transdisciplinary analysis of sustainable development and social ecology as indicated in Fig. 1 that is capable of rendering less developed regions more competitive.

To sum up, the TH model deals with the hybridization of elements from university, industry and government to generate new institutional and social layouts for the production, transfer and application of knowledge. The QH model encourages the development of innovation that is appropriate for the user (civil society), with the general public here being the driving motor of innovation processes. The *QuiH model* embraces the natural environment in addition to the university, industry, government and civic society, outlining what sustainable development might mean and imply for 'eco-innovation' and 'eco-entrepreneurship' in the current situation and for our future" (Carayannis and Campbell 2010).

4 The Living Lab: A Useful Innovation Driver and the Quintuple Helix

Our thinking is that the living lab is an operational driver behind territorial innovation. Successful innovation development is dependent on understating both existing and emerging user needs. The Living Lab has emerged as a new way of creating skills and developing specific competences and competitive advantages, a network that integrates both user-centered research and open innovation. The emergence of open innovation has led to the creation of networks, where companies team up with diverse types of partners and users to generate new products, services and technology.

The clusters in which resources are mobilized are relevant to understanding the dynamics of development of a specific region. According to the European Network of Living Labs, we are dealing with "an open innovation environment in real-life settings in which user-driven innovation is the co-creation process for new services, products, and societal infrastructures. Living Labs encompass societal and technological dimensions simultaneously in a business-citizens government-academia partnership."

In the S3 guide, the Living Labs are a part of a larger innovative ecosystem that facilitates the use of research products. In this ecosystem, the original contribution of the Living Labs is in the application of knowledge about the real-life context of stakeholders external to the enterprise, in order to identify the strengths and weaknesses of the local system (Foray et al. 2012).

A Living Lab is also an emerging Public Private Partnership (PPP) concept, a network that integrates both user-centered research and open innovation. The emergence of open innovation has led to the creation of networks, where companies team up with diverse types of partners and users to generate new products, services and technology (Chesbrough and Appleyard 2007). Open cooperation is crucial because the Living Lab needs to bring together various organizations. The focus here is on creating innovative applications based on existing technology, as well as on the design of future technology. The ability to bring public interests into the environment is important in catering for a long-term operation of systemic innovation (Niitamo et al. 2006).

A Living Labs platform analyzed within the logical framework of the QuiH model is capable of conceptualizing the territorial dimension of regional research and innovation policy (Bevilacqua and Pizzimenti 2016).

The Living Lab is an innovation tool capable of tracking and intervening in response to environmental challenges, acting from within the QuiH model.

The practical application of the QuiH Model should lead to defining a territorial Living Lab capable of overcoming the problem of the a-spatial nature of S3. Territorial Living labs may represent a way of reinforcing the links between the various local actors (firms, policy makers, universities, civil society) and the environment, lowering the barriers enabling collaboration within innovation processes (Carayannis et al. 2012).

In regional Living Labs, all innovative dimensions aim to improve the living conditions of local communities. The local system is also considered to be an active subject of the lab and functions in cooperation with it (Rota 2014). The Living Lab develops and generates tacit and codified knowledge within a specific socio-economic context. Models of "smart interface" have been proposed (Bevilacqua and Pizzimenti 2016) for lagging areas, and the following regional example indicates how a local Living Lab brought together actors in a sustainable urban environment.

Over the last few years, we have observed a significant number of applications including best practices in lagging regions, such as the Smart Cities Living Lab project for the town of Siracusa (Sicily) for the fruition of public assets and general urban development. Siracusa was the winner of the Smart Cities Living Lab competition, created as a result of an agreement signed by the National Research Council (CNR) and the National Association of Italian Municipalities (ANCI). As part of this initiative, methodologies and innovative solutions were tested in order to develop a specific area, the urban environment of Ortigia (Siracusa), where an important and overlooked stock of public assets was located. This initiative constituted a significant advance in the transformation process of the image and urban environment of the island of Ortigia in favor of better logistic accessibility to its cultural heritage. In line with a public/private partnership (4Ps) of persons, a grant was provided by the IBM Citizenship Initiative to address top strategic challenges and to improve policy development and decision making in Ortigia. In this case, the 4Ps approach was implemented in the creation and management of the local Living Lab, supported by an international organization geared to specific interests (Boccella and Salerno 2015).

5 Conclusions

The paper highlights how the logical framework of the Quintuple Helix model and Living Labs can enhance each other in improving the Smart Specialisation Strategy for the reduction of economic and territorial disparity in the lagging regions. The paper, at this stage, does not indicate specific results but indicates how a successful environmental Living Lab can facilitate and offset top-down governance with bottom-up initiatives in a specific region. At this stage, we are probably outlining a way of operating rather than indicating a model of analysis; however, certain observations might prove useful in the wider debate about the difficulty of applying the Smart Specialisation Strategy in terms of its capacity to reduce economic and territorial disparity between and within European regions. The territorial embeddedness of various stakeholders and interest groups in policy-making processes may be a way of creating durability for the decisions made. A Living Lab, therefore, might represent an optimal balance between supply and demand for territorial goods and services and provide innovative solutions for a region's or city's cultural heritage and environmental sustainability. The territorial Living Lab, configured as an open innovation model, facilitates links between the domains of various European regions in the implementation of S3.

In addition, the implementation of the Quintuple Helix for the Local Living Lab might facilitate tackling broader issues raised by the scientific debate, opposing the effectiveness of a-spatial approaches versus place-based approaches to regional development. Therefore, the productivity gap should also be taken into account, not only between regions but also within the same region.

The availability of technology helps provide a new approach to the study of the interaction between people and the built environment in the context of Living Labs.

The Living-Lab scenario can be viewed as a series of unfolding actions, drawing on available material, as well as cognitive, affective and social resources. The overall challenge facing society today is to achieve and maintain a suitable quality of life, while reducing to a sustainable level the environmental burden to which our activities give rise.

The Living Labs and the Quintuple Helix possess the ability to bring users, technology and business into an open innovative development process that establishes real-life environments. (Baccarne et al. 2016) These concepts entail long-term cooperation, co-creative research and development, by involving the user in the innovation process for 'sensing, prototyping, validating and refining complex solutions in multiple and evolving real life contexts'. Long-term cooperation between researchers, companies and end-users overturn traditional methods, and the Quintuple Helix is able to valorize assets that are not fully guaranteed in a classic a-spatial economic paradigm.

References

Baccarne, B., Logghe, S., Schuurman, D., & De Marez, L. (2016). Governing Quintuple Helix Innovation: Urban Living Labs and Socio-Ecological Entrepreneurship. *Technology Innovation Management Review, 6*(3), 22–30.

Barca, F. (2009). An Agenda for a Reformed Cohesion Policy: A Place-Based Approach to Meeting European Union Challenges and Expectations. In *Independent report prepared at the request of the European Commissioner for Regional Policy*. Danuta Hübner. European Commission, Brussels.

Bergavall-Kareborn, B., Stahlbrost, A., Eriksson, C. I., & Svensson J. (2009). *A Milieu for Innovation—Defining Living Labs*. 2nd ISPIM Innovation Symposium, New York City, USA, 6–9 December.

Boccella, N., & Salerno, I. (2015). *Beni pubblici e sviluppo urbano. Il progetto "Smart Cities Living Lab", Labor Est. n. 10.* Available at http://pkp.unirc.it/ojs/index.php/LaborEst/article/view/187.

Capello, R. (2014). Smart specialisation strategy and the new EU Cohesion Policy reform: Introductory remarks. *Scienze Regionali, 13*(1), 5–14.

Carayannis, E. G., Barth, T. D., & Campbell, D. F. (2012). The Quintuple Helix innovation model: Global warming as a challenge and driver for innovation. *Journal of Innovation and Entrepreneurship, 1*(2), 2.

Carayannis, E. G., & Campbell, D. F. J. (2009). Mode 3 and Quadruple Helix: Toward a 21st century fractal innovation ecosystem. *International Journal of Technology Management, 46*(3/4), 201–234.

Carayannis, E. G., & Campbell, D. F. J. (2010). Triple Helix, Quadruple Helix and Quintuple Helix and how do knowledge, innovation and the environment relate to each other? A proposed framework for a trans-disciplinary analysis of sustainable development and social ecology. *International Journal of Social Ecology and Sustainable Development, 1*(1), 41–69.

Chesbrough, H. W., & Appleyard, M. M. (2007). Open innovation and strategy. *California Management Review, 50*(1), 57–76.

David, P., Foray, D., & Hall, B. H. (2009). *Measuring Smart Specialisation: The Concept and the Need for Indicators. Knowledge for Growth Expert Group*. Available at http://cemi.epfl.ch/files/content/sites/cemi/files/users/178044/public/Measuring%20smart%20specialisation.doc.

EC—Commission of the European Communities. (2010). *Regional Policy Contributing to Smart Growth in Europe*. Brussels: COM(2010)553.

Etzkowitz, H., & Leydesdorff, L. (Eds.). (1997). *Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations*. London: Cassell.

Foray, D., David, P. A., & Hall, B. (2009). *Smart Specialisation—The Concept.* Knowledge Economists Policy Brief n° 9. European Commission.

Foray, D., David, P. A., & Hall, B. (2011). *Smart specialization from academic idea to political instrument, the surprising career of a concept and the difficulties involved in its implementation*. MTEI Working Paper.

Foray, D., Goddard, J., Beldarrain, X. G., Landabaso, M., McCann, P., Morgan, K., et al. (2012). *Guide to research and innovation strategies for smart specialisation (RIS 3)*. Brussels: European Commission.

Iacobucci, D., & Guzzini, E. (2016). Relatedness and connectivity in technological domains: missing links in S3 design and implementation. *European Planning Studies, 24*(8), 1511–1526.

Bevilacqua C., & Pizzimenti, P. (2016). Living Lab and Cities as Smart Specialisation Strategies Engine. *Procedia-Social and Behavioral Sciences*, *223*, 915–922.

IBM's Smarter Cities Challenge. (2012). Siracusa Summary Report. Retrieved from https://www.smartercitieschallenge.org/cities?page=8#cities.

McCann, P., & Ortega-Argilés, R. (2013) *Modern Regional Innovation Policy*. Cambridge: Cambridge Journal of Regions, Economy and Society.

McCann, P., & Ortega-Argilés, R. (2015). Smart Specialization, Regional Growth and Applications to European Union Cohesion Policy. *Regional Studies, 49*(8), 1291–1302.

Niitamo, V.-P., Kulkki, S., Eriksson, M., & Hribernik, K. A. (2006). State-of-the-art and good practice in the field of living labs. In *The 12th International Conference on Concurrent Enterprising: Innovative Products and Services through Collaborative Networks*, ICE 2006, Milan, Italy, June 26–28, pp. 349–357.

Provenzano V., Arnone M., & Seminara M. R. (2016). Innovation in the rural areas and the linkage with the Quintuple Helix Model. *Proceedings—Procedia-Social and Behavioral Sciences, 223*, 442–447.

Rota, F. S. (2014). Opportunità e limiti delle strategie di social innovation. Il caso dei living labs, in (a cura di) Mazzola F., Musolino D., Provenzano V. *Reti, nuovi settori e sostenibilità. Prospettive per l'analisi e le politiche regionali*. Franco Angeli, Milano.

Santoro, R., & Conte, M. (2009). *Living Labs in Open Innovation Functional Regions*. White paper. Retrieved from March 10, 2010. http://www.ami-communities.eu/wiki/AMI%40Work_on-line_Communities.

Shami, T. A. (2008). Living Labs: Good Practices in Europe. In Schumacher J. & Niitamo V. P. (Eds.), *European Living Labs: A New Approach for Human Centric Regional Innovation* (pp. 15–30). Wissenschaftlicher Verlag: Berlin.

Tödtling, F., & Trippl, M. (2005). One size fits all? Towards a differentiated regional innovation policy approach. *Research Policy, 34*(8), 1203–1219.

Territorial Cohesion: Evaluating the Urban-Rural Linkage Through the Lens of Public Investments

Francesco Calabrò and Giuseppina Cassalia

Abstract The paper deals with the significant issue of urban-rural linkage, concentrating on the less-developed regions of Europe, and in particular the case study of the Calabria Region (southern Italy). Despite the evolution of the urban-rural exchange, inner areas are facing economic, social and environmental problems, resulting in unemployment, depopulation, marginalization, disengagement or degradation of historic and architectural capital. Institutional bodies and policy makers, in particular at the local level, deal with the complexity of the choices that need to be faced, requiring the capacity to implement complex decision-making processes and tools capable of integrating the use of territorial resources, culture accessibility and social integration. Investigating the issues emerging from the academic literature and policy documents of the past 20 years, the paper presents the preliminary research step on the interpretation of the urban-rural dynamics through the lens of the 2007–2013 public investments made in this region. The preliminary results in terms of expenditure efficiency, private co-investments and geographical distribution highlight the need for an economic evaluation approach to support local authorities in addressing the challenge of the EU Territorial Agenda 2020.

Keywords Territorial cohesion · European funding · Public investment
Inner areas · Urban-rural linkage

The paper is the result of the joint work of the two authors. Scientific responsibility is attributable equally to Calabrò and Cassalia.

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1 Introduction

The economic and territorial development of urban and rural areas have been traditionally considered separately, both in the academic and policy field. Differences in economic, cultural and spatial sectors can give rise to divergent interests and are not conducive to a culture of cooperation and greater integration. This dichotomy in research and policies can hinder taking an integrated approach to regional economic development, resulting in a lack of awareness of the urban-rural relationships and non-cooperation between urban and rural stakeholders (Evans 1990). The nature of these interactions and the deepening of relationships may be seen increasingly as a partnership, where a variety of governance systems have evolved to manage the linkage. Little progress has been made in progressing from abstract reflection to the know-how that should orient the action of policy makers, both at the European and local levels. From a territorial point of view, the growth opportunities in the rural areas of Europe are also linked to the ability to find adequate compromises for both in order to facilitate strategic relationships between the urban and rural areas (Zonneveld and Stead 2007).

Focusing on the less developed regions of Europe, and, in particular, the inner areas,[1] territories have been the target in recent years of substantial public investments, but, in some regions, interventions have not yet produced significant social-economic effects (Gagliardi and Percoco 2017). The complexity of the choices that governmental bodies at the national and local levels are facing requires an ability to implement complex decision-making processes. Despite the evolution of the urban-rural relationship over the past three European programming cycles, inner areas—in Italy, for instance—are still facing economic, social and environmental problems, resulting in unemployment, depopulation, marginalization, disengagement, or degradation of historic and architectural capital (MUVAL 2014). This paper presents a preliminary step of a study that seeks to address the issue of the multi-level authorities' role and responsibilities in strengthening the urban-rural cooperation in the context of Europe's territorial cohesion policy. The culture of evaluation—in this sense—is an essential step towards achieving the overriding key objectives of efficiency, transparency and accountability, with the aim of determining both the costs and the benefits of publicly financed projects and to improve the efficiency and effectiveness of that investment (Nesticò and De Mare 2014).

Evaluations, therefore, support the public decision makers facing the need to choose between alternative programs and projects, under the general—and current —conditions of scarce resources (Della Spina et al. 2016; Tajani and Morano 2014). Funding pressures reinforce the need for a better understanding of how local governments can invest in urban-rural cooperation that manages territorial disparities and what the communities get in return. Such cooperation should, according to the European Smart Specialisation Strategy, deal with the local enterprises' linkage

[1]According to MUVAL (2014), Inner Areas are areas at some considerable distance from hubs providing essential services, such as education, health and mobility.

to research and development networks for balancing the rough edges in competitiveness (Bisello et al. 2017; Madureira et al. 2015; McCann and Ortega-Argilés 2014). In order to deal with this relevant issue, the paper's second section investigates the concepts and principles of the urban-rural linkage, according to the academic literature and European policy documents, leading to productive reflection on the challenges of territorial cohesion. In the third section, the contribution evaluates the urban-rural balance/imbalance through the allocation of European structural funds (2007–2013) in the southern Italian case study. In conclusion, this preliminary study's results offer a contribution to the efficiency assessment with reference to expenditure efficiency, private stakeholders' involvement and geographical distribution of public investments. It highlight the need for an economic evaluation approach to support local authorities in addressing the challenge of the EU Territorial Agenda 2020.

2 From Urban-Rural Competition to Territorial Cohesion Strategies

Over the past 20 years, various strategic EU documents have highlighted the rural-urban dimension. Unlike documents previously produced since 1995, the European Union is moving towards an explicit statement on territorial development issues. It is recognized that the role of the territory—particularly in urban-rural relationships—is crucial in pursuing the Union's objectives of competitiveness, cohesion, environmental balance, well-being and democracy (Camagni 2008).

This leads to a new concept of a territorial-cohesion dimension, in which the EU's cohesion policy places strong emphasis on the current legislative framework. There is growing understanding of the importance of balanced, sustainable and integrated territorial development, taking into account functional links in and between territories, especially rural and urban areas (Nilsson et al. 2014).

The definition of urban and rural areas is extremely challenging, especially looking at the linkages between and among them. The OECD rural-urban classification delivers a useful point of reference, marking a distinction among Predominantly Urban (PU), Intermediate (IN) and Predominantly Rural (PR) areas (OECD 1994). In Italy, the SNAI classification based on the municipalities' distance from the centers of essential services (health, education and mobility) sorts the Italian municipalities in six categories: Hub, Inter-municipal, Outlying, Intermediate, Peripheral and Ultra-peripheral.[2] Regarding the concept of "linkage", there seems to be a general lack of clarity about the nature of rural-urban interactions and relationships, commensurate with the territorial scale through which the issue is considered (Bengs and Schmidt-Thomé 2006). While the physical and

[2]SNAI stands for *Strategia per le Aree Interne/Inner Areas Strategy—Cohesion Policy 2014–2020.*

functional boundaries of urban and rural areas are becoming ever fuzzier, the inter-dependencies are becoming more complex and dynamic. According to Torre and Traversac (2011), a process of creation and emergence of new rural territories is taking place, differing from traditional agro-food territories, and counting on local identities and collective social values. A critical study on the relationship between rural-urban linkages and territorial cohesion was carried out by Smith and Courtney (2009), drawing an interesting framework about the connections among governance, rural-urban linkages and social/territorial cohesion. Likewise, a comprehensive study carried out by OECD (2013) provides an analysis of urban-rural partnerships and highlights how these can favor sustainable processes of socio-economic development, proposing a conceptual framework for the understanding of the nature and implications of growing urban-rural relationships and focusing on the demographic and economic dynamics.

Documenting the onset of a European policies' perspective, the Lisbon Treaty (2009) identified territorial cohesion as an objective of the European Union, as well as economic and social cohesion, recognizing the highly diversified nature of the various regions that compose it. In addition, the treaty also has strengthened the role of regional and local actors in European territorial policy, granting them the status of real partners. These concepts and principles can further be found in the guidelines of the European Commission on regional policy for 2014–2020, which has led to the adoption of "EU Territorial Agenda 2020: Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions" (2011).[3] The Territorial Agenda 2020, building on the ESDP, identifies cohesion policy as a 'key framework' through which the EU can address territorial development challenges and help unleash territorial potential at local, regional, national and transnational levels. The Territorial Agenda 2020 also recommends that cities should 'look beyond their administrative borders and focus on functional regions, including their peri-urban neighborhoods. At the national level, the recent Italian "National Strategy for Inner Areas" has the overall objective of promoting local development by activating underutilized territorial capital through carefully selected development projects (Urso 2016).

The issues to be addressed at the local level deal with the fragile socio-demographic dimension, the neglect of historic towns, and natural and human-induced risks as a consequence of insufficient maintenance, just to cite few matters already detected in 1995 by Edoardo Mollica, treating the problem of neglected inner areas in southern Italy (Mollica 1996). The challenge of smart and sustainable territorial development is today more linked than ever with the sub-national governments' capacity in manage rural-urban interactions effectively (Evans et al. 2005). The following section seeks to address this issue, analyzing the allocation of the 2007–2013 European structural funds in a case-study area.

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[3]Territorial Agenda of EU 2020: Towards an Inclusive, Smart and Sustainable Europe of Diverse Regions, EU 2011 Hu.

3 Evaluating the Urban-Rural Linkage Through the Allocation of European Structural Funds

The lack of transparency on how public money is spent is one of the main reasons for the slow progress in implementing development policies and in understanding whether investment projects actually respond to local demands (Druel et al. 2016; MUVAL 2012). This is a particularly hot topic in Italy at present given the low absorption rate of EU Structural Funds,[4] and the debate all over Europe continues on the extent to which, after decades of subsidies, the European Regional Policy is effective.

Far from finding an answer to the question, the paper aims to contribute to the debate on the urban-rural relationship, through the analysis of the allocation of the 2007–2013 European structural funds in the case-study area of the City of Reggio Calabria, Italy (urban area) and its deep connection with the so-called Area Grecanica (rural area). With reference to the regional public expenditure for urban and rural areas, this contribution proposes an analytical and interpretive approach that could be easily exported to other public planning processes, in order to support local policy makers in defining systemic territorial strategies. In addition, the study aims to:

- Assess the urban-rural case study area, in order to determine if the allocation of European funding influences the mitigation of territorial disparities at the local scale.
- Evaluate the efficiency of case-study investments, identifying roles and responsibilities of the multi-level authorities.
- Identify the potential approach and strategic tools able to address the 2014–2020 local-scale, territorial-cohesion programming.

The study starts from the assumption that the ERDF needs to produce territorial co-operation, through supporting links between urban and rural areas, and produce sustainable urban development through the strengthening of urban-rural links and tackling common urban-rural issues (CEC 2006: Article 6). In this regional-programming framework, the analytical assessment of the implementation of the investment policy with regard to the territorial dimension of the ERDF funds is certainly of paramount importance for the 2014–2020 public investment. The 2014–2020 ESIF are designed to support the development of participative, integrated and sustainable strategies to tackle the high concentration of economic, environmental and social problems affecting urban and rural areas. These strategies

[4]European structural and investment funds (hereafter 'structural funds' or ESIF) support economic development across EU member states and their constituent regions, with the aim of reducing economic and social inequalities between the EU's regions and nations. ESIF are divided into: European Regional Development Fund (ERDF), European Social Fund (ESF), Cohesion Fund (CF), the European Agricultural Fund for Rural Development and the European Maritime and Fisheries Fund.

are supposed to promote sustainable integrated development through activities such as: strengthening economic growth, the rehabilitation of the physical environment, brownfield redevelopment, the preservation and development of natural and cultural heritage, the promotion of entrepreneurship, local employment and community development and the provision of services to the population, taking into account changing demographic structures.

The paper examines the results of the 2007–2013 ESIF, with reference to public expenditures for urban and rural areas, proposing an analytical and interpretive approach that could support local authorities in the 2014–2020 decision-making processes. Local capacity building and incentives for effectiveness of sub-national levels of government are crucial issues for improving the quality and coherence of public policy (OECD 2015). In addition, the "horizontal" dimension involving a wider range of stakeholders are strongly boosted by ERDF to improve the effectiveness of local public-service delivery and implementation of development strategies. In this context, the culture of evaluation has the role of supporting the public decision maker facing the need to choose between alternative programs and projects, in the general—and current—condition of scarce resources (Saaty 2008; Della Spina 2017).

This paper presents the first step of the evaluation research, which will lead to the territorial impact appraisal with the purpose of verifying the contribution of 2007–2014 ESIF to the regional development of the case-study area. The assessment carried out not only deepens the scope of the evaluation culture as an element of the Cohesion Regional Policy, providing quality elements for reflection on results, but also enables highlighting the integration with mainstream debate on smart specialization strategies, the results of capitalization processes, and valorization of territorial vocations. Specifically, a framework has been developed through which the 2007–2014 European public investments can be measured and linked to the various urban and rural spheres (viewed in the light of the objectives of unitary programming), both in terms of thematic relevance and process building. The preliminary case-study research has been developed through the following steps: (1) Case-study area identification and context definition; (2) Classification of municipalities in the area; (3) Challenges and opportunities of the area; (4) Framework of European funding in the region; and (5) Expenditure analysis per categories.

Data for the study have been gathered via the "OpenCoesione" database, the Italy's national web portal on the implementation of investments planned in the 2007–2013 programming cycle by Regions and National Administrations via cohesion policy resources.[5] The data analyzed refer to the ESIF and include both the European Regional Development Fund (ERDF) and the European Social Fund (ESF). The Operative Programmes included in the dataset analysis are: ONP—Operative National Programme; OIP—Operative Interregional Programme; NIP—National Implementary Programme; NAPC—National Action Plan for

[5]www.opencoesione.gov.it [02/05/2017].

Cohesion; ORP—Regional Operative Programme; CR-APC—Calabria Region Action Plan for Cohesion; and RIP—Regional Implementary Programme.

3.1 The Context of the Case-Study Area

According to the theoretical background previously cited, the paper confronts the urban-rural issue analyzed in an emblematic case study: the case of the Metropolitan City of Reggio Calabria and its deep connection with the so-called Area Grecanica, the latter selected as the pilot project for the implementation of the Inner Areas Strategy in the Calabria Region.[6] The case-study area is part of the Metropolitan City of Reggio Calabria, formally formed on 29 December of 2016, made up of 97 municipalities, with an area of 3210.37 km^2 and 550,967 inhabitants (ISTAT 2011), 34% of the total regional population. The Municipality of Reggio Calabria is one of the oldest cities in Europe: The old *Rhegion* was, after Cuma, the oldest Greek colony founded in southern Italy (Zappalà 2011). It is the first municipality of the region in terms of population and the second one in area. The so-called Area Grecanica extends over about 880 km^2, extending from the lower Ionian Sea to the Aspromonte. In regard to the administrative borders of the Area Grecanica, the research considers the boundaries drawn by the *Strategia per le Aree Interne—Politica di Coesione 2014–2020* (2015), which identifies the following 15 municipalities: Bagaladi, Bova, Bruzzano Zeffirio, Cardeto, Ferruzzano, Montebello Ionico, Palizzi, Roccaforte del Greco, Roghudi, San Lorenzo, Staiti, Melito Porto Salvo, Condofuri, Bova Marina and Brancaleone. Nevertheless, in order to investigate the relationship between the urban-rural areas, and according to historic boundaries of the Area Grecanica, the study includes the municipality of Motta San Giovanni within the boundaries of the Area Grecanica. For centuries, this area has assumed the role of a true cultural island (Isola Ellenofona) for a number of reasons, including the historical instability of the connections and a particularly impervious hinterland. Bova, Condofuri, Gallicianò, Roccaforte del Greco and Roghudi are the municipalities with the most evident traces of Greek culture (Mollica 1996).

3.1.1 Classification of Municipalities According to the Degree of Remoteness

A large part of the Calabrian region (about 80% of the total of the municipalities and of the region) consists of inner areas, according to the SNAI classification based on the distance from the centers of essential services (health, education and

[6]Regione Calabria (2015), La strategia per le aree interne, Politica di Coesione 2014–2020.

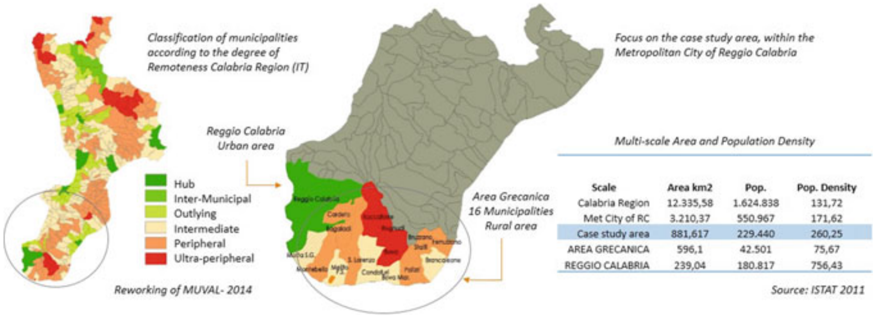

Fig. 1 Focus on the case-study area

mobility).[7] These areas, accounting for about 53% of the regional population, are central to the supply of eco-systemic goods and services (water, air, natural environments) to the capital, in terms of landscape and complex ecological systems, for the local agro-food chain and for the production of energy from renewable sources. Inner Areas are fundamental to the protection of cultural identity and the physical integrity of the territory. They also have an important historical, architectural, cultural and identity heritage and are, by their very nature, history and structure, produce social cohesion and a sense of community.

A substantial part of these territories has undergone, over the decades, a gradual process of marginalization characterized by: loss of population, reduction of the provision of collective services, declines in employment and land use, hydrogeological disruption, degradation and abandonment of the historic villages. According to Barca (MUVAL 2014), Fig. 1 identifies the 17 municipalities that are the object of study, within the limits of the specified degree of remoteness. For research purposes, the City of Reggio Calabria, classified as a "hub", will be also classified as the "urban area", while the 16 municipalities falling within the Area Grecanica, mostly classified as peripheral, will be classified as a "rural area". It is noteworthy that, in terms of urban-rural comparisons, the Area Grecanica population density as a whole—all 16 municipalities—is one-tenth of the unified Reggio Calabria municipality.

3.1.2 Challenges and Opportunities in the Area

An important issue with regards to urban-rural linkages is the significant disparities in the socio-economic characteristics of urban and rural communities, which undermine the general well-being of the society as a whole, such as differential access to core services and employment opportunities (OECD 2013). This occurs in

[7]SNAI stands for *Strategia per le Aree Interne/Inner Areas Strategy—Cohesion Policy 2014–2020.*

the Area Grecanica, as well, where in particular the problem of transport and accessibility emerges: there is a mean time of travel of about 50 min from the nearest municipality to the "hub" of Reggio Calabria. Parallel roads penetrate the 'sea mounts' and intersect the coastal route (comprising the railway system) connecting Reggio Calabria with other Ionian cities. Among the areas' key liabilities, one can stress the depopulation of the inner towns, the absence of innovation technology—in particular in the agricultural sector—and the lack of economic activity. Nevertheless, the Area Grecanica retains a strong "Greek" identity, and it benefits from the presence of several towns of historical, natural and cultural value and an environmental and climatic uniqueness that creates optimal conditions for the production of bergamot (Cassalia 2014).

3.2 Evaluating Public Investments in the Case-Study Area

3.2.1 Framework of European Funding in the Case-Study Area

The Calabria Regional Operational Programme for 2007–2013 comes under the Convergence Objective, and around 58% of the program funds have been earmarked for investments directly linked to sustainable growth and jobs in line with the Lisbon and Gothenburg agendas. The general objective of the programme is to foster sustainable economic development with the goal of converging with the average development levels of the EU. This should be achieved by mobilizing the potential of the region by means of boosting its competitiveness, making the territory more attractive, and diversifying and modernizing the productive structure. Accordingly, eleven main priorities have been identified by the 2007–2013 Calabrian ROP[8]:

- Development of the digital agenda
- Environment and risk prevention
- Protection and enhancement of environmental, cultural heritage and tourism
- Energy efficiency
- Social inclusion
- Education and training
- Promoting sustainable and quality employment
- Administrative (PA) capacity
- Promoting research innovation
- Urban and rural development
- Health
- Developing the sustainable mobility network

[8]Regione Calabria (2015) Programma Operativo Regionale 2014–2020. In particular, the "Urban and rural development" priority aims at promoting competitiveness, innovation, attractiveness and quality of life in both cities and rural areas.

Calculating details of the allocation of public funding in the case-study area, the OpenCoesione dataset (last monitored 2 May 2017) reported that, during the 2007–2013 EU Programme Cycle, of the €10 billion invested by public funding in the development of the Calabria region, 68% of the funds were effectively spent by the beneficiary. The term "public investments" in the context of this research means the contribution of European, national and regional funding. The Metropolitan City of Reggio Calabria, a quarter of the region in terms of area and a third in terms of population, has benefited by only 17% of the resources (€1,700,000,000), of which almost half (€813,446,000) had been invested in the case-study area. In addition, it should be emphasized that, in the *urban area* (the municipality of Reggio Calabria), one-third of the case-study area, benefited from 87% of the public investments (€709,741,500), while the *rural area* (Area Grecanica) benefited by €103,705,000 in terms of public investments.

3.2.2 Spending Analysis Per Categories

In great detail, Table 1 and Fig. 2 show the investments made in the 2007–13 programming cycle in the case-study area per "categories" (broadly corresponding to the operative program's priorities listed in Sect. 3.2.1). Looking at the case study as a whole, 23% of the public funding was invested in "environment and risk prevention", followed in decreasing percentage by "development of the digital agenda" and "the sustainable mobility network" (13%). The categories "social inclusion" and "health" received 1% of the total budget. As concerns the private stakeholders' involvement, most of the private co-investments have been placed in research and innovation (€11,798,245) and culture and tourism (€8,586,772).

In particular, the analysis refers to the following three points:

- The available funding for the urban and rural areas
  Two main points deserve to be stressed, according to the overview on rural-urban dimension. It is quite curious that no public funding was expended in the Area Grecanica (rural area) for public services and mobility, which is, according to Sect. 3.1.2, the major weakness of the area. Secondly, the Area Grecanica was more successful in spending the budget (67.4% compared to the 57.7% of the urban area), in particular in the fields of "environment and risks" and "energy". As result, it can be noted that expenditures are made in a highly efficient manner if the resident population and its density are low, and belong to a disadvantaged area. The exception is made in the fields of "culture and tourism" and "investment for growth and jobs". Apart from that, the category "urban and rural development" seems like an overlooked opportunity, because the urban and rural area together did not exceed 40% of investment made.
- Public investments per capita
  This graph in Fig. 2 highlights the differences in public funding received by urban and rural areas when population distribution is taken into account, that is, when funding is measured on a per-capita basis. Even if the global balance

Table 1 Public and private investments in the case-study area

2007–2013 investments in the case-study area						
Categories	Urban area		Rural area		Case study area	
	Public investm. (€)	Private investm. (€)	Public investm. (€)	Private investm. (€)	Public investm. (€)	Private investm. (€)
Digital agenda	106,140,232.50	935,280.39	506,514.76	–	106,646,747.26	935,280.39
Environment and risk	136,610,402.52	1,337,336.34	51,034,122.61	–	187,644,525.13	1,337,336.34
Culture and tourism	58,608,449.32	6,083,489.33	21,598,166.61	2,503,283.02	80,206,615.93	8,586,772.35
Energy	19,908,596.82	414,93226	2,865,266.24	18,484.55	22,773,863.06	433,416.81
Social Inclusion	8,063,569.10	12,500.00	2,854,129.12	–	10,917,698.26	12,500.00
Education	88,229,790.39	279,605.70	14,204,623.71	971.56	102,434,414.10	280,577.26
Investm. for growth and jobs	45,065,983.89	2,816,848.85	1,976,073.59	30,334.19	47,042,057.48	2,847,183.04
PA capacity	9,098,966.86	–	19,793.00		9,118,759.86	–
Research and innovation	56,800,619.07	11,685,134.82	1,149,034.66	113,110.42	57,949,653.73	11,798,245.24
Urban and rural development	65,727,436.44	–	5,258,211.74	–	70,985,648.18	–
Health	8,962,066.83		2,238,629.62	–	11,200,696.45	
Public services and mobility	106,525,349.12	–	–	–	106,525,349.12	–
TOTAL	709,741,462.90	23,565,127.69	103,704,565.66	2,666,183.74	813,446,028.56	26,231,311.43

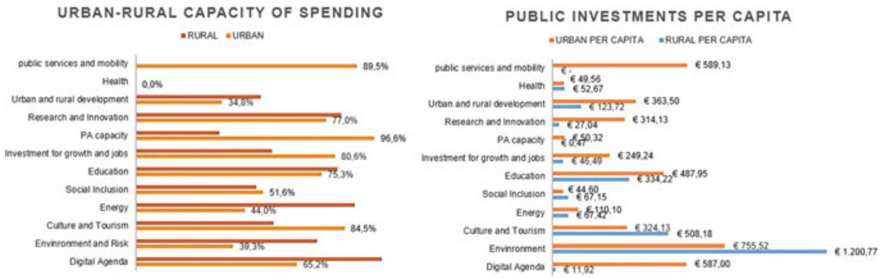

Fig. 2 Public investments per capita and capacity of spending in the case-study area

weighs on the side of urban areas (€3925 per capita versus €2440 per rural inhabitants), measuring funding allocations on a per-capita basis emphasizes that the inhabitants of Area Grecanica benefitted the most by public financing in environmental risk prevention, culture and tourism and social inclusion. The citizens of the City of Reggio Calabria, on the contrary, benefitted the most in categories such as public services and mobility, research and innovation, and investment for growth and jobs.

- Private investments in the case-study area
  In general terms, the contribution of private investments to the European program in fostering the sustainable economic development of the case-study area is very low (3% out of the total public budget invested). Table 1 tabulates the total private investment in the city of Reggio Calabria €23,565,127 versus €2,666,183 in the rural area. In terms of percentage of the public investment per area, the private contribution appears well-proportioned.

4 Pursuing Local-Scale Territorial Cohesion: Concluding Remarks

The analysis of the distribution of 2007–2013 EU structural and investment funds in the case-study area identifies the first step of the research into the urban-rural dynamics related to the territorial networking needs. In this regional programming framework, the analytical assessment of the implementation of the investment policy with regard to the territorial dimension of the ERDF funds is certainly of paramount importance for the 2014–2020 public investment. Granted that the paper reports only on the preliminary stage of a research project aiming at evaluating the territorial impacts of the public investments in the case-study area, the contribution provides evidence supporting the following results:

- Mitigation of territorial disparities—*far from a "smart-region" vision*
  The allocation of European funding doesn't seem to influence the mitigation of territorial disparities at the local scale, according to the two main territorial

needs: "public services and mobility" and "investments for growth and jobs". Indeed, the rural area didn't benefit from public investments referred to the first category, and the efficiency of the public expenditure in the second category reached 50% of the budget planned. Moreover, the category "research and innovation", a strategic asset in terms of boosting territorial competitiveness, making the area more attractive and diversifying the productive structure, comprised 7% (€57,949,653) of the entire public budget and 2% (€1,149,034) of what had been allocated for the rural area. Recent studies point out that infrastructure investment alone has little impact on local growth unless it is associated with human capital and innovation (OECD 2009). In these terms, marked inequalities in the flows of public investment across the case-study municipalities arise, highlighting how far the road to a "smart region" is still to be traversed.

- Multi-level authorities—*necessity of cross-sector and multi-level coordination*
  In order for EC policy to have the intended effects, it is necessary that programmed expenditure is fully absorbed and programs are implemented efficiently. Achievement of regional potential requires close collaboration among actors and capacity building at all levels. European and national government could better contribute towards the transparency, public understanding and democratic accountability of EU public finances, in order to support better and wider private co-financing and involvement in the regional economic development process (Druel et al. 2016). The case-study analysis shows a low level of 3% of private investments out of the total public budget invested in the area. Furthermore, even if difficult in practice, cross-sector and multi-level co-ordination are necessary. Risks of capture and corruption are particularly high in such a context, for instance in local governments with insufficient capacity to monitor investment. It's worth noting that the Calabria Region has been included in the "less developed regions—Objective 1" European Programming Cycle 2000–2006, and it still included under the "Convergence Objective" 2014–20 European Programming cycle. Effective leadership, especially at the sub-national level, is crucial for regional development. Regional and local authorities are important active stakeholders in the process. The effectiveness of policies depends on the active support of regional and local authorities, which are responsible for local development planning. In that sense, horizontal coordination across local governments is essential to increase transparency and efficiency through economies of scale, to encourage investment, and to enhance synergies among policies of urban-rural cooperation.
- Territorial cohesion implementation—*the role of decision support tools*
  Current governance arrangements are not always optimal to fully exploit synergies through urban-rural linkages. One of the most important obstacles constitutes a general lack of a supportive basis for planning and decisions, as well as the significant deficiency of socioeconomic profile data, including baseline figures, dynamics and trends. The Italian "OpenCoesione", web portal on the implementation of 2007–2013 investments programmed by regions and national

administrations via cohesion policy resources, is moving forward in this direction. Nevertheless, the lack of data and data analysis, at local scale, represents an obstacle in managing rural-urban interactions effectively. A system of performance indicators to promote mutual learning by sharing diagnosis and targets could provide incentives for effectiveness. In this context, an economic evaluation approach would supports local authorities in identifying and assessing the actual or potential economic impact of the public investments on the territory, highlighting the importance of the geographic distribution of consequences and effects and considering the urban-rural interdependency (Fusco Girard and Nijkamp 2009; Caffyn and Dahlström 2005). The Territorial System identifiable in the case-study area is an intervention area suitable for the field testing of new approaches to planning and governance aimed at the achievement of the European Territorial Agenda objectives, even through the implementation of multi-fund instruments. In this sense, the new Cohesion Policy Regulation 2014–2020 presents specific tools in the attempt to overcome the problem: Integrated Territorial Investment (ITI) and Community-Led Local Development (CLLD). They represent step changes in the ability of local stakeholders to combine funding streams and plan well-targeted local initiatives. In conclusion, further studies are needed to implement an economic evaluation model suitable for the presented case study, able to produce significant results on the public investment impacts on local economies and communities, to support local authorities in turning territorial potential into drivers of economic, environmental and social development.

References

Bengs, C., & Schmidt-Thomé, K. (2006). Urban-rural relations in Europe (ESPON 1.1.2).

Bisello, A., Grilli, G., Balest, J., Stellin, G., & Ciolli, M. (2017). Of smart and sustainable energy district projects: An overview on economic assessment methodologies. *Green energy and technology*, 127–164.

Caffyn, A., & Dahlström, M. (2005). Urban–rural interdependencies: Joining up policy in practice. *Regional Studies, 39*(3), 283–296.

Camagni, R. (2008). Regional competitiveness: Towards a concept of territorial capital. In Camagni Roberto et al. (Eds.), *Modelling regional scenarios for the Enlarged Europe* (pp. 33–48). Berlin: Springer.

Cassalia, G. (2014). Assessing heritage significance: Decision support tools for managing landscape's cultural value in Southern Italy. *Advanced Engineering Forum, 11,* 647–652.

CEC. (2006). Regulation (EC) no 1080/2006 of the European parliament and of the council of 5 July 2006 on the European regional development fund and repealing regulation (EC) no 1783/1999. Official journal of the European Union.

Della Spina, L. (2017). Integrated evaluation and multi-methodological approaches for the enhancement of the cultural landscape. In O. Gervasi et al. (Eds.), *Computational science and its applications. ICCSA 2017. Lecture notes in computer science* (Vol. 10404, pp. 478–493). Cham: Springer.

Della Spina, L., Ventura, C., & Viglianisi, A. (2016). A multicriteria assessment model for selecting strategic projects in urban Areas, ICCSA 2016. *LNCS, 9788,* 414–427.
Druel, E., Chrzanowski, P., Pollock, R., & Gray, J. (2016). *Where does Europe's money go? A guide to Eu budget data sources*. Research Report.
Evans, H. E. (1990). Rural-urban linkages and structural transformation. *Discussion Paper*, 71. Washington, DC: Infrastructure and Urban Development Department, World Bank.
Evans, B., Joas, M., Sundback, S., & Theobald, K. (2005). *Governing sustainable cities*. London/Sterling: Earthscan.
Fusco Girard, L., & Nijkamp, P. (2009). *Cultural tourism and sustainable local development*. London: Ashgate.
Gagliardi, L., & Percoco, M. (2017). The impact of European cohesion policy in urban and rural regions. *Regional Studies, 51*(6), 857–868.
Madureira, L., Gamito, T., & Ferreira, D. (2015). Il networking come strumento multi scopo per le organizzazioni innovative nelle aree rurali. *LaborEst, 11,* 38–42.
McCann, P., & Ortega-Argilés, R. (2014). Smart specialisation in European regions: Issues of strategy, institutions and implementation. *European Journal of Innovation Management, 17*(4), 409–427.
Mollica, E. (1996). *Le aree interne della Calabria: una strategia e un piano quadro per la valorizzazione delle loro risorse endogene*. Soveria Mannelli: Rubbettino.
MUVAL. (2012). *La trasparenza sui beneficiari dei Fondi Strutturali in Italia e in Europa* (Issue 27).
MUVAL. (2014). *A strategy for inner areas in Italy: Definition, objectives, tools and governance* (Issue 31).
Nesticò, A., & De Mare, G. (2014). Government tools for urban regeneration: The cities plan in Italy. A critical analysis of the results and the proposed alternative. In *Computational science and applications—ICCSA 2014* (pp. 547–562). Springer.
Nilsson, K., Nielsen, T. S., Aalbers, C., Bell, S., Boitier, B., & Chery, J. P. (2014). Strategies for sustainable urban development and urban-rural linkages, research briefings, *European Journal of Spatial Development*.
OECD. (1994). *Creating rural indicators for shaping territorial policies*. Paris: OECD Publications.
OECD. (2009). *How regions grow*. Paris: OECD.
OECD. (2013). *Rural-urban partnership: An integrated approach to economic development*. Paris: OECD.
OECD. (2015). Reaching people with development financing: The role of cities and regions. In *Brief for the Third International Conference on Sustainable Development*. Paris: OECD.
Saaty, T. L. (2008). Decision making with the analytic hierarchy process. *Internal Journal of Services Sciences, 1,* 83–98.
Smith, I., & Courtney, P. (2009). Preparatory study for a seminar on rural-urban linkages fostering social cohesion. *Discussion Paper*. DG Regional Policy.
Tajani, F., & Morano, P. (2014). Concession and lease or sale? A model for the enhancement of public properties in disuse or underutilized. *WSEAS Transactions on Business and Economics, 11,* 787–800.
Torre, A., & Traversac, J. B. (2011). *Territorial governance. Local development, rural areas and agrofood systems*. Heidelberg and New York: Springer Verlag.
Urso, G. (2016). Polycentric development policies: A reflection on the Italian "national strategy for inner areas". *Procedia—Social and Behavioral Sciences, 223,* 456–461.
Zonneveld, W., & Stead, D. (2007). European territorial cooperation and the concept of urban—rural relationships. *Planning Practice and Research, 22*(3), 439–453.
Zappalà, N. (2011). *Reggio Calabria e dintorni*. Reggio Calabria: Laruffa Editore.

The Integrated Evaluation as a Driving Tool for Cultural-Heritage Enhancement Strategies

Lucia Della Spina

Abstract The paper shows the setting up of an integrated evaluation process to identify a sustainable enhancement strategy for a particularly significant territory in southern Italy that expresses the concept of Historic Urban Landscape (HUL) proposed by the UNESCO. The evaluation process is flexible to adapt to the specificity of complex contexts, to enable interaction with heterogeneous knowledge and to capture local values associated with the particular dimensions of a multi-scalar system. The evaluation is defined as a multidimensional, dynamic, incremental and cyclical learning process, which combines evaluation techniques integrated with public-participation techniques in order to delineate shared and transparent intervention strategies. Through a shared observation process of the context have been identified the values and resources, the key stakeholder categories and their preferences. Selecting context-aware actions enables us to reduce the conflicts by transforming them into synergies, recognizing as essential the components of a constantly evolving, multidimensional and complex landscape in which various systems of values and relationships interact. A 'tailor-made' multi-methodological approach that is enables the combination of the approaches of the Soft-System Methodology, Multi-Criteria Analysis and Multi-Group Analysis with the purpose of identifying the components of the perceived scenario and developing a strategic map able to put in network a system of micro actions, material and immaterial, sensitive to context specificities.

Keywords Cultural heritage · Cultural development policies · Historic Urban Landscape (HUL) · Adaptive decision making process · Multicriteria-multi-group analysis · Stakeholder analysis

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1 Introduction

Structuring a decision-making process, well-structured in its various phases, involves delineating a methodological path that identifies the guidelines for building a valuation approach that helps to understand the dimensions and characteristics of the issues involved.

This is done while recognizing that in practice it is not always possible to maximize all goals simultaneously and that maximizing a goal involves almost always minimizes the others. Through multi-criteria evaluations, it is possible to recognize the centrality of the conflict and to find more satisfactory solutions for its resolution. In this sense, it is essential that the approach to assessments be of an "integrated" type, because it is able to consider various options that involve impacts on various sectors and, at the same time, "participatory", another word that implies the involvement of the various community sectors in decision making. The integrated evaluations can be defined as a structured process to be able to face complex questions using the knowledge coming from various disciplines and elaborated by the same stakeholder involved in the decisions. It involves, therefore, multidisciplinary approaches, in which the various dimensions of the value can conflict with each other and in themselves, among the various groups, in space and at the same time. To structure a decisional process according to an integrated approach means to face the "complexity", taking account the possibility of the self-organization, of the nonlinear dynamics, of the discontinuous behaviors inherent to complex systems, individualizing a methodological structure of reference. Through the application of differentiated approaches, it is possible to overcome the "limits" of evaluations based exclusively on priorities and preferences expressed by decision makers or "experts", also considering priorities and preferences what the community can express well. Through the combined use of decision-support systems and multi-criteria methods, it is possible to structure an MCDSS (Multi-criteria Decision Support System) (Saaty 1980; Zeleny 1982; Roy 1985; Nijkamp et al. 1990) that makes possible the study of the complexity of human decisions by building a flexible environment, in which individual learning in decision making plays a decisive role. It's possible, therefore, to understand the operational implications of the theoretical principles, outlining a path to enable construction and evaluation of possible intervention strategies.

With the aim of outlining an integrated approach to programming and the choice of interventions that can trigger local development processes as drivers for the enhancement of the landscaping and cultural heritage that are present in the territory (Calabrò and Della Spina 2013; Calabrò et al. 2015; Calabrò 2017), it is possible to define a decision-making path whose essential assumption is to recognize that the area in question is characterized by a high degree of complexity, where non-maximizable requirements are contemplated, such as the protection of the environmental system, the protection of historical-cultural values, organizational-institutional and economic-financial sustainability, the improvement of the connectivity between the local networks between them and with the interior, the improvement of the accessibility, the structuring of an integrated transport network, and the enhancement of the management and security efficiency (Della Spina and Calabrò 2008).

In the present contribution, in order to identify a sustainable enhancement strategy for a territorial area comprising the 27n municipalities in the province of Crotone, a particularly significant area in southern Italy with a cultural and landscaping system of considerable interest and a deeply-rooted agricultural tradition, a multi-methodological evaluation process was structured to support the development of alternative intervention strategies. The study was conducted during the development of a project to participate in a MiBACT's ministerial contest, by applying techniques and experimental approaches to a real case.

From the definition of the Historic Urban Landscape (HUL) (UNESCO 2011), it was thorough the theme of the landscape as a "common good", expression of a complex landscape in which persist the values the characterize the HUL. The theme of the landscape as a "common good" is a field of investigation and experimentation for an innovative model of local development that can be activated activate for the area study. The HUL definition is the most recent contribution to the international debate on the identification, conservation, enhancement and management of cultural heritage. It can be seen how sensitivity to conservation problems has been gradually extended from a timely protection concept to a wider consideration of the urban environment, to arrive at a principle of global protection and integrated conservation. The concept of HUL can be interpreted as the result of a stratification of complex values that include: topography of the site; the geomorphology, hydrology and natural characteristics; the built environment, both historical and contemporary; the infrastructures; the models of land use and space organization; the perceptions and visual relations; the social and cultural practices; the economic processes; and the intangible dimensions property of heritage in relation to specific identities.

Taking these considerations into account, we propose an approach to the territory that is based on the transformation of areas in crisis into areas of new opportunities starting from the redevelopment and enhancement of the Urban History Landscape.

The contribution develops a decision-support system that, starting from the identification of the specificities and complexities of the Urban History Landscape, identifies a context-aware enhancement strategy, aimed at building new values, tangible and intangible. The evaluation process implemented through a multi-methodological approach, complements the contribution of various fields of knowledge, and is based on sharing the responsibilities between the various stakeholder and the concertation of the choices through the complementarity between experiences and competences from different domains.

In the first part, we introduce the methodological path, identifying the phases, the techniques used and the results obtained; in the second, the results are analyzed and the research perspectives are identified.

2 Integrated Evaluations and Decision-Making Processes: A Methodological Path

The methodological path has been structured to identify a decision-making process that can involve and identify the relationships between various stakeholder in order to build shared and sustainable enhancement strategies. The proposed methodological path has been structured to enable the interaction of various techniques selected to delineate a dynamic, flexible and adaptive decision-support system, attentive to the specificities of the context and oriented to the development of intervention strategies based on expert knowledge and common knowledge and on recognized and shared values. The experimental approach was designed according to an incremental path in which, taking into account the characteristics of the territory and the relevant issues, were selected the most appropriate analysis and evaluation techniques capable of supporting the needs of the decision-making process from emerging characteristics. In particular, considering the Urban History Landscape being investigated, as an expression of everyday-life practices, of the relationships and links between the specific context and who lives it, have been selected the techniques for each of the decision-making process that are coherent with the Thinking Systems approach (Bánáthy 2000; Jackson 2003; Checkland and Poulter 2006; Ackoff 2010) applied to problem solving.

The structured methodological path consists of three main phases:

1. **Analysis problematic context**: it consists in the partecipatory observation of the context through awareness of the existing values that belong to various and multiple dimensions, tangible and intangible, hard and soft, objective and subjective, of use and non-use and intrinsic (Nijkamp and Fusco Girard 1997; Fusco Girard 2010). The collection and processing of hard and soft data result from the combination of two types of analysis: *Hard Systems Analysis (HAS) and Soft Systems Analysis (SSA)*. The collection of hard and soft data and the application of the *HAS* and *SSA* analysis require accurate selection of information starting from reliable and up-to-date sources, as well as the availability of identified stakeholder to collaborate in the decision-making process and to become protagonists for the decisions. In particular, the HAS makes it possible to produce a cognitive framework consisting mainly of quantitative information. In this particular case, the appropriate indicators were selected, structured according to a grid that identifies the thematic area, the environmental theme, the class of indicators, the coverage (territorial and temporal) and the data source. The construction of indicators has been carried out with reference to specific thematic areas such as: society, economy, tourism, transport, infrastructure, landscape, cultural heritage, local productions, and services. The useful information to structure the indicators was obtained from national, regional, provincial and municipal databases of public and private institutions that operate in the examined territory, and considering the variations from the latest census of 2011 to the current date. At the same time, by SSA analysis, the selection of

soft data has been structured from an Institutional Analysis (De Marchi et al. 2000; Funtowicz et al. 2002), useful in identifying the relevant stakeholder for the context under consideration, and an analysis of the points views and of the perceptions of the various stakeholder categories. The institutional analysis, from some of the considerations emerging from the selection of hard data, allowed the identification of the stakeholder map, divided into three main categories: promoters, operators, and users. The analysis of views and perceptions has been structured by submitting to the stakeholder one semi-structured interviews and organizing some appropriate focus groups for the most some important topics (see point 2). The results from the analyses have been decoded and interpreted to identify the resources, potentialities and significant criticalities of the territory. In this phase, we used the Ishikawa diagram (Wittwer 2009), which can identify the most likely causes of a given problem, it is also called a cause-effect or fishbone diagram (Gupta et al. 2007), which has allowed us to classify criticisms and potentials based on their relevance, highlighted through an appropriate evaluation scale (high relevance, medium relevance, low relevance), to which a color scale was matched.

2. **The elaboration of the perception of problems, preferences and possible solutions of the community** was structured through the application of Strategic Options Development and Analysis (SODA) (Eden and Simpson 1989). The method makes possible the elaboration of cognitive maps from the verbal protocol of an interview, that enabling the structuring, from a point of view formal and methodological, of the contents of the interviews and to analyze in an appropriate manner the qualitative data. To elaborate the cognitive maps means representing a system of concepts and identifying the relationships between them, in order to communicate the nature of the decision-making problem in question and its related implications.
   In order to identify the stakeholder's points of view, we conducted in-depth interviews with the help of the CATWOE method (Rosenhead and Mingers 2001), a specific technique for aiding the decision of the SSA (Checkland 1981). The CATWOE method is a useful tool for structuring the interview and for exploring the decision-making problem from multiple points of view. In the specific case, to the eight interpretative questions identified with the CATWOE model have been associated a typology of concept (criticality, potentiality, actions, future visions, obstacles, actors, environmental limits) and one identifying color. Thus, for each stakeholder group (institutions, hoteliers, restaurateurs and traders, experts, associations, farmers, tourists, citizens), was developed the relative cognitive mapping using the Decision Explorer 3.1 software. Through two appropriate analyses: domain analysis and central analysis and comparing the results, it has been possible to structure of preferences explained by the various stakeholder involved and to identify the components of the future scenario. Detected preferences help us to outline the components of valorization scenarios of Urban Landscape called "Pythagoras", identifying the future shared visions.

3. **The evaluation of scenario**: For the evaluation of preferable future visions for the Pythagoras' Urban History Landscape, has been applied the Analytic Network Process (ANP), a multicriteria evaluation method created by T. L. Saaty (Saaty 1980, 2000; Saaty and Vargas 2006) in order to overcome the linear structure of the traditional evaluation methods and to articulate a more dynamic framework, able to consider the complex interactions that characterize the reality. This is a method of supporting decisions that, in addition to the possibility of considering different types of data (quantitative and qualitative), offers the opportunity to assign various weights to the identified criteria, to manage the conflicts between objectives and to deduce the priorities between alternative options. In the ANP method, each decision problem is structured as a network of the elements organized in groups according to multiple reports of the influences. This configuration enables us to find a structure able to incorporate interdependence relationships and feedback. Considering the existence of feedback, in fact, not only alternatives may depend on the criteria, as in a usual hierarchy, but the criteria may depend on the alternatives and by other elements considerations thought significant for the decision-making problem (Della Spina et al. 2016). In addition, the method also enables the stakeholders and their points of view to be included in the network. The first step in the application of the ANP consists of structuring a hierarchy that is able to represent simply, but at the same time explicitly, the terms of the problem. In particular, first was identified a five-level hierarchical organization (Fig. 1) and, second, the elements (or clusters) of the problem were networked by identifying the connections between them (Fig. 2). After completing the construction of the model, the evaluation was done by applying the comparison to pairs, which allows us to express the judgment preference considering the links between the various elements of the network. Judgments are expressed through the "Saaty's fundamental scale".
The decoding of the interviews aimed at identifying the future visions of the Pythagoras' Urban Historic Landscape which incorporates in the selection four sustainable valorization alternatives: "Pythagoras' urban historical landscape: natural and cultural park"; "Pythagoras' urban history landscape: houses the tourist"; "Pythagoras' Urban History Landscape: natural museum"; "Pythagoras' Urban History Landscape: artistic pole".
What emerges, therefore, is a concept of integrated development of the landscape, whose material and immaterial elements, which therefore comprise the complexity and reflect the characteristics of the HUL concept, contribute together to the structuring of future development strategies. The four visions have common goals, identified from the analysis of the cognitive framework and community preferences, from the criticalities and potentialities that emerge and from the same goals for the future vision of the whole Pythagoras' territory. Also in this case have been identified some macro topics, in the context of which are explained the objectives: culture, tourism, local economies, environment and landscape, mobility, costs and revenues. In general, the four visions aspire to activate a development process in which the local system become

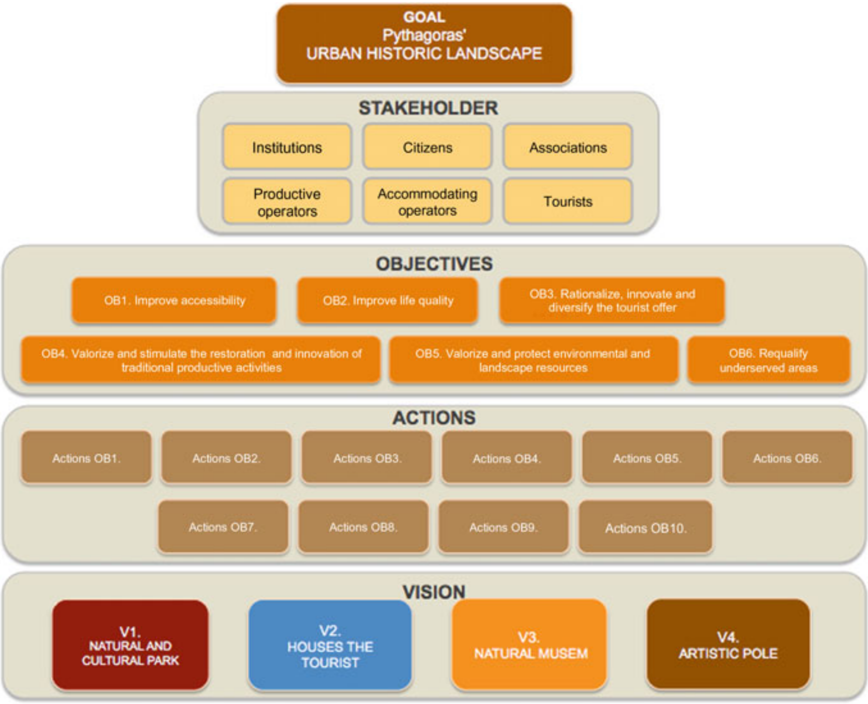

Fig. 1 Pythagoras' urban history landscape: the hierarchical structure

self-sustainable and vital, to invest in creativity, on the innovation and knowledge, essential ingredients for valorization processes, i.e., why they are not interpreted as simple aestheticism of the city's physical-space scenario (Fusco Girard 2012). If goals and actions are in common to the four future perspectives visions, the weight that the actions assume in each of the visions are substantially different. For each vision, we have constructed the relative strategic maps, in which are identified the interventions. In addition, Financial Analysis was performed on each vision, in which the results were considered as additional criteria to be taken into account for multi-criteria evaluation.

The first vision, "Pythagoras' Urban Historical Landscape: natural and cultural park", sees the territory as keeper of history, traditions, local knowledge to learn and to know along the paths and through ancient buildings. It is a path of knowledge, with a significance didactic-educational value. The functions that will host the ancient buildings will be mainly related to museums and didactic activities.

The second vision, "Pythagoras' Urban History Landscape: houses the tourist", will be oriented towards satisfying the needs of the tourist; it will host hotels, restaurants, farmhouses and provide specific didactic activities for the tourist.

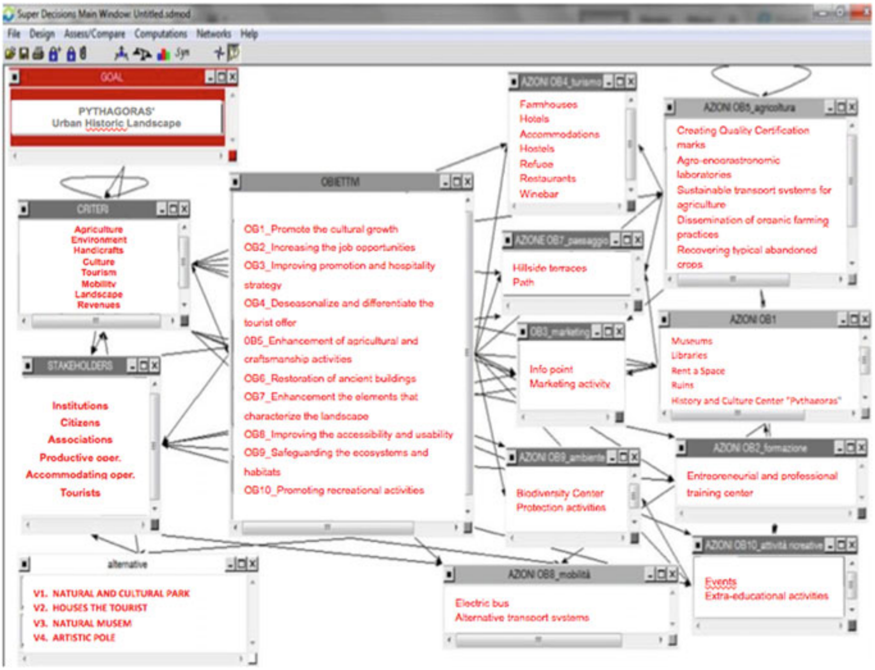

Fig. 2 Pythagoras' urban history landscape: the network structure

In part, the buildings will host also museum activities and a professional training center and entrepreneurial one in the tourism sector.

The third vision, "Pythagoras' Urban History Landscape: natural museum", aims to leave unaltered as much as possible the state of the places. In fact, it arises from the desire to fully protect the environmental heritage by minimizing interventions. Buildings next to the center will host administrative activities, management, a museum and a training center. The other buildings will be left mainly in the state of ruin, after appropriate conservation restoration work.

The fourth vision, "Pythagoras' Urban History Landscape: artistic pole", transforms the territory into a center of artistic and craftsmanship, to recover the ancient function of the country's productive heart. The buildings will host workshops linked above all to the tradition, and, at the same time, will trigger processes of production innovation. The citizens will be personally invited to participate actively in the organization and management of the entire system.

Through the application of the ANP, the preferred alternative between those evaluated is the "Pythagoras' Urban History Landscape: artistic pole" (34.2%), followed by "Pythagoras' Urban Historical Landscape: natural and cultural park" (27.5%), "Pythagoras' Urban History Landscape: natural museum" (19.7%) and "Pythagoras' Urban History Landscape: houses the tourist" (13.5%) (Fig. 3).

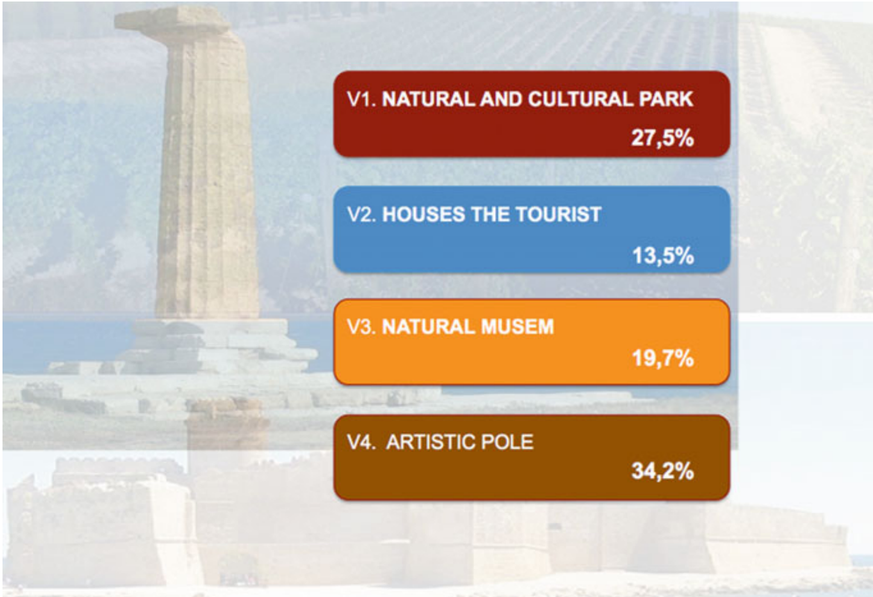

Fig. 3 Pythagoras' urban history landscape: the results of the evaluation with the ANP method

The vision "Pythagoras' Urban History Landscape: artistic pole" is an opportunity to highlight the characters of the Urban Historic Landscape by activating a process of local regeneration through a network of relationships, materials and immaterial, between ancient traditions and new uses, in which art, in its many variations, assumes a propulsive and driving role.

3 Conclusions

The study explored the potentialities of an integrated approach to the development of territorial valorization strategies sensitive to the specificities of the multiple values and of the complex resources that characterize the Pythagoras' Urban History Landscape. The experience thus structured has allowed us to verify how can be translated integrated assessment approaches into complex evaluation systems, which are able to support the design of shared and transparent planning and design choices, according to a bottom-up approach (Concilio 2010; Della Spina et al. 2015). The combined application of various methods and techniques, also coming from disciplines not necessarily within the evaluation, enable us to tackle complex decision making, which is characterized by multiple variables and a high level of uncertainty.

In such decision-making contexts, it is necessary to configure an incremental and cyclical process of evaluation, characterized by continuous feedback and constant interactions, useful for delineating a conscious and shared project of transformation and valorization, coherent with the principles of the HUL approach. In the course of experimentation, the application of an integrated and multi-methodological approach has allowed to take into account the features of the Urban Historical Landscape under study, the various multidimensional components, the tangible and intangible relations system, and the relative perception of the stakeholders, identifying the weights and identifying the various priorities, selecting actions attentive to context, able to reflect the evolutions of an interactive and dynamic dialogue between the communities, local know-how and experts (Calabrò and Della Spina 2014). At the same time, it is possible to identify some critical issues that are due in some cases to specificities of the context, and in others to the application of the evaluation techniques. The collection of the hard and soft data requires a careful selection of reliable and updated sources, as well as the availability of the stakeholders identified to collaborate in decision making and to become protagonists in building decisions. The application of the SODA approach with the elaboration of the cognitive maps enable identification of shared-preference cognitive maps, although they require long implementation and processing times. In addition, the individual points of view obtained from in-depth interviews, through the CATWOE method, should be integrated with appropriate focus groups or forums, where the various stakeholders can discuss them and together identify shared preferences. An another critical issue regards the evaluation with the ANP method, which should not be restricted to the expert knowledge only, but it should make possible an effective interaction between various fields of knowledge and points of view. The use of the ANP approach in an assembly of stakeholders would allow making explicit the preferences and activate an incremental evaluation that enables us increasingly to address the conflicts and to build converging coalitions towards shared visions.

Through a flexible and adaptive methodology path, combining complex evaluation techniques and stakeholder involvement techniques, it is possible to build valorization strategies and promote good governance processes, capable of enhancing the local deliberative democracy by activating effective collaboration between promoters, operators and users (Calabrò et al. 2013).

The choices' effectiveness is related to the ability to integrate various sector policies, but also from the consensus that will be devised for intervention alternatives (Nijkamp and Fusco Girard 1997). The success of the path will also depend on the degree of integration that can be achieved through concertation/participation/coordination processes that are in line with sustainable development strategies. This factor implies a large capacity for the coordination of public institutions and the promotion of "good" initiatives with the involvement of private and private-social stakeholders. With the support of integrated assessment approaches, it is possible to start a systemic and active form of preparation for change; they enable building shared actions in a long-term vision in order to develop and build public decision-making effectively.

References

Ackoff, R. L. (2010). *Systems thinking for curious managers*. Gillingham: Triarchy Press.

Bánáthy, B. H. (2000). *Guided evolution of society: A systems view (contemporary systems thinking)*. Berlin: Springer.

Calabrò, F., Della Spina, L., & Sturiale L. (2013). Cultural planning: A model of governance of the landscape and cultural resources in development strategies in rural contexts. In *Proceedings of the XVII—IPSAPA Interdisciplinary Scientific Conference* (Vol. 5, pp. 177–188). Lettonia: Rezekne Higher Educ Inst-Rezeknes Augstskola.

Calabrò, F., & Della Spina, L. (2014). Innovative tools for the effectiveness and efficiency of administrative action of the metropolitan cities: The strategic operational programme. In *Advanced engineering forum* (Vol. 11, pp 3–10). Switzerland: Trans Tech Publications.

Calabrò F., Della Spina, L., & Tramontana, C. (2015). Il mosaico paesistico-culturale: la dieta mediterranea per il rinascimento di un'area interna della Calabria. In *29th International Interdisciplinary Conference. The Turning Point of the Landscape-cultural Mosaic: Renaissance Revelation Resilience*. Napoli, Italy.

Calabrò, F. (2017). Local Communities and management of cultural heritage of the inner areas. An application of break-even analysis. In O. Gervasi et al. (Eds.), *Computational science and its applications—ICCSA 2017. ICCSA 2017. Lecture notes in computer science* (Vol. 10406). Springer, Cham.

Checkland, P. (1981). *System thinking, system practice*. Chichester: Wiley.

Checkland, P., & Poulter, J. (2006). *Learning for action*. Chichester: Wiley.

Concilio, G. (2010). Bricolaging knowledge and practices in spatial strategy-making. In M. Cerreta, G. Concilio & V. Monno (Eds.), *Making strategies in spatial planning. Knowledge and values* (pp. 281–303). Dordrecht: Springer.

Della Spina, L., & Calabrò, F. (2008). *La valutazione a supporto della fattibilità dei programmi di sviluppo urbano sostenibile*, LaborEst (Vol. 1, pp. 5–10). Reggio Calabria: Laruffa editore.

Della Spina, L., Scrivo, R., Ventura, C., & Viglianisi, A. (2015). Urban renewal: Negotiation procedures and evaluation models. In *Computational Science and Its Applications—ICCSA 2015—15th International Conference, Banff, AB, Canada, June 22–25, 2015, Proceedings, Part III* (Vol. 9157, pp. 88–103). Switzerland: Springer.

Della Spina, L., Ventura, C., & Viglianisi A. (2016). A multicriteria assessment model for selecting strategic projects in urban areas. In *International Conference on Computational Science and Its Applications* (Vol. 9788, pp. 414–427). Switzerland: Springer.

De Marchi, B., Funtowicz, S. O., Lo Cascio, S., & Munda, G. (2000). Combining participative and institutional approaches with multi-criteria evaluation. An empirical study for water issue in Troina, Sicily. *Ecological Economics, 34*(2), 267–282.

Eden, C., & Simpson, P. (1989). SODA and cognitive mapping in practice. In J. Rosenhead (Ed.), *Rational analysis for a problematic world* (pp. 43–70). Chichester: Wiley.

Funtowicz, S. O., Martinez-Alier, J., Munda, G., & Ravetz, J. (2002). Multicriteria-based environmental policy. In H. Abaza & A. Baranzini (Eds.), *Implementing sustainable development* (pp. 53–77). Cheltenham: UNEP/Edward Elgar.

Fusco Girard, L. (2010). Creative evaluations for a human sustainable planning. In *Making strategies in spatial planning* (pp. 305–327). Springer Netherlands.

Fusco Girard, L. (2012). Per uno sviluppo umano sostenibile nel Mezzogiorno: Come gestire la transizione verso una nuova base economica urbana. In AA.VV., *Nord e Sud a 150 anni dall'Unità d'Italia* (pp. 759–779). Roma: Svimez.

Gupta, K., Sleezer, C. M., & Russ-Eft, D. F. (2007). *A practical guide to needs assessment*. San Francisco: Wiley.

Jackson, M. (2003). *Systems thinking: Creating holisms for managers*. Chichester: Wiley.

Nijkamp, P., Rietveld, P., & Voogd, H. (1990). *Multicriteria evaluation in physical planning*. Amsterdam: Elsevier.

Nijkamp, P., & Fusco Girard, L. (1997). *Le valutazioni per lo sviluppo sostenibile della città e del territorio*. Milano: Franco Angeli.

Rosenhead, J., & Mingers, J. (2001). *Rational analysis for a problematic world revisited: Problem structuring methods for complexity, uncertainty and conflict*. Chichester: Wiley.

Roy, B. (1985). *Méthodologie multicritère d'aide à la décision*. Paris: Economica.

Saaty, T. L. (1980). *The analytic hierarchy process, planning, piority setting, resource allocation*. New York: McGraw-Hill.

Saaty, T. L. (2000). Fundamentals of the analytic hierarchy process. RWS Publications.

Saaty, T. A., & Vargas, L. G. (2006). *Decision making with the analytic process*. New York: Springer.

UNESCO. (2011). *Recommendation on the historic urban landscape*. Paris: UNESCO World Heritage Centre.

Wittwer, J. W. (2009). Fishbone diagram/cause and effect diagram. In Excel, from Vertex42.com. Accessed at http://www.vertex42.com/ExcelTemplates/fishbone-diagram.html. 27 June 2016.

Zeleny, M. (1982). *Multiple criteria decision making*. New York: McGraw-Hill.

Smart Territorial Relationships: A Conceptual Framework to Cope with the Rural-Urban Divide in Mountainous Regions

Elisa Ravazzoli, Helena Götsch and Christian Hoffmann

Abstract So far, the literature discussed rural-urban linkages as an instrument that has the capacity to reduce the rural-urban divide and to improve the living conditions of rural and mountainous areas. However, structural changes in the economy and society and advances in transportation and communication technology, as well as transformations in the cities' functions and structures, have significantly modified the dynamics between rural and urban areas from a unidirectional relationships to multidimensional ones. Interactions today happen in non-contiguous spaces; they occur in a broad territorial space that is no longer limited to geographical boundaries. In order to understand the new types of relationships that are occurring today between various territories and to comprehend their nature we believe it is necessary to develop a new conceptual framework. A new conceptual framework, based on the concept of "smart-territorial relationships", will enable planners to re-frame, adapt, explain and describe linkages and interactions as they currently appear in our society.

Keywords Smart territorial relationships · Rural-urban divide · Proximity
Rural mountainous area · Spatial justice

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1 Introduction

Rural and mountainous areas are important sites for food production: they represent a reservoir of natural resources and highly valued landscapes, which provide long-term benefits for the European population (OECD 2013; European Commission 2010). In contrast to urban areas and metropoles, rather perceived as consumptive systems, rural areas are predominantly responsible for productive functions. Due to structural changes in the economy, rural areas across Europe are facing, or have already passed, a transition process towards becoming more prosperous regions: they have been transformed from a low-productive agriculture and rural-based economy to a high-value agriculture and non-farm economy (multi-functional agriculture) (OECD 2006). Indeed, rural areas today are economically diversified: Besides benefitting from processing and refining their natural resources for the global markets, they also profit from creating services for visitors and tourists (Van Rheenen and Mengistu 2009; Copus et al. 2008). Nevertheless, while some rural areas are flourishing, many other are declining; particularly in many European countries, young adults are migrating to major urban centers in search for both better education and job opportunities (Auclair and Vanoni 2004; Stockdale 2006). When considering the Alps, it is widely documented that remote and rural areas are affected the most by the consequences of demographic changes, such as ageing population and decreasing working-age population, maintenance of services of general interest, and erosion of public and private services among others (Permanent Secretariat of Alpine Convention—PSAC 2015; Rees et al. 2012; Bausch et al. 2014).

In the literature, it is notorious that well-functioning rural-urban linkages (e.g., flows of people, economic exchange) are important drivers of economic activities and have the potential to reduce the rural-urban divide and to overcome spatial demographic unbalances, while producing social and economic benefits for rural areas (Copus 2013; Mayer et al. 2016). Interconnections between urban and rural areas stimulate both material and non-material exchanges, fostering more sustainable and inclusive growth (Dower 2013). These interactions and exchanges are recognized as important issues in the field of geography and rural development and in the future will continue to assume growing importance, especially as the economic and social divide between urban and rural population further increases.

The paper presents a new conceptual framework for understanding key and emerging aspects related to urban-rural linkages. We argue that the new conceptual framework for understanding contemporary rural-urban interactions would better display unexamined links and describe the current exchanges that exist between different types of spaces. From a theoretical perspective, the new conceptual framework is particularly required to interpret the changing nature and characteristics of rural-urban linkages and their complexity. In practical terms, a new conceptual framework serves to suggest policies that are adequate and able to respond to the 21st century's changing society needs and requirements.

The framework is based on the assumption that the concept "rural-urban linkages" is no longer appropriate to interpret the current phenomena involving interactions between rural, regional, transregional and transnational territories. The relationships between rural and urban areas should be understood under existing transformation—by considering the structural changes in society and the economy and the consequent changes in the dynamics and relations between territories—in an innovative perspective. Precisely, it is necessary to consider the modifications that villages, cities and territories have undergone in mountainous and rural areas that have changed the contemporary living conditions meaningfully. It is necessary to underline the potentials of advanced technologies to create virtual rural-urban relationships, reduce the rural-urban divide, and to foster the capacity of the territorial capital to exploit new value-added opportunities in rural and mountainous areas. Moreover, we have to consider that fixed boundaries between urban and rural regions, if they ever existed, are now blurring as rural areas take on more urban functions and cities attempt to create rural spaces in urban settings (Irwin et al. 2010; Castle et al. 2011), making the interconnections between them more intense.

We begin by presenting concepts and theories from geography and regional development on the changing nature of rural-urban linkages and the role of technology. We describe determinants and dimensions of the framework to bolster its development. Finally, we discuss the need to adopt the concept of smart-territorial relationships in order to describe contemporary complex urban-rural linkages.

2 Method

Conceptual frameworks have three levels: the theoretical level, the research level and the practical level. The theoretical level involves aspects of the concepts through a literature review; the research level defines the components for empirical research; the practical level outlines the governance and policy instruments to enhance territorial relationships practically (Masnavi 2007). The conceptual framework we suggest in this paper focuses mainly on the development of the theoretical level, leaving the other two levels for future research. The theoretical level is developed based on a literature review, where main concepts from various theories are carefully analyzed and used to describe urban-rural linkages. This enables researchers to select concepts and ideas based on their ability to describe the complex dynamics, exchanges and interconnections that exist today among actors, and between various territories at different administrative levels. Once selected, the concepts incorporated into the framework should be able to set place-based and people-based policy recommendations (Gill 2010) and identify governance tools able to foster synergies between rural and urban areas and among economic sectors, especially in territories with geographical specificities (Gløersen 2012).

3 Results

The development of a new conceptual framework results from the literature review, which is explained in this chapter. From the literature review, a need emerges to re-consider and go beyond some consolidated concepts that have always characterized the debate on rural-urban linkages—such as physical proximity, material linkages, and urban-rural dependency (OECD 2006). The examination of these concepts and related theories is useful to describe the changing nature of rural-urban linkages and to suggest the concept of "smart-territorial relationships" as the more appropriate to use.

3.1 Concepts and Theories About Urban-Rural Linkages

The literature on urban-rural linkage in the field of geography and regional development is vast. Below is a brief review focusing on the role of technological advances and the nature of urban-rural linkages.

Role of Technological Advances

The relationships that exist today between urban, rural and peri-urban spaces, as well as among actors, are highly influenced by rapid changes in information technology, globalization and governmental devolution (Repp et al. 2012; Dutta and Bilbao-Osorio 2012; Davoudi and Stead 2002). In the past, technological innovations—related to the construction of roads, highways and telephone systems—had a large spatial impact, mainly on improving the movements of products and people around space; hence, rural-urban transactions were limited by the physical characteristics of these technologies. Today, smart technologies—the internet, broadband satellite technologies or autonomous driving cars—have greatly reduced costs to bridge physical distance and facilitated rapid immaterial movements of information and capital, making spatial boundaries more blurred (Courtney et al. 2009; Khanna 2016). Relations between people and firms do not happen now only in physical space but broad-band connections allow an intensive virtual exchange of information worldwide. Physical proximity, contiguity and material links are nowadays partly substituted or extended by immaterial links, which become more relevant for collaborations and exchanges between various actors. Even though physical relations still exist between spaces and actors, interactions between people and across spaces do not any longer depend exclusively on spatial proximity; currently, advanced web-technologies, automation processes or control techniques in the industry 4.0 provide opportunities to enhance "organizational proximity networks" (Copus 2013) or "organized proximity" (Torre and Rallet 2005), where various types of spaces, actors and objects are connected virtually, in real time. Web infrastructures installed in public transport enable a multifunctional use of time while physically bridging spatial distances. Moreover, intelligent logistic solutions like the modal split from road to rail or autonomous driving solutions for cars and trucks enhance the efficiency of transporting goods and make production spatially independent. Yet, one needs to be aware that, even though patterns of interaction have undergone tremendous changes, physical proximity and organizational proximity should not be conceived as two separate entities, rather as parts of the same space and as co-existing elements. This creates comparative advantages for rural locations and enhances rural-urban interconnectedness.

Nature of Urban-Rural Linkages

Historically, at least since the Industrial Revolution, rural-urban interdependency has been under the urban dominance so that exchanges were primarily from rural to urban regions (Davoudi and Stead 2002). Yet today, rural-urban relationships are less asymmetrical and are less likely to involve contiguous hinterlands or areas that are functionally linked. This is related to the fact that middle-sized towns, villages and other towns are very diverse in their structures, functions and economy. Due to their functional configuration, rural communities are not dependent anymore on the economy of urban areas; they establish connections not only with their hinterlands, but also with non-contiguous regions and cities; hence, exchanges increasingly occur between non-bordering areas, among cities and towns, between rural areas and metropolitan regions, and within functional regions, as well as between actors that are located beyond provincial, regional and national boundaries, involving the whole territory and various types of spaces (Coutard et al. 2014; Repp et al. 2012; OECD 2013). Relations are embedded in a network with a multitude of different actors from various levels (urban, peri-urban and rural) and territories (OECD 2014). Thanks to this polycentric spatial structure (ESPON 2007), the dependency on one central city declines. Nevertheless, due to their service capacity and diversity of relationships, important metropoles or big cities will always influence surrounding small cities and villages.

When describing urban-rural interactions, there is a need to go beyond historical spatial hierarchies and traditional administrative boundaries towards a broad concept of territory that is able to embrace the relationships that occur between various types of spaces. Territorial relationships can be understood in a broad sense and not only as the relationship between an urban area and its neighboring periphery, because what characterizes territorial relationships is their noncontiguous nature and their changing character of territorial types. Indeed, relationships are happening beyond provincial and regional boundaries in an integrated territorial setting, internationally and simultaneously. Due to the variety of relationships and interactions happening both at national (provincial, regional, local) and international levels, and to the fact that a common definition of "rural" and "urban" in theoretical and operational terms is still lacking, we argue that it is inappropriate when describing relations between different types of territories and actors to use the urban-rural dichotomy paradigm and the "rural-urban linkage" concept. Therefore, attention should be paid to a-spatial (organizational) network, to territorial relationships and their contribution to sustainable development.

3.2 Conceptual Framework

In this section, we present the conceptual framework developed to better understand the nature of contemporary rural-urban linkages. The framework builds on the concept of smart-territorial relationships as the most appropriate to describe the nature of today's urban-rural linkages.

Following is an explanation of the concepts. The term "smart technology"—including advanced web technologies, automation processes, industry 4.0 and intelligent logistics—will drive the new a-spatial and spatial exchanges among urban and rural areas, bringing positive feedback effects for rural areas (Copus 2013; Dutta and Bilbao-Osorio 2012; Torre and Rallet 2005). For this reason, technological advances are vital components in today's urban-rural relationships. The term "territory" refers to a space characterized by relational, material or virtual connections and geographical features like natural elements, human activities and relations between actors for satisfying their needs. Territory is conceived here as a broad space that is both physical and virtual (OECD 2013). The need to go beyond outdated spatial hierarchies and traditional administrative boundaries makes the concept of territory more appropriate to indicate the space where different types of exchanges happen.

The term "relationship" embraces all material links, social and economic interactions, and all sorts of exchanges that take place between various actors located in different types of spaces (Mayer et al. 2016; Coutard et al. 2014; Gløersen 2012; Repp et al. 2012). In the literature, the terms "linkage" and "relationship" are used interchangeably; however, the term "relationship" is actually more appropriate to describe the types of exchanges, interactions and interdependencies that are occurring nowadays. The term relationship embraces various types of exchanges, complex relationships and novel spatial interactions made possible by smart technologies and social innovations, thus incorporating not only relations between urban areas and their hinterlands but also those between different types of territories.

The concept of "space" does not reflect the spatial allocation theory of Einstein, nor the space-container theory conceptualized by Simmel (1992); on the contrary, it embeds an idea of space that is much wider and considers globalization processes, technological innovations, organizational proximity and the new concept of the "unlimited world" (Lutz 2006) that connect both rural and urban, as well as transregional and transnational, areas. The concept of space, at the basis of the framework builds on the "relational space" concept theorized by Löw (2001) according to which space is a "dynamic construction integrated in operational processes" that can be derived from the allocation of human beings and the social goods (and services)".

The framework recognizes determinants and dimensions affecting territorial relationships (Fig. 1). The main determinants, which have been identified as forces driving increased relationships between urban and rural areas, are changes in society and economy and globalization forces and technological advances. Among them all, technological advances have linked rural people and communities to the

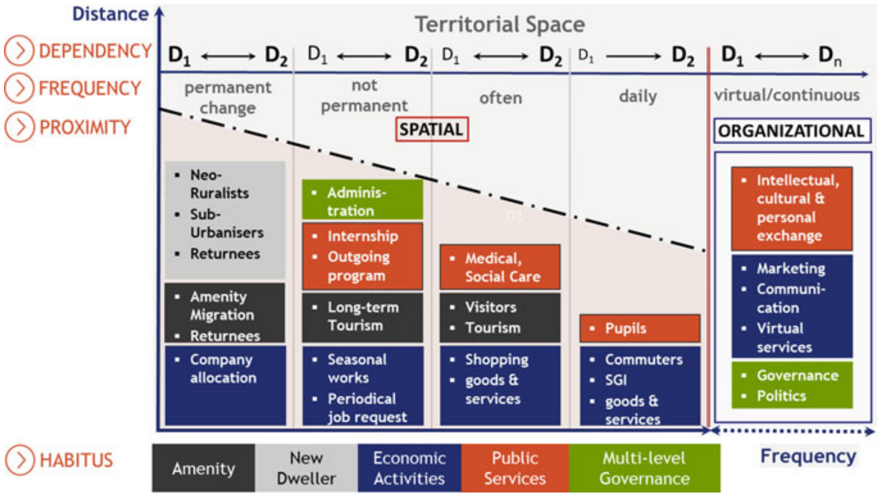

Fig. 1 Dimensions and determinants affecting territorial relationships (based on Perlik 2006)

global economy and brought aspects of rural life into urban life (Lichter and Brown 2011). Smart solutions offer several opportunities for improvement and help bridge spatial distances (Dutta and Bilbao-Osorio 2012). Important megatrends are influencing our society, people's movements, perceptions and actions. Structural changes in the economy lead to diversified business perspectives and foster non-farm economies in rural areas. Demographic changes forge an ambivalent picture where the countryside suffers from aging and depopulation and metropoles face enduring growth (Permanent Secretariat of Alpine Convention—PSAC 2015). Furthermore, the decrease in public services, due to liberalization and privatization processes (Coutard et al. 2014), comes along with a dependence on cars that affect mainly young and elderly people, and induces negative effects on climate. Digitalization processes and industry 4.0 as one of the major changes in today's society offers new smart solutions, to enforce economic growth through "organizational proximity networks" (Copus 2013), independently from their physical spatial position. Spatial development of cities, villages and towns today is very diverse in terms of their structures and functions; we are moving from a conception where physical distances and agglomeration were key drivers of development, to a conception dominated by organizational proximity.

The four dimensions influencing territorial relationships are: dependency, frequency, proximity and habitus. Dependency refers to the direction of interactions between territories, which can be unidirectional or bidirectional (D1 -> D2 or D1 <-> D2); it impacts on spatial operations significantly (Stoetzer 2008). Frequency of interrelations between territories refers to the regularity of interactions occurring between territories; the frequency is determined by and determines dependency. Proximity refers to the type of material and nonmaterial relations; interactions can be based on physical-spatial proximity or on virtual and organizational proximity networks. Finally, relations are also triggered by special types of habit and life-styles (Bourdieu 1979), which are the major drivers of spatial development. Habitus can be: (i) exchange in "amenities" and environmental goods, (ii) demographic linkages due to "new dwellers", (iii) economic transaction and innovative items regarding "economic activities", (iv) delivery of public services or (v) multi-level governance interactions (OECD 2009). Actually, habitus strongly influence the rational distribution of actors or social groups within the dynamic social space (Bourdieu 1985, 1989, 1993; Wacquant 1996; Dangschat 2009), where spatial structures and societal operations are converging. The habitus and life-style determine the operational behavior of actors in both a "spatial" or "organizational proximity" space. The "frequency" within which these needs are demanded is decisive in determining the relationship between destinations (D_1 and D_2): the more frequent goods or services are requested, the higher is the opportunity for alternatives. Overall, these dimensions influence the creation of the "relational space". Looking at Fig. 1 and considering material flows under "spatial proximity", we can affirm that spatial proximity and frequency are relevant in defining the type of dependency between territories; if the frequency for satisfying particular needs is low (e.g., yearly), fewer destinations are "dependent" on each other, and large distances between destinations are more acceptable; if the frequency for satisfying a particular need is high (e.g., daily), such as commuting to school, the dependency between destinations is great, and the territory with fewer services and resources is strongly dependent. In contrast, territorial relationships dealing with immaterial flows under "organizational proximity" are operating "independently" from their destinations in a multi-dimensional, open and balanced relational-space (Bourdieu 1989, 1993). Although the demand for immaterial services, like information or knowledge, has the advantage of being capable of being satisfied world-wide in real time, digitalization nevertheless imposes, to some extent, the limit for territories to be dependent upon the quality and accessibility of IT infrastructure and the capacity of the local human capital to exploit new opportunities (Copus 2013).

The framework recognizes centripetal and centrifugal forces driving the dynamics of territorial relationships. Besides the well-established economic drivers, such as concentration, growth and agglomeration economies (Puga 2010), the literature recognizes the importance of residents' qualifications and spatial conditions. According to their capacities to valorize the available territorial capital and the endogenous potentials, residents' qualifications may sustain local competitiveness and take advantage of the opportunities arising from the dynamics of territorial relationships (Camagni and Capello 2013). The interlinkages and worldwide relations of modern societies is much greater now than ever before and goes clearly exceeds the defined boundedness of social systems (Giddens 1991; Arvanitakis 2010). Therefore, territorial relationships reflects the mutual dependency between space and society and the dual interrelations between societal operations and spatial structures (Smith and Courtney 2009). Moreover, the needs of certain actors and social groups within territories generate the requirement for improving—consciously or unconsciously—their social position (Honneth 1990 in Berner 2015), influencing territorial relationships. Finally, the framework recognizes that territorial relationships are dynamic and change continuously across time. Also, it recognizes the importance of feedback loops. Within the territorial space, spatial-developments resulted from the operating society and certain living arrangements, which then again influence those developments (ARL Akademie für Raumforschung und Landesplanung 2016).

4 Discussion

In this paper, we explain the reasons for a new conceptual framework able to revise the dichotomy of rural-urban areas. From our point of view, it is no longer adequate to reduce the discussion just to spatial proximity or to a rural-urban hierarchy. As urban and rural areas dissolve continuously, we should rather concentrate on the dynamics of territorial processes, in which the exchanges between metropoles, provincial capitals, and small- and medium-sized towns, as well as villages in rural areas, are considered in an equipollent way. We consider space less and less as a static entity and more and more as a dynamic set, where different types of interrelations can happen at any time and are not limited anymore to just a particular type of territory. Due to smart technical solutions or social innovations, which enable the empowerment of endogenous resources, territorial relationships are going far beyond the classical space-container vision. Continuous interrelations and real-time connections with nearly urban agglomerations or rural areas overcome the "rural-urban dichotomy" vision towards a "rural-urban continuum" vision. The latter vision was already proposed by Jane Jacobs in the 70s; she stated that the distinction between city commerce and rural agriculture, between 'city-created work' and 'rural work', as well as among 'city consumption' and 'rural production', is artificial and imaginary (Jacobs 1969). As soon as peripheral rural areas extend their relationships towards a-spatial and immaterial flows in order to gain information or exchange knowledge via virtual economic services, we leave the physical set of interactions behind us and converge towards a solely "broad relational space" as a multidimensional constitution of social space. Regarding this perception of space, the approach of "smart-territorial relationships" suits best and makes it possible to describe new types of relations between territories. Thereby metropoles, urban agglomerations and rural areas should be included equivalently, as the difference of "rural" and "urban" continuously dissolves. Especially, areas that are physically difficult to access can overcome the burden of their peripheral locations via smart solutions. Thanks to the digitalization trend and various types of smart solutions, which include technical or social components, physical and virtual accessibility of destinations and natural resources, institutional and societal structures and the exchange of information and knowledge can improve the conditions of remote areas. Developing "smart-territorial relationships" with the help of smart solutions, especially in mountainous regions, can bridge physical distance, enable equipollent living conditions, promote spatial justice (Miosga 2016) and prevent further economic shrinkage and depopulation; they can support diversification and modernization strategies to capitalize on local assets and to empower territorial capitals to install digital facilities that enhance the virtual relationships and exchanges.

5 Conclusions

This paper aims to develop a conceptual framework that can be used to understand smart-territorial relationships. Three main issues have emerged from the paper:

First, our literature review indicates that the approach based on rural-urban linkages lacks consideration of the vastly growing complexity of interrelations that exist between territories, the importance of digitalization processes, industry 4.0 and the presence of technologies in everyday life, all of which make spaces less physical, less dependent of time and increasingly physically unbounded. This gap is costly for research and policy development because key dynamics are lost. Therefore, a framework that incorporates the importance of technological advances and changes in economy and society will likely be able to advance research and policy in the field.

Second, the dichotomy of "rural" and "urban" is coming to an end, because it is not consistent anymore with the current state of discussion. Spaces ranging from big cities to rural areas encompass a broad spectrum of complex interrelations, which is too simple to be described as "urban" or "rural". Some publications even use the term "urban hinterland", which implies a normative degradation, and thus the need from an ethical point of view to be neglected. Moreover, territories are struggling with the rural-urban dichotomy, as they cannot be classified exclusively "rural" or "urban" (Repp et al. 2012; Davoudi and Stead 2002), and a shift of paradigm towards an "urban-rural continuum" (Repp et al. 2012; Jacobs 1969) is recommended. The new conceptual framework of "smart-territorial relationships" seeks to overcome the outdated dichotomy of "rural" and "urban" and the decreasing dependency on physical spaces. This approach includes the progress of technology, as well as the broad range of regional disparities, which have undergone major changes throughout recent years. This is the starting point from which numerous possibilities arise in order to overcome spatial demographic imbalances and to foster the principles of social justice, thus attaining equipollent living conditions across territories.

Third, it is important to transform analysis into policies that operate effectively and interactively, and cooperate vertically and horizontally. A place-based people-centered approach (Gill 2010), in combination with megatrends, should empower the specificities of each territory and promote adequate living conditions, especially in areas with geographical specificities. The authors are aware that this integrative, transboundary, interdisciplinary approach (e.g. smart-territorial relationships) is not easy to realize. On the one hand, EU initiatives like Macro-regions, trans-boundary cooperation areas like EUREGIO or the INTERREG Programme foster an integrative transboundary approach; whereas, on the other hand, they are strongly anchored to administrative boundaries, because financial means are bound to them, which in the end hinders an integrative approach. This underlines that an integrative approach can only be realized with the support and involvement of local and national politics, with constant consideration of current challenges and by taking advantage of the technological solutions, which bring mountainous regions new opportunities for improving social, governmental and ecological standards and for achieving better living conditions.

References

ARL Akademie für Raumforschung und Landesplanung (Ed.). (2016). *Daseinsvorsorge und gleichwertige Lebensverhältnisse neu denken–Perspektiven und Handlungsfelder*. Positionspapier ARL 105: Hannover.

Arvanitakis, J. (2010). Anthony Giddens (1991) The consequences of modernity. Polity Press.

Auclair, E., & Vanoni, D. (2004). The attractiveness of rural areas for young people. In B. Jentsch & M. Shucksmith (Eds.), *Young people in rural areas of Europe* (pp. 74–104) Ashgate: Aldershot.

Bausch, T., Koch, M., & Veser, A. (2014). *Coping with demographic change in the alpine regions: Actions and strategies for spatial and regional development*. Munich: Springer.

Berner, H. (2015). Handeln bei Pierre Bourdieu—Implikationen für die Sozialraumforschung. In *sozialraum.de* (7) Ausgabe 1/2015. http://www.sozialraum.de/handeln-bei-pierre-bourdieu.php. Accessed at 07 April 2017.

Bourdieu, P. (1993). *Sozialer Sinn*. Suhrkamp Verlag: Frankfurt am Main.

Bourdieu, P. (1989). Sozialer Raum, symbolischer Raum. In J. Dünne & S. Günzel (Eds.) (2006), *Raumtheorie–Grundlagentexte aus Philosophie und Kulturwissenschaften*. Suhrkamp Verlag: Frankfurt am Main.

Bourdieu, P. (1985). *Sozialer Raum und Klassen*. Lecon sur la lecon. Ffm.

Bourdieu, P. (1979). *Entwurf einer Theorie der Praxis auf der Grundlage der kabylischen Gesellschaft*. Suhrkamp Verlag: Frankfurt am Main.

Camagni, R., & Capello, R. (2013). Regional competitiveness and territorial capital: A conceptual approach and empirical evidence from the European union. *Regional Studies, 47*(9), 1383–1402.

Castle, E. N., Wu, J., & Weber, B. A. (2011). Place orientation and rural–urban interdependence. *Applied Economic Perspectives and Policy 33*(2), 179–204.

Copus, A. (2013). Urban-rural relationships in the new century: Clarifying and updating the intervention logic. In *New Paradigm in action—on successful partnerships* (pp. 7–29). Ministry of Regional Development: Warsaw.

Copus, A., Psaltopoulos, D., Skuras, D., Terluin, I., Weingarten, P., Giray, F., (Ed.) et al. (2008). *Approaches to rural typology in the European union*. JRC Scientific and Technical Reports, European Commission, Joint Research Centre, Institute for Prospective Technological Studies: Luxembourg.

Courtney, P., Psaltopoulos, D., & Skuras, D. (2009). *Rural-urban Interactions*. EDORA (European Development Opportunities for Rural Areas), ESPON.

Coutard, O., Finnveden, G., Kabisch, S., Kitchin, R., Matos, R., Nijkamp, P., et al. (2014). *Urban megatrends: Towards a European research agenda*. Urban Europe, Joint Programming Initiative Urban Europe.

Dangschat, J. (2009). Symbolische Macht und Habitus des Ortes. Die „Architektur der Gesellschaft" aus Sicht der Theorie(n) sozialer Ungleichheit von Pierre Bourdieu. In J. Fischer & H. Delitz (Ed.), *Die Architektur der Gesellschaft*. Transcript Verlag: Bielefeld.

Davoudi, S., & Stead, D. (2002) Urban-rural relationships: An introduction and a brief history. *Built Environment, 28*(4), 269–277.

Dower, M. (2013). Rural development in the New Paradigm. In M. Kolczyński (Ed.), *New Paradigm in action successful partnerships*. Polish Ministry of Regional Development: Warsaw.

Dutta, S., & Bilbao-Osorio, B. (2012). *The global information technology report 2012*. World Economic Forum and INSEAD: Geneva.

European Commission. (2010). *Sustainable development of mountain regions and the experience of the Carpathian Mountains*. The Congress of Local and Regional Authorities of the Council of Europe, Committee on Sustainable Development, 19th Session, Strasbourg.

ESPON. (2007). *Polycentric urban development and rural-urban partnership—thematic study of INTERREG and ESPON activities*. European Union, INTERACT.

Giddens, A. (1991). *The consequences of modernity.* Polity Press.

Gill, I. (2010). "Regional development policies: Place-based or people-centered?" VoxEU.org, 9 October.

Gløersen, E. (2012). Renewing the theory and practice of European applied territorial research on mountains, islands and sparsely populated areas. *Regional Studies, 46*, 443–457.

Honneth, A. (1990). *Die zerrissene Welt des Sozialen*. Sozialphilosophische Aufsätze. Suhrkamp Verlag: Frankfurt.

Irwin, E. G., Isserman, A. M., Kilkenny, M., & Partridge, M. D. (2010). A century of research on rural development and regional issues. *American Journal of Agricultural Economics, 92*(2), 522–553.

Jacobs, J. (1969). *The economy of the city.* New York: Vintage Books.

Khanna, P. (2016). Connectography: Mapping the future of global civilization. New York: Random House.

Lichter, D. T., & Brown, D. W. (2011). Rural America in an urban society: Changing spatial and social boundaries. *Annual Review of Sociology, 37*, 565–92.

Löw, M. (2001). *Raumsoziologie*. Suhrkamp: Frankfurt.

Lutz, W. (2006). „Vom „Containerraum "zur „entgrenzten "Welt–Raumbilder als sozialwissenschaftliche Leitbilder." *Social Geography Discussions, 2.1*, 179–214.

Masnavi, M. R. (2007). Measuring urban sustainability: Developing a conceptual framework for bridging the gap between theoretical levels and the operational levels, *International Journal of Environmental Research, 1*(2), 188–197.

Mayer, H., Habersetzer, A., & Meili, R. (2016). Rural-urban linkages and sustainable regional development: The role of entrepreneurs in linking peripheries and centers. *Sustainability, 8*, 745.

Miosga, M. (2016). Gleichwertige Lebensverhältnisse und Arbeitsbedingungen in allen Landesteilen. Die Suche nach neuen Wegen zur Umsetzung des Verfassungsauftrags in Bayern. In *Daseinsvorsorge und Zusammenhalt*. Vorbereitender Bericht zur Jahrestagung 2016 in Hannover.

OECD. (2006). *The new rural paradigm: Policies and governance*. OECD Publishing.

OECD. (2009). *How regions grow: Trends and analysis*. OECD Publishing: Paris. http://dx.doi.org/10.1787/9789264039469-en. Accessed at 03 April 2017.

OECD. (2013). *Rural-urban partnerships: An integrated approach to economic development*. OECD Publishing.

OECD. (2014). *OECD regional outlook, regions and cities: Where policies and people meet*. OECD Publishing.

Perlik, M. (2006). The specifics of amenity migration in the European Alps. In L. A. G. Moss (Ed.), *The amenity migrants: Seeking and sustaining mountains and their cultures* (pp. 215–231). Cambridge, MA, S.

Permanent Secretariat of Alpine Convention—PSAC. (2015). Demographic changes in the Alps, report on the state of the Alps. Alpine Signals—Special Edition 5.

Puga, D. (2010). The magnitude and causes of agglomeration economies. *Journal of Regional Science, 50*, 203–220.

Rees, P., Van Der Gaag, N., De Beer, J., & Heins, F. (2012). European regional populations: Current trends, future pathways, and policy options. *European Journal of Population, 28*, 385–416.

Repp, A., Zscheischler, J., Weith, T., Strauß, C., Gaasch, N., & Müller, K. (2012). *Urban-rurale Verflechtungen. Analytische Zugänge und Governance-Diskurs*. Diskussionspapier Nr. 4, December 2012. Leibniz-Zentrum für Agrarlandschaftsforschung (ZALF), Institut für Sozioökonomie.

Simmel, G. (1992). *Soziologie. Untersuchungen über die Formen der Vergesellschaftung*. Suhrkamp: Frankfurt.

Smith, I. & Courtney, P. (2009). *Preparatory study for a seminar on rural-urban linkages fostering social cohesion*. Discussion Paper. DG Regional Policy, European Commission.

Stockdale, A. (2006). Migration: Pre-requisite for rural economic regeneration? *Journal of Rural Studies, 22*, 354–366.

Stoetzer, S. (2008, April). *Space thinks? Soziologische Raumkonzepte*. Speech Berlin 18.

Torre, A., & Rallet, A. (2005). Proximity and localization. *Regional Studies, 39*(1), 47–59.

Van Rheenen, T. & Mengistu, T. (2009). Rural areas in transition: A developing world perspective. In *Multifunctional rural land management: Economics and policies* 319.

Wacquant, L. J. D. (1996). Auf dem Wege zu einer Sozialpraxeologie. In P. Bourdieu & L. J. D. Wacquant (Eds.), *Reflexive Antrophologie*. Suhrkamp Verlag: Frankfurt.

The Valorization of Economic Assets and Social Capacities of the Historic Farmhouse System in Peri-Urban Allocation: A Sample of Application of the Corporate Social Responsible (CSR) Approach

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Abstract Nowadays the strategies underlying agricultural and environmental policies (the Lisbon strategy "EU 2020")—in particular the *Sixth Environment Action Programme 2010: Our Future, Our Choice*—emphasize the need to create a market that is more environmentally friendly and "responsible". The recent debate shows that the "green" variable in financial management is placed at the center of employers' thoughts on both the discretionary dimension (culture, ethics and responsibility) and the normative-prescriptive dimension. Some positive experiences reveal the following topics: (1) the approaches of multifunctional agriculture in synergy with the themes of the European debate on Corporate Social Responsibility; (2) the definition of a new business framework; and (3) the management model oriented to stakeholders and to ethical management. The vision of the green entrepreneur in managing the company is an innovative point of view with respect to legal obligations and falls within the sphere of responsibility for environmental management. The literature, in fact, focuses on: (1) a responsible business-management model based on the "stakeholder" model, as opposed to the "shareholder model", where the creation of value is not confined to equity holders of risk, but in which companies assume management objectives that bring mutual benefit to the community; and (2) the development of specific items in the analysis of financial statements that take into account aspects of environmental responsibility. In accord with this, the paper analyzes the application of the principles of the "responsible" management process to an Italian case study and to underline which effects they have on the scenario of enhancement of the historical farmhouse system in Volpiano (Canavese, in the metropolitan region of Turin, Italy). The coexistence of historic rural settlement patterns and new housing and industrial estates is rather common and widespread, but this case is paradigmatic, because in the territory of

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Volpiano the applied measures and principles followed a paradigm change in dealing with this historic farmhouse structures coexisting among new housing and industrial estates: this is an issue of great importance and not only at the local level. In fact, the final project scenario was subject to operational feasibility analysis using traditional instruments. Some specific reflections were made to estimate the financial investment for restoration and re-functioning, on the timing of site preparation and management data, and on the identification of financing channels (PSR—Programma di Sviluppo Rurale and the European CAP—Common Agricultural Policy). Lastly, feasibility is linked to the economic social responsibility, with elements of originality in the test performance and new assumptions concerning the risk/return ratio.

Keywords Peri-urban farming · Corporate social responsibility (CSR) Discounted cash flow analysis · Socio-ecological accounting · Historical farmhouse system

1 Introduction: General Goals and Opening Questions

In 2016, the Municipality of Volpiano (industrial and rural peri-urban area) asked a research group from Politecnico di Torino for support in the enhancement of the historical farmhouse system for the following activities/priorities: (1) data collection and GIS of the historical heritage of the farms; (2) mapping stakeholders and the relationship with private entrepreneurs; (3) development scenarios; and (4) creating a new model of economic activities. To find common ground on which to create a Protocollo d'Intesa (Collaborative Agenda) and a Cabina di Regia (Decisional Board), the research group asked these questions: "How can the Municipality draw up the process with its partners?"; and "What can be the road map to try to define the ambitious process that enhances the system of historic buildings and develops new economies in and around Volpiano?" According to Allen (2003), the definition of "peri-urban interface range" is complex and the territory of the case-study is paradigmatic due to the following: (1) it is characterized by the coexistence of historical rural settlement patterns (partially altered by the construction of roads) with new housing and industrial estates; (2) the process involving urban expansion to the decline of agricultural and rural employment opportunities; (3) the significant implications, not only for the livelihoods and quality of life of those who live in these areas, but also for the sustainability of urban and rural development; and (4) the complexity which derives from the artificial distinction between "urban" and "rural", a distinction that "(mis)informs not only the setting up of institutional arrangements but also, and more broadly, the deployment of planning approaches and tools" (Allen 2003: 135).

The experience—on going—that we want to illustrate has outlined an approach and tools for answering these questions: the research group has applied a tool-kit for simulating a hierarchical set of instruments to evaluate the performance of revitalized/regenerated historical farmhouses in Volpiano–close to Turin.

The application is the integrated testing of the following tools: (1) the creation of value for the system of farmhouses and farming activities applying the Corporate Social Responsibility (CSR) approach, revised in the multifunctional agriculture model (MAM), as these tools synergistically try to address the aspects of the farmer's ethical responsibility and achievement of profit with "ethical" and social components (Dalton and Cosier 1982; Davis 1960, 1967, 1973; Davis and Blomstrom 1966); (2) verification of the feasibility of the exploitation scenario by testing the well-known DCFA tool, but revised in a green key, thanks to the ideas referred to under point 1, in order to demonstrate how such processes can be virtuous even for complex cases such as wealthy systems of high historical value, but also with productive features and peri-urban localization (Aupperle et al. 1985; Cochran and Wood 1984); (3) the launch of a participatory process involving all stakeholders, thanks to a specific mapping of stakeholders, tailored to the multi-functional farming model (Heald 1970; Freeman 1984; Preston 1978; Preston and Post 1975).

In this sense, the paper is articulated in sections that repeat the experimentation process.

As a first step, the paper aims to review the extensive literature (Carroll 1977, 1979, 1981, 1983, 1991, 1994) on the subject of Corporate Social Responsibility (CSR). It follows a reflection on the strengths and weaknesses of similar operations: the development of structural frameworks of knowledge of rural landscapes and their settlements, the operational aspects of evaluation and feasibility tests with the introduction of environmental items into the traditional economic accounting approach (green value in International Standards). The concept of multifunctional agriculture, conceived, on one hand, as agriculture that produces primary goods and, on the other, as agriculture that produces secondary services.

The second step is to elaborate the specific Financial Management Analysis Model (FMAM) for the enhancement of the historical farmhouses, where particular attention is paid to two technical steps: (1) mapping stakeholders in accordance with the CSR approach; and (2) identifying specific items in the financial statements (in this phase of testing only at categorical and descriptive level).

The project scenario of the sample area selected was analyzed for operational feasibility using traditional instruments (Discounted Cash Flow Analysis—DFCA), foreseeing: the functional recovery and restoration of the farms, traditional fodder and "new" (hazel) crops and the creation of spaces for the use of agriculture and animal husbandry as a source of therapy, education and ennoblement.

Lastly, the DFCA presents elements of originality in the feasibility test performance and new assumptions on the risk/return ratio. Two models are compared and commented on: the traditional model without "green voices" and a soft approach from the CSR, and a more innovative one with "green voices", which adopts the CSR approach more effectively.

2 The Theoretical Background

The Lisbon strategy "EU 2020"—in particular the *Sixth Environment Action Programme 2010: Our Future, Our Choice*—highlights the need to create a more environmentally friendly and "responsible" market (Kok 2004).

Recent literature on these themes is very substantial (Ackerman 1973; Ackerman and Bauer 1976; Aupperle et al. 1985; Davis 1960, 1967, 1973; Druker 1954, 1984; Zenisek 1979).

In particular, to provide theoretical-methodological and application responses to the opening questions (see *Introduction*), the research group has applied a toolkit. The conceptual framework—shared with the public administration—is based on four key concepts, of both a strategic nature on a macro scale, and a more tactical nature on a micro scale, as follows: (A) MACRO_LEVEL: a rethinking of the concept of the relationship between companies/businesses and communities in a vital system key, in the light of the features of the case study, which—for the authors—has been limited to a reflection still to be developed; (B) MICRO_LEVEL VERSUS MACRO_LEVEL: three approaches to the definition of a new design concept, the *Circular Model* of the Business Concept, Corporate Social Responsibility (CSR) and the Financial Management Analysis Model (FMAM), for stakeholders, the first of which is a background, while the other two have led to the development of the methodological and technical aspects. In addition, the authors—as stated in the *Introduction*—apply the peri-urban territorial scale, defined in the literature, by Allen (2003) for example, in the strategic approach to environmental planning and management of the peri-urban interface.

The authors believe that the integrated testing of these approaches can provide answers to the questions of the Public Administration of Volpiano and some theoretical-practical nodes that characterize the case study. They can be found in other similar cases with the same localization characteristics, of four distinct types. First, the management of a historical asset for which the value of historic buildings (the historical farmhouse system) and incoming cash flows of the activities are closely connected. Second, attention to the green components of the multifunctional agriculture model, which can affect and change the performance management results. Third, the aspect of restoration and restoration costs which, in the case of the study, are not high due to good conservation conditions: they do not have a major impact on investment items, do not weigh on the aspects of yield capitalization and delegate the importance of feasibility to the management of the items characterizing the "core" activities of the multifunctional agriculture model. Fourth, the management scenarios for all stakeholders involved in a sort of social relationship: the issue of ethical and social responsibility is also internalized into management items that take into account the benefits and risks not only for the farmers, but also the consumers and the citizens involved in the multifunctional farming model. At MACRO_LEVEL, with regard to the first theoretical model, the following definition is mentioned: "The vital system is a system that survives, remaining united; it is homeostatically balanced, both internally and externally.

Furthermore, vital mechanisms are an opportunity to grow and learn, to develop and adapt, becoming more and more effective within the environment" (Chiel and Beer 1997).

The aspect of adaptability is particularly evident in the case of Volpiano, which can be symbolically conceived as a homeostatic system: the system of historic farmhouses is hinged between the densely urbanized territory (currently conceived within the metropolitan city) and the still tangible signs of the area's agricultural and rural vocation, and the productivity and use of soils based on ancient knowledge.

If the analysis scale becomes MICRO_LEVEL, the analysis focuses particularly on: (1) the management of functions and activities included and planned for that system; and (2) how such management can create added value for individual businesses and impacts on the territory without sacrificing the protection of protected historical farmhouses. This approach must then be integrated with CSR and an innovative management model that also accepts the "ethical" and "green" dimensions.

CSR should create an additional value to attract markets that considers more likely social and environmental items. One of the first definitions of CSR comes from Bowen (1953), but more recent contributions (Abbott and Monsen 1979; Backman 1975; Bowman and Haire 1975; Carroll 1979, 1994; Eilbert and Parket 1973; Manne and Wallich 1972) and, above all, Dahlsrud (2008), emphasize the five dimensions of CSR (Table 1).

The innovative aspects of CSR are based on the assumption that today it is no longer realistic to address investment in, and the feasibility and sustainability of, agricultural-productive businesses without taking into account the scientific community's debates about: (1) the "responsible" role of the entrepreneur, also towards the community and public institutions; and (2) cost-opportunity and business risk issues also in a "green" key. The Global Corporate Social Responsibility Policies Project of 2003 states: "Global corporate social responsibility can be defined as a business practice based on ethical values and respect for workers, communities and the environment" (Dahlsrund 2008); and (3) the accountancy system and the

Table 1 CSR model: the five dimensions

Dimension	Dimension refers to
The stakeholders dimension	The natural environment
The social dimension	The relationship between business and society
The economic dimension	Socio-economic or financial aspects, including describing CSR in terms of a business operation
The voluntariness dimension	Stakeholders or stakeholder groups
The environmental dimension	Actions not prescribed by law

Source Dahlsrund (2008)

processes relating to participative stakeholders, which can influence administrative and production processes. In this work, the research team outlined (in conjunction with partners) a framework that shares the principles of CSR but reflects the new approach of the Multifunctional Agriculture Model (MAM).

2.1 The New Approach in a Rural Context: A Multifunctional Agriculture Model (MAM)

The activities of briefing between the partners (Municipality, Network of Territorial Municipalities, Soprintendenza/Superintendence, active citizens, associations and owners of the farms) have revealed a common framework of economic-financial reasoning and valorization. These arguments have supported the choice of a shared transformation by all stakeholders involved. As mentioned in the *Introduction,* the framework is structured on the theoretical-methodological and application models of the Multifunctional Agriculture Model (MAM) and Process. In applying them to this case study, the authors have re-interpreted the concept of multifunctional agriculture in a dual form: primarily, the MAM conceived as multifunctional agriculture in diversification processes, producing primary goods, as well as agriculture that produces secondary services (diversification of the product, such as fodder, crops, hazelnuts, agritourism, green agriculture, social agriculture or farming with its various declinations etc.); secondly, following the suggestion of Wilson (2009: 269), the framework connects the macro- and micro-levels of the decision-making process.

3 The Case Study: The Historical Farmhouses System in Volpiano (Torino, Italy)

The town of Volpiano is located in the northern part of Turin (Piedmont, Italy) and it belongs to the Canavese macroarea. This territory is characterized by the coexistence and the consolidated interaction of historical rural settlement patterns, partially altered by the construction of roads, and new housing and industrial estates. Accessibility to the territory is configured as one of the most important elements to structure and rationalize the housing system and, above all, to allow development conditions and the competitiveness of the local productive system compared to that at the regional and national levels (Fig. 1). In response to the requests of the public administration, the Politecnico Torino research group has launched some preliminary activities for identifying a scenario for the enhancement of historic farms and for checking the feasibility of this scenario, where the CSR and MAM principles are reinterpreted through the well-known DCFA tool: (1) creating thematic maps that have an informative data set and architecture suitable for georeferencing operations, which will be one of the future developments of this research (see Figs. 1, 2, 3 and 4) the implementation of SWOT analyses, structured according to strategic themes that support the choice of sample/survey areas and the mapping of stakeholders.

The Volpiano area is connected to the major neighboring city centers by a hierarchical road plot of axes, by the Canavesana railway line which touches the right side of the city center (the *Concentrico*) and by the cycle paths (Fig. 2). The anthropic signs play a dominant role in characterization on a local scale, initially for the agricultural landscape forms and complementary to the interaction of the agricultural landscape with historical settlements, i.e., farmhouses.

Until the mid-eighteenth century, the territory of Volpiano was still enclosed within its walls, only later were the first rural buildings built, outside the "village" (the *Ricetto*). There are now 28 farmhouses, some of which are subject to a protection/preservation order (*vincolo di tutela*) by the Superintendence, while others are subject to a bond of architectural conservation by the Municipality.

With reference to current use (Fig. 3), the farmhouses are used for residential purposes (15 out of 28), residential purposes with agricultural production activities (9 out of 28), residential purposes with production-tertiary activities (1 out of 28), or for storage purposes (1 out of 28), with 2 out of 28 being abandoned.

The farmhouses evoke historical memories of Volpiano, and they retrace the footsteps of its fervid agricultural past. Generational change, synonymous with innovation and modernization, is the way to go, so that the return to the rural world does not translate into a traditional recovery of agricultural activities but can

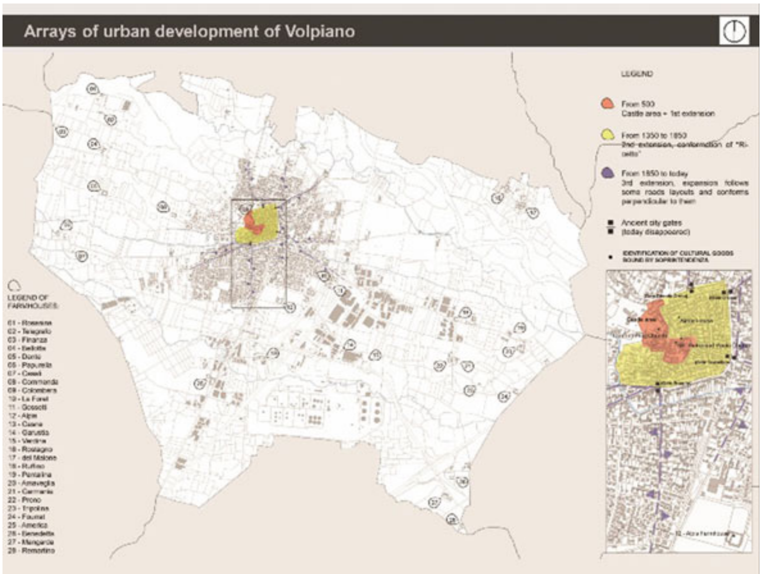

Fig. 1 A system of farmhouses: the accessibility system. *Source* Authors' own work

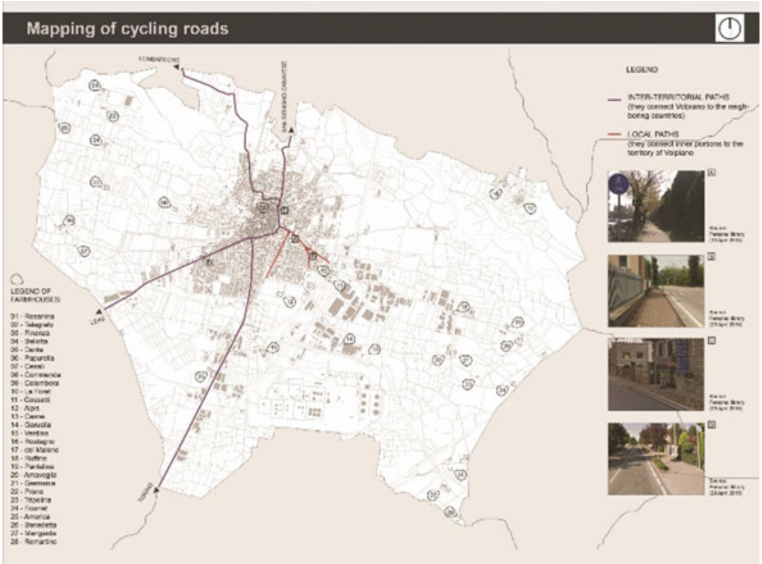

Fig. 2 A system of farmhouses: the cycle paths. *Source* Authors' own work

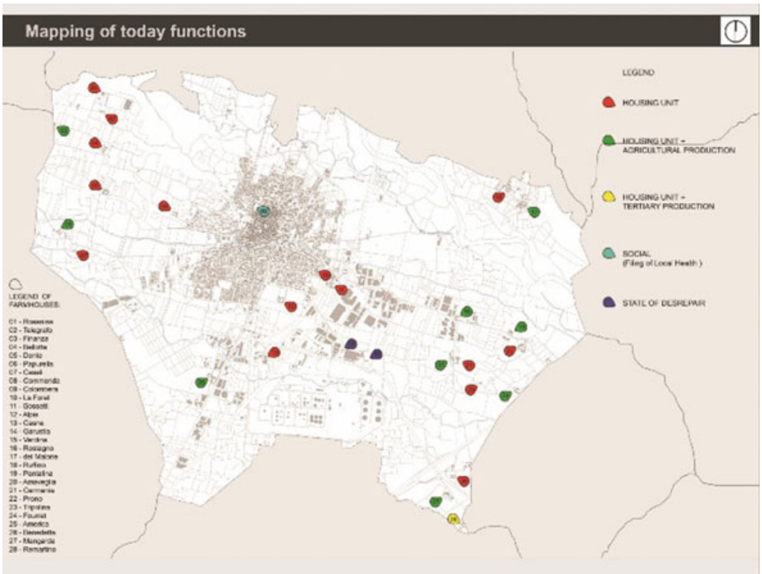

Fig. 3 A system of farmhouses: current functions. *Source* Authors' own work

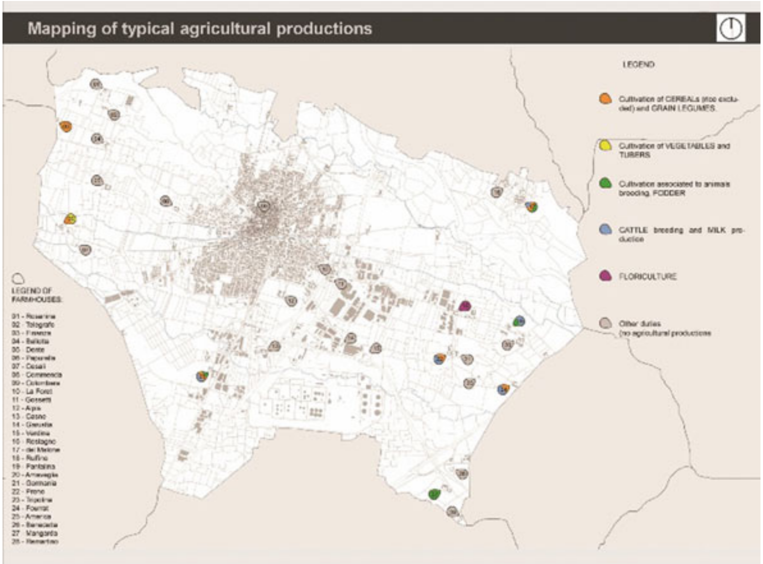

Fig. 4 A system of farmhouses: current productions. *Source* Authors' own work

consider the production of different goods that are intended as a service to the community (Fig. 4). This leads to the concept of multifunctional agriculture, which—as highlighted in Sect. 2.1—in addition to the multidimensionality of decision-making levels, consists of two aspects: the main one coinciding with the production of goods destined for human and animal consumption, and the second one consisting in the production of various type of goods and services (education, instruction, rehabilitation, ennobling, work training). The creation of competitive and sustainable agriculture, by consolidating and developing agriculture that is innovative, multifunctional and qualitative, without neglecting the aspect related to environmental compatibility and awareness among businesses, is one of the best-known points of the strategy developed by European PAC, regional PSR and local Patto Territoriale del Canavese (Canavese Network of Territorial Municipalities). This point is essential in order to respond to a society that demands agricultural productions in line with the European food model, as well as a rural context to be preserved in terms of environmental and landscape features, and social fabric. Having to deal with a conspicuous number of rural buildings, which are scattered here and there and are often not directly connected to each other, during the strategic assessment is necessary in order to make a choice.

The SWOT Analysis tool, whose final results are briefly illustrated in Sect. 4, enabled the selection of the five farmhouses (of 28 total) of the final scenario of the sample area, on which the toolkit of the proposal has been tested. The elements resulting from a SWOT analysis that had greater influence in outlining the sample area were (see the next section for details): (1) average distance from the city center

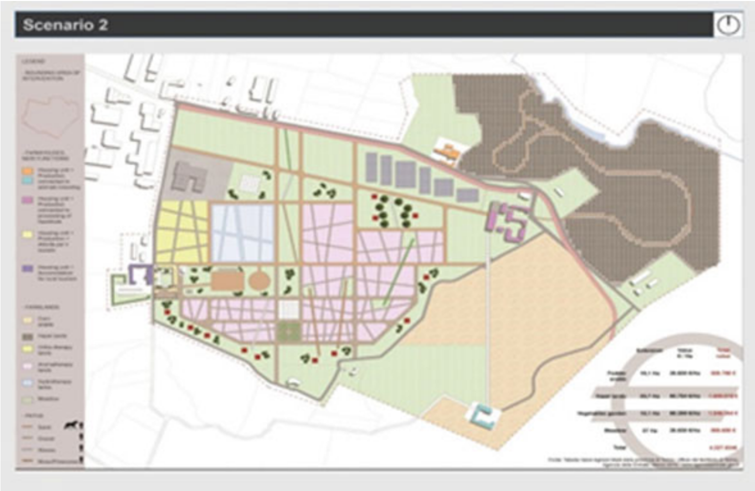

Fig. 5 Scenario 2: the sample area. *Source* Authors' work

and from the railway station (3.5 km); (2) good accessibility (SP 39, provincial road); (3) allocation of land for agricultural use, actively linked to agricultural production activities; (4) low costs of restoration work: the state of degradation is not irreversible; and (5) rules for architectural conservation imposed by the Municipality.

The sample area has a size of 130 ha and is located in the eastern quadrant of the Volpiano district, between the industrial area, the southern bend of Malone and the border with the town of Brandizzo (Fig. 5).

4 Method: A Purpose of New Framework

The effort to experiment with this theoretical framework in Volpiano starts from the following items: (1) the application of principles of the "responsible" management process in the Italian case study; (2) the scenario of the historical farmhouse system in Volpiano: the planning process of peri-urban areas is related to the system of historic buildings and productive activities; (3) the territory is paradigmatic, characterized by the coexistence of historical rural settlement patterns (partially altered by the construction of roads) with new housing and industrial estates: this is an issue of great importance, not only at local level; and (4) it has formed a board of stakeholders (Decisional Board) who seek to create a roadmap for joint action: Politecnico di Torino, Municipality of Volpiano, Canavese Network of Territorial Municipalities, Superintendence, active citizens, associations and owners of the farms.

The method has provided well-defined work phases, in particular three macro phases.

The first is articulated into these elements: (1) the overview of CSR in the MAM; (2) the application of the concept of multifunctional agriculture, conceived as agriculture that produces primary goods, as well as agriculture that produces secondary services (Fig. 6); and (3) a reflection of the strengths and weaknesses of similar operations (Granata 2013; Fregonara 2017): the development of structural frameworks of knowledge of rural landscapes and there settlements, the operational aspects of evaluation and feasibility tests with the introduction of environmental items into the traditional economic accounting approach (green value in International Standards).

The second involved: (1) a briefing with stakeholders identified with the mapping of CSR; (2) the SWOT Analysis; (3) the choice of sample area; (4) the simulation on a sample area of five farmhouses, on which to test the multifunctional process approach.

Figure 7 shows the mapping of the stakeholders carried out by the authors based on the principles of CSR, the MAM and the classification structure suggested by Lichfield (1996, 2005), Coscia et al. (2015), Coscia and De Filippi (2016) and Coscia and Curto (2017) in the well-known model of the Community Impact Analysis (CIA). The stakeholder model applied to the case study today is limited to

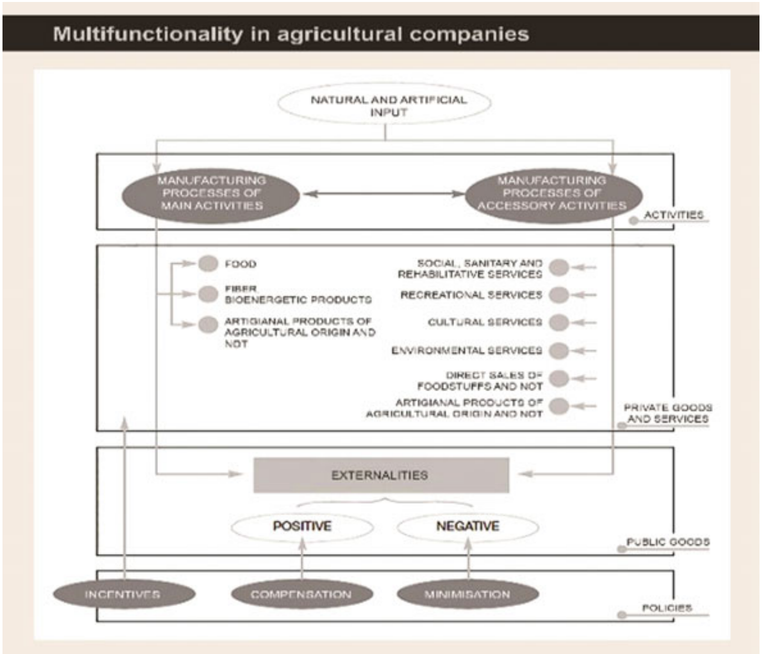

Fig. 6 Concept of project. *Source* Aimone et al. (2006) and Authors' own work

the descriptive list of the various social groups concerned, but the authors plan to develop in the future the impact assessment for each interest group, in order to streamline the CSR process with an articulated and complex identification of all the effects it generates (see Sect. 6, Conclusion).

The SWOT Analysis is configured as the tool which, in a strategic phase, enables emphasis on the aspects, elements and highlights of a system that, once recognized, should be placed between internal and external factors. Faced with a large amount of buildings spread throughout the territory and in order to reach a coherent and plausible design proposal, based on the creation of a system, then a circuit of goods, it became necessary to carry out a skimming to identify a sample area: the SWOT supported that task. During this operation, SWOT analysis issues that played the most important role, or carried the most weight were, in decreasing order of importance, accessibility, relationship with the context, and the current function and state of preservation. This choice led to the identification of five farmhouses located in the eastern quadrant of the Volpiano district, between the industrial estate and the border with the territory of Brandizzo. These farmhouses are: Pantalina, Amaveglia, Germania, Prono and Fourrat. In its traditional structure, the output of SWOT Analysis consists of the aggregation of one or more issues, including different level of knowledge, in order to distil the "real" considerations resulting from the observation: in this version, an original element is the synthetic list of strategic aspects emerging from the four classic parameters, namely the set of real phenomena, called sensitive themes (Fig. 8, final column on the right).

Finally, the third step was the development of the specific FMAM (from the private developer's point of view, but from the perspective of CSR) for the enhancement of the historical farmhouses. Particular attention was paid to three technical phases: (1) mapping of the stakeholders in accordance with the CSR

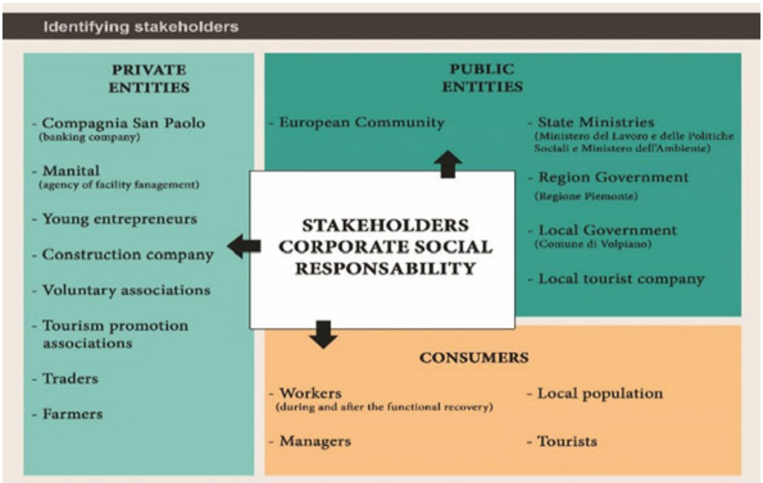

Fig. 7 The CSR mapping of stakeholders. *Source* Aimone et al. (2006) and Authors' own work

Fig. 8 The SWOT Analysis. *Source* Authors' own work

approach (Fig. 7); (2) the identification of specific items in the financial statements (in this test phase, mostly at categorical and descriptive level, with only some quantitative sensitive items); and (3) the governance model.

With regard to the latter aspect, the process involved the establishment of an Associazione Temporanea di Scopo/ATS (Temporary Association of Purpose—Consortium of Farmhouses + local public subject), with the ATS subscribing all parties' attention to a management process and investment of resources, but with a "corporate responsibility approach".

5 Preliminary Results: Learning Points

The results achieved through the SWOT analysis, the meeting with the owners of the five farmhouses present in the sample area and the Municipality's considerations led to the drawing up of three project scenarios (Fig. 9).

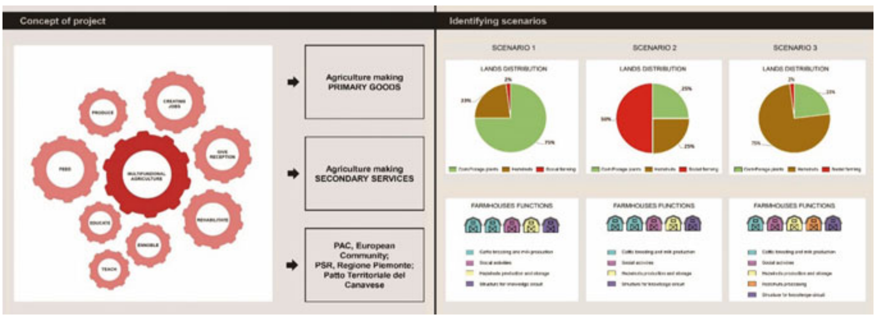

Fig. 9 The MAM: conceptual framework and the three project scenarios. *Source* Authors' own work

Each one differs from the others in terms of crops, which diversifies the amount of land among traditional (corn and forage plants) and innovative crops (hazelnut groves) and spaces allocated to social farming (ortho-therapy, ortho-didactic and pet therapy).

The different distribution of these quantities changes the average agricultural value of the land. The latter is determined at provincial level for homogeneous agrarian regions and soil quality, pursuant to Law n. 865/1971 and determines the incidence of annual profit.

In the first, less ambitious, scenario, it is expected that 75% of the land is devoted to corn and forage plants, 23% to hazelnuts and 2% to social farming (ortho-therapy and ortho-didactic).

As for the farmhouses: two of them are currently in operation (cattle breeding and milk production); one could accommodate social activities; and one of the others could be used for the production and storage of hazelnuts, while the last could become a structure for rural tourism and education. In this first case, the average agricultural value would increase by 46.9% compared to the current value.

In the second scenario, it is expected that 25% of the land will be used to grow corn and forage plants, 25% to grow hazelnuts and 50% for social farming (ortho-therapy, ortho-didactic, pet therapy, aroma-therapy, hydro-therapy, bare-foot paths). As for the farmhouses: their functions are the same as in the first scenario. In the second case, the average agricultural value would increase by 55.36% compared to the current value.

In the third, most ambitious and risky, scenario, it is expected that 75% of the land is devoted to the cultivation of hazelnuts, 23% to corn and forage plants and 2% to social farming (ortho-therapy and ortho-didactic). As for the farmhouses: their functions are the same as in the first scenario, expect for one of the farmhouses, which could accommodate a structure for processing hazelnuts. In this third case, the average agricultural value would increase by 77.42% compared to the current value. Both the farmhouse consortium and the local public entity decide to promote the second scenario, being the one best suited to the goal of creating a multifunctional and competitive agriculture, and intend to initiate the process envisaged in the CSR approach (Steiner 1971; Walton 1967; Wartick and Cochran 1985).

The final project scenario (number two) was checked using traditional feasibility test instruments (Coscia and Curto 2017; Mangialardo and Micelli 2017). Two versions were developed and compared (Fregonara et al. 2016, 2017).

The final scenario was checked by operating on (see Figs. 10 and 11) the functional recovery and the restoration of the farms, traditional fodder and "new" (hazel) crops and the creation of spaces for the use of agriculture and animal husbandry as a source of therapy, education and ennoblement; (2) some specific reflections were made on an estimate of the investment costs for restoration and re-functioning, on the timing of site preparation and the management data, and on the identification of financing channels (for example PSR).

If we were to define the two possible scenarios, we would say that both are based on a new concept of agriculture: agriculture that is capable, in addition to the main

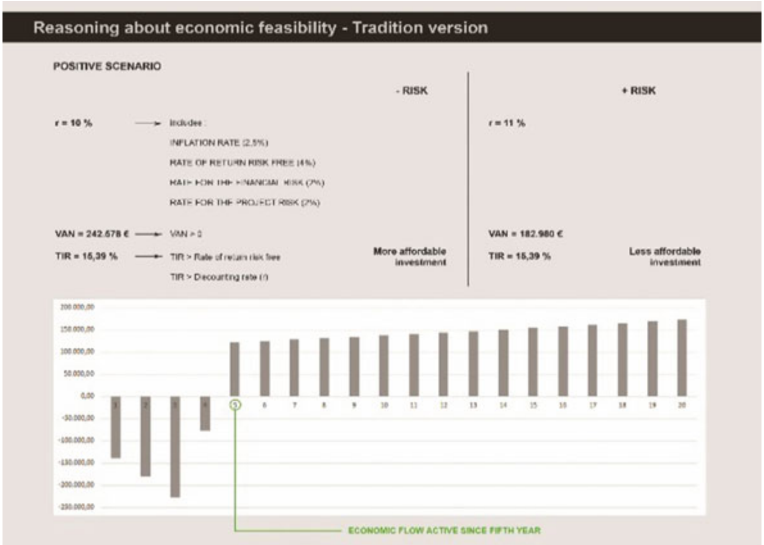

Fig. 10 Final scenario: feasibility results of traditional DCFA. *Source* Authors' own work

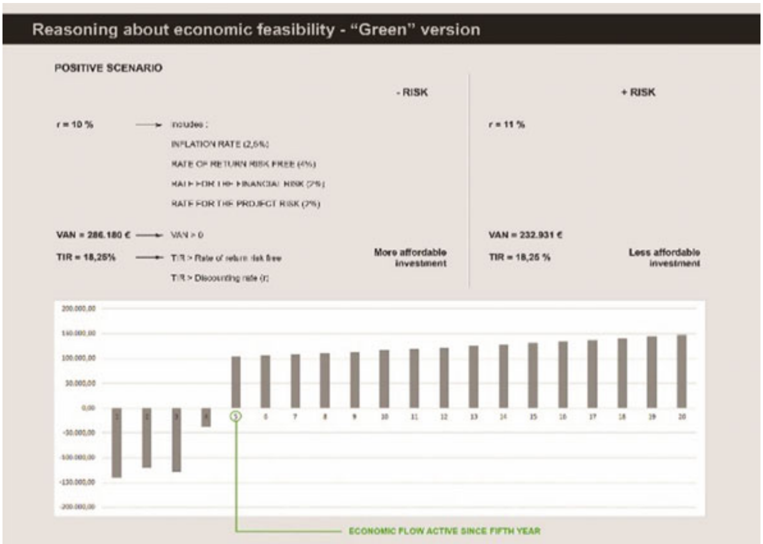

Fig. 11 Feasibility results of green version of DCFA. *Source* Authors' own work

activity, of producing public goods and externalities and ancillary activities—consisting of the transformation and sale of cultural, recreational, social, rehabilitative and environmental services. The difference between the two scenarios lies in the concept of social responsibility, which is stronger in the green version. The concept of corporate social responsibility essentially means that companies decide on their own initiative to help improve society and make the environment cleaner. They adopt an approach that integrates financial, commercial and social aspects by developing a long-term strategy, investing more in human capital and the environment and relationships with other stakeholders. Corporate social responsibility reflected considers the effective integrations of these into the local environment (Committee for Economic Development 1971; Sethi 1975). Businesses make their contribution to the community and, inversely, they depend on good health, stability and the prosperity of the communities that welcome them (Epstein 1987; Tuzzolino and Armandi 1981). The reputation of a local enterprise and its image not only as an employer and producer, but also as a protagonist of local life, certainly affect its competitiveness (Granata 2013; Strand 1983; Swanson 1995).

Furthermore, companies engage in local life, particularly by providing complementary professional training, supporting non-profit organizations in the protection of the environment, recruiting among the excluded, providing shelter for the children of employees, shrinking local partnerships, sponsoring local sports or cultural events or making donations to charity (Eels and Walton 1974; Fitch 1976; Frederick 1960; Holmes 1976; Johnson 1971; Jones 1980; Kreps 1940; Selekman 1959).

Analyzing the economic aspects, the first, traditional, version takes into consideration the following costs and revenues: land and building acquisition (−€344,100), project (−€97,701), investment (−€1,395,736), management (−€446,386), management (€561,645), annual rent (€6000) and funding (€800,000).

In the second, "green", version, the costs for land and building acquisition, project and investment are the same as in the first version. In the light of the Corporate Social Responsibility approach (CSR), the management items include: environmental insurance, certification and advice. This increases management costs to €463,976 (5% compared to the traditional version). In the same way, revenues for management and annual rent remain unchanged compared to the first version, but funding increases to €1,000,000. Government agencies/entities, particularly the Ministry of the Environment, use economic incentives to encourage entrepreneurs who design their project with a "green print". The DCF was calculated with a discounting rate of 10%, which is the sum of the rate of inflation (2.5%), the rate of return risk free (4% for agricultural design), the rate for financial risk and the rate for project risk. The cash-flow-analysis period is 20 years, articulated as follows: the first year for the bureaucratic and project phase, the following three years for recovery operations and to start refunctioning and the remainder for management activity.

In both of these cases, in the initial phase and in the restoration and recovery operations, the economic flow is negative, becoming active as of the fifth year with revenues from management.

The difference is found in the consortium returns: TIR 15.39% in the traditional cash-flow analysis versus 18.25% in the green version.

The decision that a higher, internal rate-of-return is the best economic decision is only true if the capital value is also higher than that of the alternative investment. The internal-interest-rate of return was calculated by dividing a positive scenario, i.e.: in the case where the operating time coincides with that expected by lenders and so the financing tranches are disbursed, tenants regularly pay the rent, and agricultural productions and multifunctional activity revenues are good (Cochron and Wood 1984; Hřebíček et al. 2012; Wood 1991).

The mapping of the stakeholders in descriptive form enabled them to engage in these feasibility considerations, in addition to the public administration, also targeting users and potential consumers, in order to participate in an active and preventive manner in the scenario of enhancement and management of the five sample farms. The conditions we have considered take into account the minimums required to attain a positive cash flow.

6 Conclusion

The experimental results outlined in the preceding paragraphs can be critically analyzed in relation to the replicability of the experience, the positive effects that have already been generated by this experimentation and the issues that remain open, which will be subject to future developments.

Below is the articulation of the outcomes and reflections

– *Experiences*

The reinterpretation of the toolkit of the alternate integrated method (DCFA with the *green* items according to the MAM and to the CSR approach) was positive. An exemplary statement could be: "The integration of financial performance within environmental, social and governance performance reflects a growing desire by stakeholders for more information on a broader range of issues".

The "peri-urban" theme remains complex and still not entirely focused: the board never addressed issues of land use and protection of the landscape and did not resolve the differences between urban and rural themes. Verification of the feasibility of the "green" scenario of enhancement of the five sample farms indicates higher performance than the traditional scenario, testing the sensitivity of even just a few operational items. In particular, the profit is generated by the multifunctional diversification of production, coupled with an increase in the value of the land. A high degree of success and the certainty of financing and facilitation are strong binding factors for a positive return on the operation.

– *Benefits and added value*

Experimentation has shown that this framework generates positive values both in terms of operating profits for owners, and in terms of the benefits to the community and interest groups involved. On one hand, the asset value of the buildings increases not very much from the investment items (the costs of refurbishment are contained), but thanks to a capitalization of income derived from functions, responsibly chosen and designed by the five owners together with the Politecnico di Torino and the Municipality of Volpiano. On the other, the people involved embarked on a process of "environmental education" and social responsibility in the transformation of rural areas, with the emphasis on preserving historical memory.

– *Next steps*

Experimentation has been a tool to provide information and facilitate the appeal to and proposed involvement of different parties, but some aspects require consideration (see Fig. 6): (1) the board has initiated a "listening" model between the parties and prepared the items but the ATS/Temporary Association of Purpose (farmhouse consortium + public administration entity) is now only a "good intention", not yet having signed a Protocollo d'Intesa (Collaborative Agenda); (2) the team of the Politecnico di Torino supports the knowledge datasets, but the management process have not been completed and the Municipality of Volpiano have a totally responsibility; (3) the feasibility study must be completed by an analysis of the impacts on each stakeholder (Impacts Social and Benefits/CIA Method).

References

Abbott, W. F., & Monsen, R. J. (1979). On the measurement of corporate social responsibility: Self-reported disclosures as a method of measuring corporate social involvement. *Academy of Management Journal, 22,* 501–515.

Ackerman, R. W. (1973). How companies respond to social demands. *Harvard Business Review, 51*(4), 88–98.

Ackerman, R. W., & Bauer, R. A. (1976). *Corporate social responsiveness*. Reston, VA: Reston.

Allen, A. (2003). Environmental planning and management of the peri-urban interface: Perspectives on an emerging field. *Environment and urbanization, 15*(1), 135–148.

Aimone, S., Cassibba, L., Cagliero, R., Milanetto, L., & Novelli, S. (2006). *Multifunzionalità dell'azienda agricola*. IRES: Torino, Italy.

Aupperle, K. E., Carroll, A. B., & Hatfield, J. D. (1985). An empirical investigation of the relationship between corporate social responsibility and profitability. *Academy of Management Journal, 28,* 446–463.

Backman, J. (Ed.). (1975). *Social responsibility and accountability*. New York: New York University Press.

Bowen, H. R. (1953). *Social responsibilities of the businessman*. New York: Harper and Row.

Bowman, E. H., & Haire, M. (1975). A strategic posture toward corporate social responsibility. *California Management Review, 18,* 49–58.

Carroll, A. B. (Ed.). (1977). *Managing corporate social responsibility*. Boston: Little, Brown.

Carroll, A. B. (1979). A three-dimensional conceptual model of corporate social performance. *Academy of Management Review, 4,* 497–505.

Carroll, A. B. (1981). *Business and society: Managing corporate social performance*. Boston: Little, Brown.

Carroll, A. B. (1983, July 15). Corporate social responsibility: Will industry respond to cutbacks in social program funding? *Vital Speeches of the Day, 49,* 604–608.
Carroll, A. B. (1991, July/August). The pyramid of corporate social responsibility: Toward the moral management of organizational stakeholders. *Business Horizons, 34,* 39–48.
Carroll, A. B. (1994). Social issues in management research: Experts' views, analysis and commentary. *Business and Society, 33,* 5–29.
Chiel, Hillel J., & Beer, Randall D. (1997). The brain has a body: Adaptive behavior emerges from interactions of nervous system, body and environment. *Trends in Neurosciences, 20*(12), 553–557.
Cochran, P. L., & Wood, R. A. (1984). Corporate social responsibility and financial performance. *Academy of Management Journal, 27,* 42–56.
Committee for Economic Development. (1971). *Social responsibilities of business corporations*. New York: Author.
Coscia, C., Fregonara, E., & Rolando, D. (2015). Project management and briefing: Supporting tools for territorial planning. The case of disposal of military properties. *Territorio, 73,* 135–144.
Coscia, C., & Curto, R. (2017). Valorising in the absence of public resources and weak markets: The case of Ivrea, the 20th century industrial city. In Stanghellini S., et al. (Eds.), *Appraisal: From theory to practice results of SIEV 2015* (pp. 79–99). Berlino: Springer.
Coscia, C., & De Filippi, F. (2016). L'uso di piattaforme digitali collaborative nella prospettiva di un'amministrazione condivisa. Il progetto Miramap a Torino (ITA version). The use of collaborative digital platforms in the perspective of shared administration. The MiraMap project in Turin (EN version). *TerritorioItalia, 1,* 61–104.
Dahlsrud, A. (2008). How corporate social responsibility is defined: An analysis of 37 definitions. *Corporate Social Responsibility and Environmental Management, 15*(1), 1–13.
Dalton, D. R., & Cosier, R. A. (1982, May/June). The four faces of social responsibility. *Business Horizons, 23,* 19–27.
Davis, K. (1960, Spring). Can business afford to ignore social responsibilities? *California Management Review, 2,* 70–76.
Davis, K. (1967, Winter). Understanding the social responsibility puzzle: What does the businessman owe to society? *Business Horizons, 10,* 45–50.
Davis, K. (1973). The case for and against business assumption of social responsibilities. *Academy of Management Journal, 16,* 312–322.
Davis, K., & Blomstrom, R. L. (1966). *Business and its environment*. New York: McGraw-Hill.
Drucker, P. F. (1954). *The practice of management*. New York: Harper and Row.
Drucker, P. F. (1984). The new meaning of corporate social responsibility. *California Management Review, 26,* 53–63.
Eells, R., & Walton, C. (1974). *Conceptual foundations of business* (3rd ed.). Burr Ridge, IL: Irwin.
Eilbert, H., & Parket, I. R. (1973, August). The current status of corporate social responsibility. *Business Horizons, 16,* 514.
Epstein, E. M. (1987). The corporate social policy process: Beyond business ethics, corporate social responsibility, and corporate social responsiveness. *California Management Review, 29,* 99–114.
Fitch, H. G. (1976). Achieving corporate social responsibility. *Academy of Management Review, 1,* 38–46.
Frederick, W. C. (1960). The growing concern over business responsibility. *California Management Review, 2,* 54–61.
Freeman, R. E. (1984). *Strategic management: A stakeholder approach*. Boston: Pitman.
Fregonara, E. (2017). Methodologies for supporting sustainability in energy and buildings. The contribution of Project Economic Evaluation. *Energy Procedia, 111C,* 2–11.
Fregonara, E., Giordano, R., Rolando, D., & Tulliani, J. M. (2016). Integrating environmental and economic sustainability in new building construction and retrofits. *The Journal of Urban Technology, 23*(4), 3–28.

Fregonara, E., Giordano, R., Ferrando, D. G., & Pattono, S. (2017). Economic-environmental indicators to support investment decisions: A focus on the buildings' end-of-life stage. *Buildings, 7*(3), 1–20.
Granata, M. F. (2013). Aspetti valutativi nella costruzione del sistema informativo per la gestione ambientale dell'azienda. *Valori e Valutazioni. VI, 10,* 117–132.
Hřebíček, J., et al. (2012). Corporate performance indicators for agriculture and food processing sector. *Acta universitatis agriculturae et silviculturae Mendelianae Brunensis, 60*(4), 121–132.
Heald, M. (1970). *The social responsibilities of business: Company and community, 1900–1960*. Cleveland, OH: Case Western Reserve University Press.
Holmes, S. L. (1976, June). Executive perceptions of corporate social responsibility. *Business Horizons, 19,* 34–40.
Johnson, H. L. (1971). *Business in contemporary society: Framework and issues*. Belmont, CA: Wadsworth.
Jones, T. M. (1980, Spring). Corporate social responsibility revisited, redefined. *California Management Review, 22,* 59–67.
Kok, W. (2004). *Facing the challenge: The Lisbon strategy for growth and employment. Report from the High Level Group chaired by Wim Kok*. Luxembourg: Office for Official Publications of the European Communities.
Kreps, T. J. (1940). *Measurement of the social performance of business. In An investigation of concentration of economic power for the temporary national economic committee* (Monograph No. 7). Washington, DC: U.S. Government Printing Office.
Lichfield, N. (1996). *Community impact evaluation*. London: Bristol, UCL Press.
Lichfield, N. (2005). *Community impact evaluation: Principles and practice*. London: Routledge.
Manne, H. G., & Wallich, H. C. (1972). *The modern corporation and social responsibility*. Washington, DC: American Enterprise Institute for Public Policy Research.
Mangialardo, A., & Micelli, E. (2017). *Processi partecipati per la valorizzazione del patrimonio immobiliare pubblico: il ruolo del capitale sociale e delle politiche pubbliche*. LaborEst, 14, 52–57.
Preston, L. E. (Ed.). (1978). *Research in corporate social performance and policy* (Vol. 1). Greenwich, CT: JAI.
Preston, L. E., & Post, J. E. (1975). *Private management and public policy: The principle of public responsibility*. Englewood Cliffs, NJ: Prentice Hall.
Selekman, B. (1959). *A moral philosophy for business*. New York: McGraw-Hill, Google Scholar.
Sethi, S. P. (1975). Dimensions of corporate social performance: An analytic framework. *California Management Review, 17,* 58–64.
Steiner, G. A. (1971). *Business and society*. New York: Random House.
Strand, R. (1983). A systems paradigm of organizational adaptations to the social environment. *Academy of Management Review, 8,* 90–96.
Swanson, D. L. (1995). Addressing a theoretical problem by reorienting the corporate social performance model. *Academy of Management Review, 20,* 43–64.
Tuzzolino, F., & Armandi, B. R. (1981). A need-hierarchy framework for assessing corporate social responsibility. *Academy of Management Review, 6,* 21–28.
Walton, C. C. (1967). *Corporate social responsibilities*. Belmont, CA: Wadsworth.
Wartick, S. L., & Cochran, P. L. (1985). The evolution of the corporate social performance model. *Academy of Management Review, 10,* 758–769.
Wilson, G. A. (2009). The spatiality of multifunctional agriculture: A human geography perspective. *Geoforum, 40*(2), 269–280.
Wood, D. J. (1991). Corporate social performance revisited. *Academy of Management Review, 16,* 691–718.
Zenisek, T. J. (1979). Corporate social responsibility: A conceptualization based on organizational literature. *Academy of Management Review, 4,* 359–368.

Enhancing the Endogenous Potential of Agricultural Landscapes: Strategies and Projects for a Inland Rural Region of Sicily

Gerlandina Prestia and Valeria Scavone

Abstract This paper focuses on the potential of the rural landscape of Sicily, the largest island in the Mediterranean Sea, taking into particular account the critical need to deal with the problem of depopulation of the small inner areas by leveraging the “integrated exploitation” of local resources. The rural landscape is considered to be capable of playing an essential role in many fields: ecology, production, culture and tourism. In this regard, guidelines are set by the Sustainable Development Goals of the United Nations, the EU guidelines and the experience from Italy’s Rural Development Plans, the latter of which aim at achieving the much sought-after multi-functionality of agriculture. This study has been conducted in our particular moment in history, when new attention is being drawn to the potential of rural landscape due to its fragility, the crisis of traditional production systems and the changes caused by urbanization, which have had irreversible effects on many rural areas, based on traditional agriculture, and on ecosystem services. Keeping this goal in mind, the Sicilian case study should be considered as a sort of “test bench” where the validity of the abovementioned considerations can be tested. The area Agrigento-Caltanissetta-Enna in mid-southeastern Sicily is an area composed of sixteen municipalities in the three (ex) regional provinces of Agrigento, Caltanissetta and Enna, which, from the coast facing Africa (characterised by major cultural sites UNESCO Heritage) stretches to the “heart” of inner Sicily along the “grey line” composed of trunk road S.S. 122. The rural landscape that characterizes this area is the result of a complex process of interactions between various natural and anthropic factors that often conflict with each other and define the identity of the landscape itself and its dynamic and economic processes. The area treated in this paper has been analyzed to highlight its particular features, thus proposing a

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"landscape project" called *NetWalk*. This paper employs several different strategies needed to develop the *NetWalk* project, each with its own specific aims: opportunities arising from the agreement that allows the Italian state-property agency to sell its roadman's houses, and from the downgrading of trunk road 122, which might become a slow path through this region while connecting with important areas and resources; the return to "walking paths" (promoted by the Italian Ministry of Cultural Heritage and Activities and Tourism in 2016), with the purpose of creating a green network made up of slow paths, of previously abandoned buildings that should be renovated and adapted for new uses, of highly-valued (even though they are currently considered of minor importance) rural landscapes, and of intangible assets which thus become tangible; the Italian Rural Development Plans, which involve a strategic change in the role of agriculture, which should be linked to the concept of "multi-functionality" in many different ways: from farming for energy production, to the protection of rural landscapes in terms of tourism services, to education and social services; the many food quality certifications granted to many typical Sicilian products. All these activities, when properly carried out, will create a "bio-region" in the area covered by the project. The inhabitants of this region will share a sense of belonging, identity and collective memory.

Keywords Agricultural landscape · Rural development plans · Endogenous potential · Sicily

1 The Importance of the Rural Environment: A Method for Studying the Inner Areas of Mid-Southeastern Sicily

This study has been developed at a moment in history when—under the umbrella of sustainability and integration—new attention is being drawn to the potentiality of rural landscapes, with particular reference to the future of the various "inner" and "rural" areas of Italy.[1] In particular, "Inner Areas" are defined as areas being at some considerable distance from centers offering such services, and where there has been a fall in population and a rise in degradation. Demographic trends, access to healthcare and adequate education provision are just some of the essential criteria for defining and classifying Inner Areas. These areas currently make up approximately 60% of the Italian territory and are home to around 13.540 million people. The Italian national strategy for reversing the depopulation and marginalization of these areas, hinging on two key economic policy assets: improving personal services and triggering local development projects (MUVAL 2014). The renewed interest in rural landscapes is due, in the first place, to its characteristic fragility caused by the acceleration of economic and social processes on a global scale. The crisis of traditional production systems—driven by the globalization of trade—is

[1]These terms will be defined in the following sections.

not the only challenge implied in preserving the landscape, but it certainly is the one that has the most dramatic and irreversible effects on many hill and mountain landscapes based on traditional agriculture. The changes in landscape caused by urbanization and the creation of buildings for tourism purposes (in the traditional meaning of the word) is the other serious threat: acres of coastal and hill landscape have been completely destroyed over the recent few decades, with negative impact on ecosystem services, which are necessary for the survival of all living creatures.

Another aspect, which is often overlooked or has not yet been completely clarified, is the contribution that the preservation of rural landscape can make to the local economy: for many typical products branded with DOP, DOC, IGT and other Italian quality labels, it is necessary to take advantage of the potential offered by the "added value" of the Italian landscape.[2] This aspect has been recently highlighted by the "Rural Development Plans", which, since 2007, have acknowledged the importance of the various funding events, which imply a strategic change to the role of agriculture by associating it in many different ways to the concept of multi-functionality: from farming for energy production, to the preservation of the environment and rural and natural landscape, to the supply of tourism, social and education services. This is a new way of interpreting agriculture (by the Common Agricultural Policy), where multi-functionality becomes a tool for preserving the rural landscape, which, in fact, is a strategic goal in the agricultural field.

Moreover, the Italian rural landscape is characterized by the presence of several artifacts from ancient civilizations, which contribute further to documenting the stratification of the landscape itself. In particular, there are many architectural findings, which, according to the guidelines of the 1999 "Landscape Plan", are classified as "production, military and religious architecture". Particularly interesting are those artifacts from production architecture (in particular farms, farmhouses and mills), most of which are in a state of neglect and therefore prone to degradation. They represent a substantial and underestimated part of cultural heritage across the rural landscape, not only in Italy but also throughout Europe; it is therefore necessary to consider recovering and reusing such artifacts. In this regard, with the "Conference Européenne des Ministres Responsables de l' Aménagement du Territoire" (CEMAT), the European Council has, since 1983, established guidelines for renovation works on agricultural buildings, which set a paradigm for preserving rural landscapes[3] in general. Particularly meaningful was the development by English Heritage of a guideline in 2006 that set rules for the protection and development of agricultural buildings, so as to ensure their correct reuse while maintaining their architectural characteristics and their relationship with the surroundings ("The conversion of traditional farm buildings" 2006) (Fig. 1).

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[2]Thematic paper issued by the Ministry for Agricultural, Food and Forestry Policies, Rural Development Plan 2007–-2013, page 7, compare http://landscapeunifi.it/images/pdf/documento_tematico_Paesaggio_-_Overview.pdf (25/05/2016).

[3]Compare Charte Européenne de l'aménagement du territoire Charte de Torremolinos (Spain), 20 May 1983.

Fig. 1 Region included in the case study. Councils under the province of Agrigento, Enna and Caltanissetta

2 Case Study

Starting from the above-mentioned considerations, this paper examines the rural landscape of mid-southeastern Sicily, while focusing on a "region" that contains 16 municipalities in the provinces of Agrigento (Agrigento, Aragona, Canicattì, Castrofilippo, Comitini, Grotte, Favara, Naro, Racalmuto), of Caltanissetta (Caltanissetta, Delia, Montedoro, San Cataldo, Serradifalco) and of Enna (Enna, Pietraperzia). The concerned region, which stretches over an area of 1873 km^2, is classified by the Italian National Institute of Statistics ISTAT as "inner hills" and the above-mentioned municipalities fall within one or more categories of disadvantage (agriculture, environment and settlement).[4]

The orography is rather complex: the height varies from 338 mt in the area of Favara to over 950 mt. in the area of Enna; only five municipalities are located in the altitude zone defined as "coastal hills", while ten are located in the "inner hills", i.e., an area generally characterized by an altitude of less than 700 mt.

The municipalities of this region, the rurality and remoteness of which have been evaluated, are located in rural areas (except for Agrigento, which is considered a "pole" in both classifications). Even though the level of remoteness is "limited", as the remoteness of all municipalities has been classified as "medium" (except for the remoteness of Montedoro), in seven municipalities, rurality is connected with "development issues". This negative trend also appears in various different economy sectors; in fact, by comparing data from the classification of economic

[4]Compare *Atlante Nazionale del territorio rurale* (2010) prepared by the Ministry for Agricultural, Food and Forestry Policies.

activities during the five historic periods 1971, 1981, 1991, 2001, 2011, some significant data emerges:

- even though agriculture is still the driving sector of the economy, currently, more than ever, a decrease in the number of businesses has been recorded;
- the extraction of minerals is hardly carried out anymore in nine municipalities, while, on the contrary, in Canicattì, Favara and Enna, an increase was recorded in 2011 compared to the other censuses;
- in Canicattì, Castrofilippo, Favara, Caltanissetta, Serradifalco and Pietraperzia, the business sector had a more or less significant increase in the number of businesses in 2001 compared to 2011;
- the manufacturing industry has remained mostly unchanged in almost all the municipalities;
- there is no hospitality business at all in four municipalities (Aragona, Castrofilippo, Comitini and Delia);
- the restoration industry had a sharp overall increase in 2011 (Table 1).

3 *NetWalk*: From Prerequisites to a Proposal for a "Territorial Project"

The *NetWalk* project is based on an agreement, signed in December 2015 between ANAS (the Italian National Autonomous Roads Corporation), the Italian Ministry of Cultural Heritage and Activities and Tourism, the Italian Ministry of Infrastructure and Transport, and the Italian State-Property Agency, for the redevelopment and reuse of public properties for cultural and tourism purposes, starting from the roadman's houses[5] spread along Italy's trunk roads. As mentioned above, this agreement is just a starting point, as the pilot project does not take into account well-known paths that connect prestigious areas from the point of view of landscape, history, arts and architecture; on the contrary, it deals with an area that is currently not considered prestigious.

The roadman's houses taken into consideration in this paper are those along trunk roads, in particular trunk road S.S. 122, Agrigento-Caltanissetta (nowadays replaced by the faster trunk road S.S. 640), which links and crosses seven of the 16 municipalities concerned.[6] While defining the area for the project, regions of other municipalities linked to this trunk road have been included, which—as it emerges from the analysis—need to be considered as fragile contexts suffering from

[5]Throughout Italy, ANAS owns 1244 roadman's houses along major trunk roads, where road-maintenance workers used to live until the mid-1990s.

[6]The last part approaching Enna is Central Sicily trunk road 117 bis.

Table 1 SWOT case of study, 2016, edited by Gerlandina Prestia

Strengths	Weaknesses
A great wealth of cultural and natural resources Traditional rural landscape Network infrastructure being implemented via articulated network of paths and historic roads Many events and festivals provincial interest Local agro-food products bearing quality brands Dissemination of the demand for rural tourism Representation of this portion of the Sicilian rural area, returned by copyright literature (Sciascia, Pirandello, …) Tourist focal points are very close A mild climate throughout the year Limited human pressure Propensity associations (GAL)	Diffuse risk of desertification of the land Cultural and Natural Heritage excluded the offer tourist Poor training opportunities High unemployment High rate of depopulation Lack of local development strategies Shortage of accommodations Tourism product poor/non-existent Poor utilization of quality production Low level of livability Progressive abandonment of agriculture
Opportunities	**Threats**
Financing from PSR for multifunctional agriculture Funding for the conversion to organic farming Sicily is a region of "Convergence objective" Renewed interest in DPS for internal areas Development programs that focus on rural tourism (LEADER) Actions to the energy efficiency and energy production from renewable sources (e.g., SEAP) Implementation of the Provincial and Regional Information System Positive demographic dynamics in some municipalities in the area, mostly coastal areas Adoption of sustainable farming practices Proposal for declassification of the SS 122 (which is devoid of the characteristics of a highway, Legislative Decree no. 285/1992) to allow a reduction of the vehicular traffic Projects on land developed from analysis and strategy (this project)	Experience of the Integrated Territorial Programs (PIT) not completed obsolete ordinary planning tools Failure to intercept the funds of the PSR Increasing competitiveness by other countries on agricultural production Worsening of essential services in rural areas, particularly in mountainous areas due to the reduction of public spending and unsustainable organizational models Lack of a "Vision City" and shared with private operators to guide local development policies Lack of knowledge and/or awareness of the actors in the area on innovative and strategic potential roles of environmental, historical and cultural resources

economic and demographic disadvantages; at the same time, these regions have an unexpressed potential arising mainly from their rural landscapes, like "Terzo paesaggio" (Clement 2005).

Starting from this scenario and from the above-mentioned input from the Italian Ministry of Cultural Heritage and Activities and Tourism, this paper pursues a main objective: to develop a strategy aimed at planning and designing a "green line" of paths (that should be rediscovered or created from scratch) for "slow mobility" (with a particular reference to walking)—an alternative to trunk road S.S. 122

(the grey line)—which should connect the main centers taken into account in the area of Agrigento, Caltanissetta and Enna (by crossing them or connecting to them). The aim of this green line is to discover the cultural heritage and the rural landscape of the area; this heritage is often improperly considered "minor heritage", which Gilles Clement in Third Landscape (2005) defined a marginal area with indeterminate spaces, with unexpressed potential, a special example of biodiversity between undisturbed nature and anthropic activities.

This objective can be achieved only through joint and co-ordinated activities: the strategy cannot be followed by single municipalities, as they are small communities without the necessary resources and, most importantly, because all inner and/or rural areas suffer the same problems. The first step, therefore, is to involve the administrations and the *stakeholders* (from residents, to convince them to stay, to farmers and land owners, who need to open up to the multifunctionality of agriculture) by informing and educating them about the importance of installing this project, so as to actively develop the area they live and work in. After all, the endeavor to preserve this heritage (an endeavor that Italy confirmed by signing the European Landscape Convention in 2006) requires a collective effort that should include the administrations, all the public institutions, but also associations and private citizens.

The proposed landscape project is based on the following elements:

- the activities being carried out on a national level to restore and re-use the roadman's houses along trunk roads
- the recently renewed attention from the Department for the Economic Development and Cohesion towards inner areas
- the new funding for rural development, which concerns activities other than traditional agriculture
- the spread of a new way of carrying out sustainable tourism,[7] the success of rural tourism, and the awareness that tourism programs (which should not be considered just a means of marketing) should become necessary to those communities to which urban planning applies
- the high quality, which is often unknown to most people, of some inner rural landscapes that are hardly accessible
- the will to set up a project focused on the themes of slow mobility (in particular, the "walking route" at this moment in history, 2016, called "the year of walking") and the themes of recovering abandoned buildings in rural landscapes
- the meaning of landscape as the subject and, at the same time, the object of new energy policies

NetWalk is intended as a "landscape project" because of its approach characterized by a tendency to change, which is realized by creating added landscape

[7]The European Commission put sustainable tourism at the center of its strategy (Communication 352/2010), and in 2013, it presented the European Tourism Indicators System for sustainable destination management.

value; according to Dematteis (2001: 22), this definition “can be used when self-organized local-development processes are activated that, in turn, activate various types of resources, which were not available at the beginning of the process”. The landscape project goes beyond traditional approaches (which consider agroforestry areas that should be protected by sectorial policies, i.e., naturalistic spaces, as protected areas with barns and “fences”), so as to let open spaces evolve into laboratory areas for new productive, environmental and beneficial relationships between the city and the rural world, capable of restoring the centrality of the rural world in terms of economy, production, environment, landscape, recreation, culture and social relationships, so as to create self-sustainable local development models.

According to the results of the analysis, the area of study can be considered as a template on which to develop the project hypothesis, which should combine various elements (considerations on rural landscape, resources and new tools available) to create a project that expresses a development strategy based on local resources under the umbrella of sustainability (Prestia and Scavone 2016).

NetWalk should be based on the concept of a network, while highlighting the importance of “moving in a sustainable, environmentally friendly way”, i.e., the concept of “moving slowly”, of “walking” as a healthy, democratic and inexpensive activity, which expresses the concept of “slow mobility” and, in particular, of “human-powered mobility”. In addition to the fact that the health benefits of walking have been widely recognized, “walking” can be considered the ideal means to learn about and benefit from the rural landscape, without limiting oneself to only look at it, but also learning to observe it, thus becoming an active protagonist in it (Turri 2003). “Walking” thus becomes a process of self-education, intended not only for visitors, but also for local communities; a process which should help them achieve a relationship with the landscape and its genetic heritage (Volpe 2015), both tangible and intangible, which is not “metaphysical data” but rather it “continuously regenerates its meaning and reshapes itself according to the development trends of the society” (Volpe 2015: 104).

The primary objective of *NetWalk* is, therefore, to trigger a process of development of the local potential of the landscape, which should tackle the problem of economic hardship and be based on the thousand-year-old history of the relationship with nature, with the awareness that the context in the inner rural areas of Sicily, which are characterized by exceptionally beautiful landscapes, are a priceless, yet undiscovered treasure. This objective can be achieved through a series of project activities, which revalue those elements highlighted by the analysis:

- to physically link to the road network those places where there are abandoned buildings spread across the rural landscape, like farms, farmhouses, mills and old villages, which should be renovated and adapted to new uses
- to connect, in a sustainable way, to the road network also minor towns, which thus will be included in a sort of extended rural park
- to renovate and recover abandoned areas (buildings, infrastructure, etc.)
- to use the funding from apparently “external” sources (rural development plans)

- to use the communicative effect which could arise from applying for the National Registry of Rural Landscapes

To avoid isolated and thus useless actions, the project should be the result of proper extended planning, where the people in charge and the municipality administrations should be urged to act by involving the various relevant stakeholders. In particular, the following can be considered stakeholders in the project:

- local businesses (agricultural businesses, dairy factories, oil manufacturers, wine makers, bicycle manufacturers, manufacturers of sports items)
- people in charge of public transport (the Italian State Railways)
- local associations (cultural, sports, religious and environmental associations, but also local action groups)
- tourism agencies and agents
- landowners and agricultural entrepreneurs (with whom agreements should be entered into, so as to allow passage through private property; a sort of “rules for passage” [8] which are useful with a view to multifunctional agriculture).

4 New Paths and New Uses for Abandoned Areas

At the core of the *NetWalk* project lies the green line of existing paths (which often have historical origins) and of paths that need to be built from scratch. The landscape plan (from the guidelines to the territorial plans, in which they have been approved) has restored many royal country roads (97), old droveways, and primary public roads that connect cities with smaller villages. Similarly to the sheep tracks in Abruzzo and Molise, royal country roads in Sicily date back to the times of old pastoral economy, which has always characterized this area. They were built as public roads along which livestock were historically driven, and, over time, became important connection roads between cities, villages and the countryside. As a result of Italian Law 2248/1865, which classified roads into trunk (state) roads, province roads, municipal roads and local roads, royal country roads became less important, also because the pastoral economy started to decrease.[9] Most of these roads ended up being converted into trunk roads, while others remained until today and, in the area covered by this paper, they can be regarded as useful references for the development of a series of paths (although some may need to be connected to the road network), and of new “stretches of paths” that cross the rural landscape and ensure continuity with the past (Fig. 2).

[8]Currently, only licensed hunters are allowed to enter private property (art. 842 of the Italian Civil Code).

[9]Country roads converted into ordinary drivable roads, occupation of public spaces was progressively authorized and the original road width was reduced. Only with Royal Decree no. 3244 of 30 December 1923 was the use of royal country roads regulated.

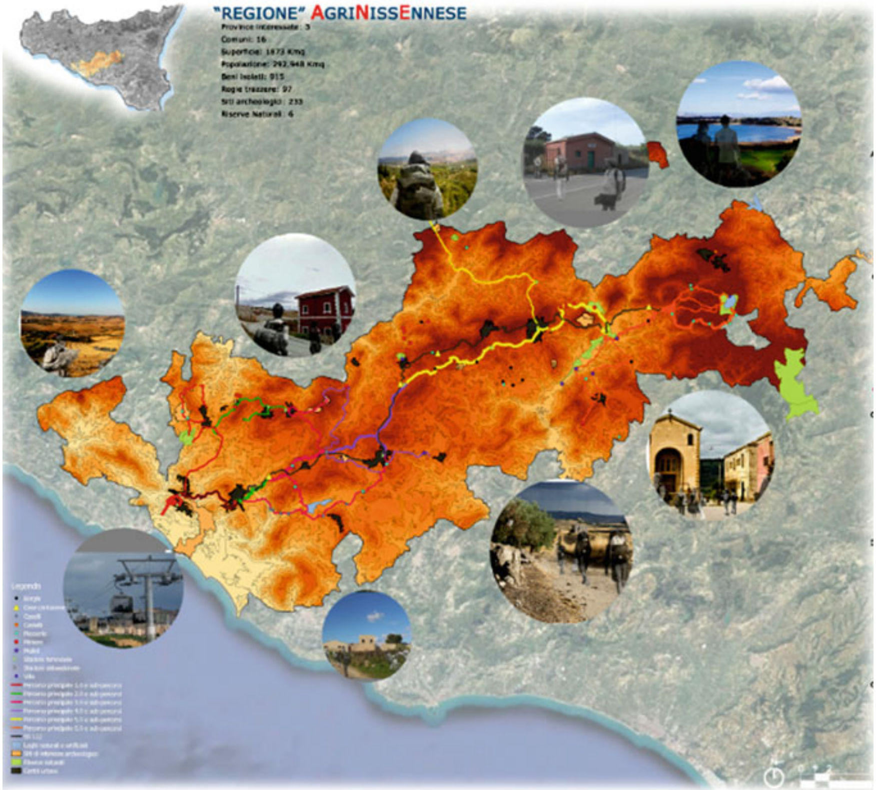

Fig. 2 The *NetWalk* project

The *NetWalk* project focuses heavily on paths that can be followed on foot (mainly) but also on bicycles or on donkeys. A path is a material (and ideal) means by which visitors encounter the geographical, natural, landscape, anthropological and cultural aspects of the area; in this regard, paths deserve adequate maintenance (existing paths) and attention during planning. When planning the slow mobility network and each single path, the following requirements must be met:

- to develop less-frequented areas
- to showcase (compare Amendola 2006) the natural and cultural heritage of the areas
- to reduce the environmental impact of motor traffic by paying particular attention to intermodal transport (access to paths via public transport, parking areas and limited access for vehicles on certain roads)
- to always provide adequate accessibility
- to build a network of accommodation and food services along main non-motorized paths, starting from the facilities that are already there but are currently underutilized

- to develop a standardized road -sign system based on communication graphics
- to develop historical paths (old sacred roads, Roman roads and transhumance routes)
- to implement low-impact actions that harmoniously blend with the landscape, by using natural construction materials suited to the local traditions
- to identify suitable ways of managing and maintaining the paths jointly between various public and private bodies
- to build restaurant facilities

As far as the *NetWalk* project is concerned, the creation of facilities with the following three purposes is of critical importance: restauration (either bivouacs typical of rural areas or for a few minutes' rest), accommodation (for those who want to follow all the paths in the area), meeting and discussion (residents, administration and *stakeholders).* The construction of the above-mentioned facilities needs to take into account the new guidelines about sustainability and soil consumption.

As regards the latter point, the target of eliminating soil consumption has already been defined, on a European level, with the thematic strategy for soil protection of 2006, which highlighted the need to establish a series of good practices to reduce the negative effects of soil consumption and, in particular, of its irreversible and most obvious form: *soil sealing*. The strategy was applied as a result of COM/2012/046.

By the end of 2020, the European Community policies shall, therefore, take into consideration the direct and indirect impact on the use of soil; this general objective was referred to in 2011 with the roadmap to a resource-efficient Europe (COM (2011) 571), which set the target of a zero increase in soil consumption by 2050. This target has recently been confirmed by the European Parliament with the approval of the 7th Environment Action Programme.

Moreover, the European Commission deemed it useful to establish priorities and procedures to reach the target and, in 2012, it published guidelines on best practice to limit, mitigate or compensate soil sealing. The established approach to limiting soil consumption and its impact is to carry out policies and actions aimed, in this order, at limiting, mitigating and compensating soil sealing, and which shall be defined in detail in the territories of the member states.

In light of these considerations, working on the abandoned areas is the most sustainable and logical solution, in line with the targets and strategies set by the regional landscape plan of Sicily, even though the guidelines and approved programs of the regional landscape plan only mention static.

The architectural heritage, which is rather remarkable, is the memory of a place, it identifies the local community from a cultural point of view and it can create an economy aimed at achieving the local development targets. The most widespread buildings in the area Agrigento–Caltanissetta–Enna are farmhouses, farms, hills, castles, rural churches and rural villages, which are reminders of the so-called "minor" culture. In the "region" under consideration, there are 915 abandoned areas, 233 sites of archaeological interest and six natural reserves. Many of these elements are located in hardly accessible areas, which makes them less attractive compared to other better-serviced tourist destinations with higher visibility. The lack of knowledge about this heritage, typical of the rural environment, and about its identity value causes the heritage itself to be neglected and abandoned, and to be prone to degradation; in the worst cases, abandoned areas of heritage are renovated in a way that is not consistent with the type of buildings and the characteristics of the landscape that surrounds them.

Work carried out on rural architectural heritage, so as to recover it for a consistent re-use, needs to follow project strategies and environmental technologies aimed at sustainability. All project and construction decisions should therefore be tested for sustainability. Only by recognizing the specific bonds between rural artifacts and their location and the climate factors that characterize it, can a careful and environmentally compatible recovery be accomplished.

With a view to sustainability, any work on the existing rural buildings of heritage interest needs to adopt criteria with the following objectives: the saving of energy and resources; environmental compatibility; consistency with the intended use; social and cultural consistency; economic compatibility.

There has been growing interest and awareness from the European Union towards a comprehensive protection of landscapes: though the Conference Européenne des Ministres Responsables de l'Amenagement du Territoire (CEMAT), the European Council has set guidelines for the recovery of agricultural landscapes and the protection of rural buildings. Of particular importance is the development by the English Heritage, in 2006, of the guidelines "The conversion of traditional farm buildings", aimed at guaranteeing a correct reuse of rural buildings (depending on the degree of compatibility and adaptability to all the proposed changes), by maintaining their characteristics and their relationship with the surroundings (De Montis et al. 2013).

5 Conclusion

The Sustainable Development Goals set by the UN, the EU guidelines and the experience from Italy's Rural Development Plans, the latter of which aims at implementing the much sought-after multifunctionality of agriculture, should serve as guidelines. This paper details a method of studying rural landscape and planning tourism activities in rural landscapes, and, above all, involving local communities at a point in history when new attention is being drawn to the potential of rural landscapes. After having selected the paths and nodes for the *NetWalk* project, and having defined the roles and the tools available for funding the necessary activities, the final step of the proposed project, as its name suggests, is to run a sort of simulation. In the Agrigento–Caltanissetta–Enna area, the existing local attractions need to be identified, and new attractions need to be planned; more importantly, at the same time, a series of itineraries based on the existing paths and those to be created need to be identified according to the principles of slow mobility with a view to sustainability: six main paths (which start from trunk road S.S. 122, the so-called "grey line") connected to the main attraction areas, to which minor paths are also linked (in order of importance based on how much each single path is used), which include some elements that are located away from the main paths; in this way, these elements are revalued and all the municipalities (especially in the rural area, but also in the urban area) that lie within the area covered by this paper are involved. The connection of the minor paths to the main paths is based on the space-time distances; visitors thus become active protagonists, as they can choose which path they want to follow and how they want to follow it: they can go back on a path or they can stop one path and start another. The paths to include in the project should be selected based on the unique characteristics of the area where the paths themselves are located. This can be achieved through a study of the morphology of the area, which, however, reveals a complex situation. The paths were thus selected based on their degree of slope, which helped classify the itineraries based on level of difficulty, intended target and other elements (cultivated fields, water courses, tree-lined paths) by which visitors can chose which path they want to follow.

Lastly, by studying the regional landscape plan of Sicily, many remote and often abandoned heritage assets could be identified more easily, which helped select those that were suitable for the *NetWalk* project and were thus included in the landscape-development network of the Agrigento–Caltanissetta–Enna area.

With the *NetWalk* project, these goals can be achieved in a sustainable way (no. 1, 3, 8, 11, 15).

References

Amendola, G. (2006). *La città vetrina. I luoghi del commercio e le nuove forme del consumo*. Napoli: Liguori.

Clement, G. (2005). *Manifesto del Terzo paesaggio*. Macerata: Quodlibet.

De Montis, G., Farina, P., & Barra, M. (2013). Il recupero dei fabbricati rurali in ambito europeo: una proposta di linee guida. In M. Barbari (Ed.), *L'edilizia rurale tra sviluppo tecnologico e tutela del territorio*. Convegno della II Sezione AIIA, Firenze 20–22 settembre 2012 (pp. 371–381). Firenze: Firenze University Press.

Dematteis, G. (2001). Per una geografia della territorialità attiva e dei valori territoriali. In P. Bonora (Ed.), *SLoT Quaderno 1* (pp. 11–30). Bologna: Baskerville.

Guidelines about the matter of good practices to limit, mitigate and compensate soil sealing. Accessed at: Accessed at: June 14, 2016, from http://ec.europa.eu/environment/soil/pdf/guidelines/IT%20-%20Sealing%20Guidelines.pdf.

Muval. (2014). *Strategia Nazionale per le Aree Interne: definizione, obiettivi, strumenti e governance, MUVAL 3*. Roma: Collana Materiali UVAL.

Prestia, G., & Scavone, V. (2016, in press). *Aree rurali e nuove opportunità dal Piano di Sviluppo Rurale. Studio dell'area "rur-interna" della provincia nissena*.

Report on the implementation of the Soil Thematic Strategy and ongoing activities. From http://ec.europa.eu/environment/soil/three_en.htm. Accessed 14 June 2016.

The conversion of traditional farm buildings. Accessed at: May 17, 2017, from https://historicengland.org.uk/images-books/publications/conversion-of-traditional-farm-buildings/.

The implementation of the soil thematic strategy and on run activities. Accessed at: June 14, 2016, from http://eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX:52012DC0046.

Turri, E. (2003). *Il paesaggio come teatro. Dal territorio vissuto al territorio rappresentato*. Venezia: Marsilio.

Volpe, G. (2015). *Patrimonio al futuro. Un manifesto per i beni culturali e il paesaggio*. Milano: Mondadori Electa.

Marginal Mountainous Areas: Starting Over from Smart Communities—The Case Study of Seren del Grappa

Federica Maino, Andrea Omizzolo and Thomas Streifeneder

Abstract In most mountainous areas, the socioeconomic changes over the past 50 years have favored settlement dynamics and development models without considering the criteria of sustainability. This is, for example, the case for the intensively touristic exploitation of the most popular destinations or the abandonment of marginal areas due to the concentration of the population in urban areas. Mountainous areas are rich in the natural and cultural values, which provide long-term benefits also to cities and towns, but they are particularly vulnerable and sometimes inhospitable. The survival chances of vital communities in marginal mountainous territories depend on a developmental approach that considers how to handle economic growth, environmental conservation, identity and cultural issues, as well as enhancing the endogenous potential in a common way. This contribution presents the results of an exemplary strategic plan for Seren del Grappa, a small village located in the north-eastern Italian Alps. The definition of a shared vision and strategic guidelines for the future of the territory, up to the implementation of the first concrete projects, were developed through a participatory process involving the local population, the administrators and the economic operators. Moreover, the article includes a description of the applied methodology, as well as a discussion of essential prerequisites, successes and weaknesses of the process. The authors emphasize the importance of paying particular attention to mountainous areas from which innovative and self-sustainable development processes can start. Furthermore, they highlight the mountainous communities' peculiarities which make them "smart communities".

Keywords Mountain marginal areas · Smart communities · Sustainable development · Unlocking development potential · Participatory strategic plan

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1 Introduction

Mountains cover approximately one-fifth of the Earth's land surface (Price 1994), provide home for 720 million people and, indirectly, long-term benefits for billions more living downstream (FAO 2015). Mountainous areas are vitally important in many ways: as centers of diversity, both biological and cultural; as 'water towers' supplying most of the continent's water; in terms of hydrogeological protection; as highly valued landscapes; as food production area; and as space for recreation and tourism (Smethurst 2000; Nordregio 2004; Price 2014).

Besides these benefits, mountains are considered as having permanent natural handicaps, due to topographic and climatic restrictions (Nordregio 2004). For this reason, they are often associated with the concepts of "less-favoured areas (LFA)" (Hoogeveen et al. 2004) and "marginality" (Andreoli and Tellani 1998) from a cultural, social, economic and political point of view, as well as due to their accessibility and the distance to decision-making centers (Lazzarini 2013).

A further special feature of mountainous areas is their vulnerability to climate change, land degradation, natural disasters (Price 1994) and, in some cases, significant variations in the size of resident populations (Bätzing et al. 1996; Corrado 2014). In the specific case of the Alps, the phenomenon of depopulation has been accentuated by the socioeconomic changes of the past century (Permanent Secretariat of the Alpine Convention, 2015). In Italy, for example, 900-thousand people have left mountainous areas since 1951, compared with an increase of the national population of about 12 million in the same period (Cerea and Marcantoni 2016).

Traditional planning tools (Porcellini 2013) and a lack of attention from politicians in recent decades (Mantino 2010), as well as a change of life style and the scarcity of economic resources, among other factors (Corrado et al. 2014), have not been able to reverse these dynamics, increasing the risk of depopulation of mountainous areas (Cerea and Marcantoni 2016). As recently pointed out by the United Nations General Assembly (UNGA 2017) "mountain territories need a long-term vision and holistic-multi-stakeholder approaches […] that can lead to the sustainable development of highland areas", improving the livelihood of the local mountain communities and the sustainable use of mountain resources.

According to the UNGA indications, the authors believe that one of the main keystones for sustainable development could be the mountain communities themselves, due to their strong links with their own territory, their knowledge and their experience. Over time, they have developed the capacity to adapt to fragile environments, cope with difficult living conditions, provide solutions for sustainable management of natural resources and initiate collective actions for improving the quality of their life (Cantiani et al. 2016; Ianni et al. 2015). According to Manfredi's general definition (2015), many of these features characterize a "smart community".

This paper reports the main results of an applied research study carried out by means of a case study. The aim is to raise the attention of the opportunities in marginal mountainous areas. Thus the paper attempts to answer the following questions: How does one maintain vital communities in mountainous areas?; how can we support them and foster sustainable and smart planning processes?; which are the prerequisites that can make mountain communities "smart communities"?; and what are the main strengths and weaknesses they have we encounter?

2 Case Study

Seren del Grappa is a small village in the northeastern Italian Alps, between the UNESCO World Heritage Dolomites and the Po valley. It is part of the province of Belluno and lies close to the autonomous region of Trentino-Alto Adige. Due to its location, the province of Belluno is negatively affected by the administrative fragmentation a various legislative and economic opportunities of the Italian Alpine Space. Ever since the 1950s, this mountainous area has been characterized by a poor economy, marked by a strong rural tradition based mainly on mountain farming. Right after the Second World War, it became a key player in Italy's industrial development. Over time, the eyewear industry and the manufacturing industry, both leading sectors of the economy, caused a gradual drain of farmers from the countryside and a concentration of the population in the valleys, especially in the major urban centers like Belluno and Feltre, as well as the consequent depopulation of more marginal municipalities (Zanetti 2013) (Fig. 1).

Seren del Grappa covers an area of little more than 62 km^2 and is marked by a basically vertical morphology, starting at 350 m, the level of the lowlands, and rising to over 1500 m in its mountainous sector (Melchiorre et al. 2014). It is

Fig. 1 Col de Bof, a characteristic hamlet of Seren del Grappa

therefore a wholly mountainous municipality, where the only lowland area is the urban settlement in the valley and the agricultural area that leads into the Feltre basin. Historically, it has been an area of mass out-migration. ISTAT statistics for the resident population from the 1871 to the 2011 censuses (Fig. 2) clearly illustrate the settlement dynamics of the municipality and underline the high level of depopulation during the past century (with the exception of the period around the year 2000). This trend is still ongoing.

Its marginal position, far from the tourist flows that have impacted the Dolomites, and its distance from the main thoroughfares, have helped preserve an almost uncontaminated area that still retains age-old knowledge and traditions, together with high environmental value.

The potential of the area and the local community's unique dynamism and industriousness were recognized by the term "new mountain dweller", as defined by Corrado et al. (2014). In 2012, this newcomer bought a house in the municipality and subsequently created the "Val di Seren Onlus" Foundation, with the aim of revitalizing the territory and countering land degradation and abandonment.

The Foundation, which responds to the needs of many citizens and of several of the most representative entities in the surrounding area, turned to the Institute for Regional Development at Eurac Research to obtain support in setting up and guiding a plan aimed at defining the problems of the valley and at developing shared and sustainable strategic options for the area's medium and long-term future.

Eurac Research was tasked with the technical and scientific leadership of the plan and with the role of coordinating the entire process. It has supported the Foundation with its own funds. The goal of Eurac's research activity is to implement best practices to foster the sustainable socioeconomic development in mountainous areas and boost interregional cooperation. By identifying potentials and critical issues, researchers aim to highlight the new dynamics that currently affect several marginal areas in the Alps and provide factual supporting knowledge to be used in developing policies and new planning tools better suited to sustaining and strengthening their development.

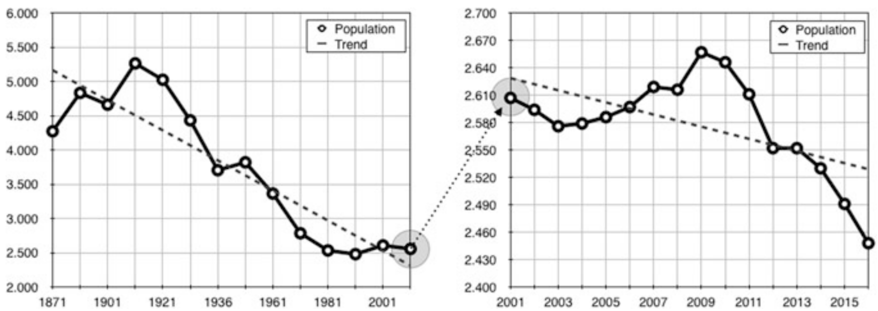

Fig. 2 Resident population in Seren del Grappa. Historical series (1871–2011 censuses) and recent trend (2001–2016). Elaboration by Eurac Research based on ISTAT data

3 Method

Given the complexity of the challenges, the authors identified strategic planning as the appropriate tool to address the critical issues of the case study. Indeed, it involves establishing an overall, desirable vision of regional development. It encourages contributions from a variety of public and private players and provides effective coordination of all actions on the basis of common and shared goals (Tanese et al. 2006). Although strategic plans are tools that are generally applied to urban areas and mainly intended for medium-large towns (Ioppolo et al. 2016), their flexible methodology can be adapted to marginal mountain-community settings.

A further key element of the strategic planning process is the participatory approach, which is also promoted by the European Innovation Partnership on Smart Cities and Communities (EC 2015). It comprises cities, industry and citizens in order to improve urban life through more sustainable integrated solutions. Moreover, the European Commission encourages the use of such an approach in rural areas, i.e., the "Community-Led Local Development" (CLLD), that turns traditional "top-down" development policies upside down. Local players, who have been passive "beneficiaries" in the past, become active partners and drivers of this development (EC 2014). Over the past 20 years, the application of the principles underlying CLLD have spread across Europe, and European Programmes that contain CLLD elements have a long history in many cities (EC 2014). Moreover, outside Europe and for similar reasons, the World Bank supports projects using a very similar "Community-Driven Development" (CDD) methodology (Binswanger-Mkhize et al. 2010).

In this case study, Eurac Research led the local development plan involving the entire community from the outset in a broad participatory process. The process was implemented drawing on strategic planning tools, on the CLLD approach and on the literature related to inclusive decision-making systems (EC 2014; Tanese et al. 2006; Holman et al. 2009). It was organized into six phases (Fig. 3) and was marked by the following features:

- The use of tools focused on active listening (Sclavi 2014) and on exploring the issue in question: this requires willingness and ability to acknowledge the requirements of actors involved in the participatory process, to identify the variety of interests at stake and to make the best use of the specific resources and challenges of the area under study;
- Relevance of the process per se, which needs to be set up with clear and concrete goals but also with the flexibility required for its remodulation; the process is open-ended with respect to its final outcome and is capable of resorting to innovative interaction techniques;
- A focus on learning as a key dimension to grow the relevant local community and foster its self-management skills.

The first preliminary and preparatory phase comprised initial contacts with key players in the area, on-site visits, and collecting relevant information and existing projects, as well as a context analysis. Subsequently, the local community was

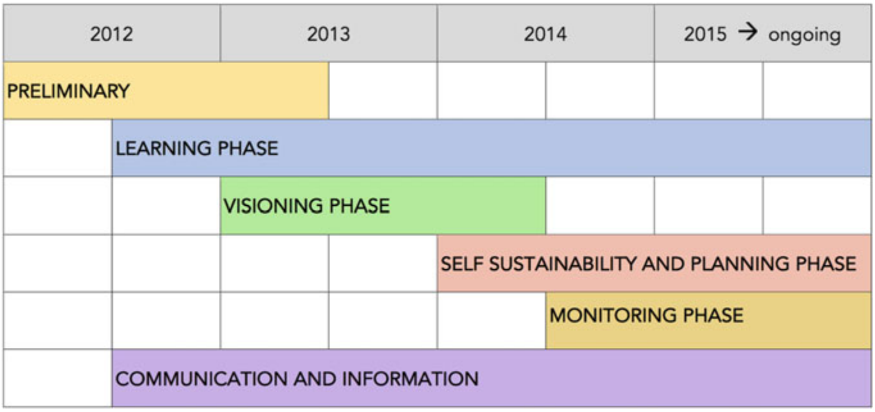

Fig. 3 Phases of the participatory process

invited to share in the process of defining the issue through a SWOT analysis, hence identifying the priority matters to be addressed.

The second phase focused on learning and on the collection and discussion of best practices, on meetings with experts, on organizing educational visits and on specific training sessions related to some of the key issues. This phase has been active during the entire process and has been a key dimension in growing the social capital of the local community. The discussion opportunities between citizens, administrators, technicians and researchers fostered mutual learning and greatly enriched the process, stimulating new solutions, alternative hypotheses and innovative projects.

The third phase was "*visioning*", which consisted of building a common vision, defining strategic guidelines and collecting actions. This was the phase during which the process was most creative and most open and during which participants were asked to imagine a desirable future for their territory and establish a common frame of reference. All ideas and project proposals were collected during this phase.

The fourth phase consisted of *planning and self-sustainability*. It involved the actual launch of the decision-making process related to what had to be done and how it was to be done. This was a particularly sensitive phase during which, among other things, leadership was transferred. The purpose of this phase was to implement project ideas and, at the same time, to foster the self-management skills of all the players involved.

The fifth phase consisted of *monitoring* and was an integral and necessary part of the strategic planning process, to the extent that the supervision and evaluation of outcomes and their evolution over time was a necessary condition to ensure the continuity and sustainability of the projects that had been launched. This phase also provided the opportunity to update goals to meet new requirements and to assess potential changes or updates to the list of projects with the knowledge that, as they progress, the relative weight and priorities of proposed actions may change.

In parallel with the above phases, *communication and information* instruments (*the sixth phase*) were also implemented to include all players and inform them about ongoing activities. Great care was given to ensuring inclusion of all stakeholders: this was achieved through targeted and motivating invitations, preceded by a listening phase that had the key purpose of building relationships based on trust and collaboration. The communication was designed to be simple but attractive. Care was taken to organize and manage informal exchanges and face-to-face contacts between participants, outside official channels, to allow participants to feel comfortable.

Despite being structured at every stage, the participatory process has always been marked by great flexibility and adaptability to the overall context. The participants' work was structured by alternating work in small groups (focus groups with 5–15 people) to foster interaction and in-depth understanding, and plenary sessions with the presence of all participants, to provide information, share work in progress, and gather new ideas and insights.

The approach presented by the researchers focused on empowerment, which ensures the best level of local community involvement in the process (Arstein 1969). According to Cantiani's definition (2006), the term can mean increased awareness of one's rights and abilities, a reversal, or at least a change in the power-and-influence relationships between local actors and their accepting direct accountability for the management of their territory.

4 Results

The first output of the planning process consisted in defining the issue that needed to be addressed. By working together with all the stakeholders, five themes were identified as being the most representative and strategic ones for the future of the area: these five themes are the fields within which future projects and actions will be implemented.

Subsequently the local community forged a common vision for its territory, which was later defined into ten strategic guidelines. Project proposals were drawn up within this framework. The implementation of project ideas was fostered by meetings with experts and representatives from potential funding bodies and institutions, and the gathering of best practices and site visits which led to building up an original and well-structured set of proposals.

Subsequently, through the adoption of an advisory-deliberative event, known as Open Space Technology (Owen 2008), participants were invited to take the leadership of projects that they were most interested in and for which they were willing to become accountable. For each project proposal, a contact person was appointed, a working team was created and an agenda was then set. The event led to the launch of the first concrete projects, a little over a year after the process had started: the renovation of a historical building that became the meeting point for the community, the implementation of an experimental vineyard of resistant hybrids, a web marketing course to develop innovative communication tools and to promote the

Fig. 4 The experimental vineyard of resistant hybrids

territory, and the organization of a successful festival called "The Mountain of the Future" (Fig. 4).

In addition to proceeding with the projects mentioned above, the community also engaged in developing other project proposals, some of which were achievable within a short time span and with relatively limited resources (e.g., implementation of a system for the sale of local products; training courses and technical support for farmers; promotion of bicycle tourism), while others required a longer time frame and more resources owing to their innovative and ambitious objectives that aimed at developing solutions for some of the area's structural problems (e.g., starting a land defragmentation process, creation of a scattered hospitality system throughout the valley and the establishment of a cooperative of communities).

All the projects that have already been launched have received funding from a variety of sources, ranging from private capital to regional funds for rural development, as well as funds from local and national associations. Preliminary options for potential funding sources have been identified for the implementation of future projects, including the main European programs for the financing of projects marked by greater complexity and a broader scope.

Early results from the process have had the indirect positive effect of making the area more attractive: this fostered the integration of new families and created a fertile environment for new business start-ups.

5 Discussion

By comparing the strategic plan for Seren del Grappa to programs implemented in other settings, it has proven to be distinctive since it was developed “bottom-up”, i.e., based on the wishes of the local community that set itself up as a foundation. At the end of the process, the municipal authorities adopted the strategic plan as one of their operational tools. Evidence of the distinctive strength of the bottom-up process that was developed can be seen in the fact that, despite an administrative change that occurred halfway through the plan, there were no negative repercussions on the overall strategic planning process.

The projects that were launched are the result of a substantial and synergistic relationship between private, public and academic entities. Within this relationship, private entities were action-oriented, growth drivers and had the support of an efficient and forward-looking public administration and solid expertise provided by researchers.

Many of the projects that emerged during the process are related to agriculture, hence highlighting the strategic relevance of this sector for the sustainable and lasting development of mountainous areas (Streifeneder and Ruffini 2007). Moreover, what also emerges is that the strategic projects that were identified during the process (e.g., land defragmentation, community cooperatives, agricultural and technological training) relate to issues of general interest for the revitalization of many marginal other mountainous areas, which can draw operational guidance from this case study.

The support given to the launch of the first concrete projects bred a sense of confidence and gave renewed impetus to the area. The projects act as drivers for other projects and help revitalize the territory in terms of agricultural activities, as well as in other sectors.

The results that have been achieved are very much the outcome of the community’s strong sense of territorial attachment, its desire to share the same future and values and its ability to overcome problems through pro-active mobilization. The century-old, close links between mountain communities and their natural resources has helped to build a strong bond between the territory and its local community, a bond that is still very much alive today (Cantiani et al. 2016).

Mountain communities are still the custodians of traditional knowledge in sectors like agriculture, crafts, forestry, pastoral activities and construction. These sectors are significant strengths of rural communities in the Alpine region and have been handed down over generations through families or kinship relations (Marchesoni 2016). This sociocultural richness has proven to be an especially fertile environment for the launch of a participatory process. At the same time, all this created initial difficulties in accepting external inputs, in giving “outsiders” access to properties, local know-how, well-established social relationships and a pre-existing economic network. Consequently, a key factor during the early stages of the process was the effort required to overcome this initial distrust and to create a climate of collaboration.

Opening up the decision-making process also means dealing with different points of view. Consequently, one also needs to know how to deal with divergent positions, conflicting interests, and how to cope with misunderstandings and misconceptions. Conflicts are an integral part of the process and, if well managed, they can bring new energy to change, encouraging exchanges of views, as well as stimulating creativity and the development of new solutions.

A further limitation of this case study is the small size of the area covered by the strategic planning process and its small population size; the latter is a feature that is often unavoidable in marginal areas suffering from depopulation. However, this limitation was more than offset by the high level of attendance at meetings and by the creation of synergies at a larger scale by networking with the surrounding areas (both urban and rural), and by expanding the network beyond the local level (from an inter-communal to an international scale), hence fostering interregional cooperation.

6 Conclusions

According to Ianni et al. (2015), maintaining vital communities in mountainous areas is a concern for the entire Alpine Region, and it is an essential condition today for many reasons (physical protection of the territory, biodiversity, preserving all the values associated with the local cultures and traditions etc.) and it is an equally important requirement for the well-being of many urban populations living in the towns and cities in the plains (Cantiani et al. 2016).

This case study contributes to emphasizing how mountain communities can become the “new” strategic players of sustainable socioeconomic development. With regards to Italy’s mountainous areas, Cerea and Marcantoni (2016) have highlighted this paradigm shift: they report that mountainous areas today produce €235 billion in value added, 16.3% of the overall wealth generated in Italy.

Besides their natural resources, many mountain communities have the prerequisites to be considered as “smart communities” in their own right, or:

> Communities of individuals who live and work in a defined geographical area, with distinctive characteristics and priorities, they are linked by social ties, the interactions of which shape social life and generate a common identity. They also generate social capital and collective action and provide the means to access additional resources. Consequently, they are communities in which the exploitation of resources, the nature of investments, the direction given to technological development and institutional change coexist harmoniously and enhance present and future potentials for the fulfilment of individual and community aspirations and needs. These include anticipating changes and stresses, restoring initial conditions after shocks, seizing opportunities to improve the quality of life, transforming development systems and preserving available stocks of tangible and intangible resources (Manfredi 2015).

The case study confirms the importance of supporting mountain areas that are particularly dynamic and vibrant, and the importance of adopting appropriate policies and tools to proactively overcome the specific disadvantages of mountainous environments, and support real change. On a par with big cities, the most marginal mountainous areas that struggle with the depopulation dynamics described above also need some form of coordination to build up an overall development perspective and establish priorities for medium- and long-term interventions.

Strategic planning tools, adapted as appropriate to specific cases, can constitute the ideal framework for the planning and programming of mountain communities. Considering that this development process is recognized as being shareable and feasible, it can stimulate the mobilization of individuals within the social and economic development of their mountain communities. It is also a driving force for the development of projects, as well as being a technical and financial driver. It can be used to focus stakeholder attention on a restricted number of viable development projects in situations (marginal mountainous areas) where resources are scarce, where the approach required is based on regeneration, reuse and savings, and on imagining new ways of conceiving development. The specificity of such a tool fuels participation from a variety of economic and social stakeholders, including those of surrounding areas, thus encouraging spatial relationships and connections that are especially strategic in overcoming the constraints induced by the *s*mall spatial dimensions of mountainous areas.

Although there is no single approach to sustainable development, by adapting the approach proposed above to the resources and distinctive features of each community and mountain territory, the study aims to provide methodological suggestions to other areas that might be interested in undertaking similar processes. The study also aims to provide factual knowledge to strengthen policies intended to support marginal mountainous areas.

References

Andreoli, M., & Tellarini, V. (1998). Marginality and development in Italy: A study review. Perceptions of marginality. In H. Jussila, W. Leimgruber, & R. Majoral (Eds.), *Theoretical issues and regional perceptions of marginality in geographical space* (pp. 101–121). Aldershot: Ashgate.

Arstein, S. R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners, 35*(4), 216–224.

Bätzing, W., Perlik, M., & Dekleva, M. (1996). Urbanization and depopulation in the Alps. *Mountain Research and Development, 16,* 335–350.

Binswanger-Mkhize, H. P., De Regt, J. P., & Spector, S. (2010). *Local and community driven development: Moving to scale in theory and practice. New Frontiers of Social Policy*. Washington: World Bank.

Cantiani, M.G. (2006). Participatory approach in forest planning. *FOREST@*, *3*(2), 281–299. Accesed at: February 3, 2017, from http://www.sisef.it/forest@/contents/?id=efor0361-0030281.

Cantiani, M. G., Geitner, C., Haida, C., Maino, F., Tattoni, C., Vettorato, D., et al. (2016). Balancing economic development and environmental conservation for a new governance of Alpine areas. *Sustainability, 8,* 802–820.

Cerea, G., & Marcantoni, M. (2016). *La montagna perduta. Come la pianura ha condizionato lo sviluppo italiano*. Milano: Franco Angeli.

Corrado, F. (2014). Processes of re-settlement in mountain areas. *Journal of Alpine Research Revue de géographie alpine, 102,* 3.
Corrado, F., Dematteis, G., & Di Gioia, A. (2014). *Nuovi montanari: Abitare le Alpi nel XXI secolo*. Milano: Franco Angeli.
European Commission (EC). (2014). *Guidance on community-led local development for local actors*. Accessed at: February 3, 2017, from http://ec.europa.eu/regional_policy/sources/docgener/informat/2014/guidance_clld_local_actors_en.pdf .
European Commission (EC). (2015). *Smart Cities and Communities*. The European Innovation Partnership on Smart Cities and Communities. Accessed at: February 3, 2017, from http://ec.europa.eu/eip/smartcities/index_en.htm .
Food and Agriculture Organization of the United Nations (FAO). (2015). *Understanding Mountain Soils*. A contribution from mountain areas to the International Year of Soils 2015. Rome. Accesed at: February 3, 2017, from http://www.fao.org/3/a-i4704e.pdf.
Holman, P., Devane, T., & Cady, S. (2009). *The change handbook: The definitive resource to today's best methods for engaging whole systems*. Oakland: Berrett-Koehler Publishers.
Hoogeveen, Y., Petersen, J.-E., Balazs, K., Higuero, I., & EEA. (2004). High nature value farmland—Characteristics, trends and policy challenges. EEA Report (Vol. 1), Copenhagen.
Ianni, E., Geneletti, D., & Ciolli, M. (2015). Revitalizing traditional ecological knowledge: A study in an Alpine rural community. *Environmental and Management, 56,* 144–156.
Ioppolo, G., Cucurachi, S., Salomone, R., Saija, G., & Shi, L. (2016). Sustainable local development and environmental governance: A strategic planning experience. *Sustainability, 8,* 180.
Lazzarini, G. (2013). *Le risorse di un territorio montano marginale: Usseaux e le sue borgate*. Milano: FrancoAngeli.
Manfredi, F. (2015). *Smart community: comunità sostenibili e resilienti*. Bari: Cacucci.
Mantino, F. (2010). *Innovazione nella crisi economica: strategie e fabbisogni di politiche nelle aree montane italiane*. Roma, CNEL.
Melchiorre, M., et al. (2014). *Guida al territorio di Seren del Grappa tra storia, natura, arte, cultura e gastronomia*. Seren del Grappa: DBS.
Nordregio. (2004). *Mountain areas in Europe: Analysis of mountain areas in EU member states, acceding and other European countries*. Stockholm: Nordic Centre for Spatial Development.
Owen, H. (2008). *Open space technology: A user's guide*. San Francisco: Berrett-Koehler Publishers.
Permanent Secretariat of the Alpine Convention. (2015). *Demographic changes in the Alps. Report on the state of the Alps—Alpine convention*, Alpine Signals, 5. Bolzano: Alpine Convention.
Porcellini, S. (2013). *Aree Marginali Italia—Laboratorio di opportunità*. Trento: Edizioni del Faro.
Price, M. F. (1994). Mountains: Globally important ecosystems. *FAO—Food and Agriculture Organization of the United Nations, Unasylva,* 195. Moving Mountains, Rome: FAO.
Price, M. F. (2014). *Mountains: A very short introduction*. Oxford: Oxford University Press.
Sclavi, M. (2014). Shadowing and consensus building: A golden bridge. *Asia Pacific Journal of Marketing and Logistics, 9*(1), 66–68.
Smethurst, D. (2000). Mountain geography. *Geographical Review, 90*(1), 35–36.
Streifeneder, T., & Ruffini, F. V. (2007). Ausgewählte Aspekte des Agrarstrukturwandels in den Alpen—Ein Vergleich harmonisierter Agrarstrukturindikatoren auf Gemeindeebene im Alpenkonventionsgebiet. Berichte über Landwirtschaft. *Zeitschrift für Agrarpolitik und Landwirtschaft, 85*(3), 406–440.
Tanese, A., Di Filippo, E., & Rennie, R. (2006). *La pianificazione strategica per lo sviluppo dei territori*. Roma: Rubbettino.
United Nations General Assembly (UNGA). (2017). *A/RES/71/234—United Nations general assembly resolution: Sustainable mountain development (2016)*. Accessed at: February 3, 2017, from http://undocs.org/A/RES/71/234 .
Zanetti, C. (2013). *Le diverse vie del ritorno alla terra nel bellunese*. In Agriregionieuropa anno 9, n.°33, p. 32. Accesed at: February 3, 2017, from http://agriregionieuropa.univpm.it/it/content/article/31/33/le-diverse-vie-delritorno-alla-terra-nel-bellunese

Part VI
Rethinking Mobility

Rethinking the Taxi: Case Study of Hamburg on the Prospects of Urban Fleets for Enhancing Sustainable Mobility

Susanne Schatzinger, Chyi Yng Rose Lim and Steffen Braun

Abstract Despite being a vital part of the urban mobility system, the taxi receives little attention from planners and policy makers; thus, its potential contributions to enhance sustainable mobility are often overlooked. Consequently, this paper adopts an innovative perspective to rethink the taxi for enhancing sustainable urban mobility. It takes a closer look at the prospects of urban taxi fleets for supporting the transition of a city's mobility system towards sustainability. The work is attributed to the project "*Future Urban Taxi*" under the initiative "*Ambient Mobility Lab*" supported with funding from the Ministry of Economic Affairs, Labor and Housing of the federal state Baden-Württemberg in Germany. To relate to a specific urban context, ten German cities were previously analyzed and Hamburg chosen as a use case. The city provides good availability of both taxi and mobility data, and the municipality is comparatively open to innovative concepts (e.g., the voluntary introduction of the fiscal taximeter, allowing more flexible pricing). By analyzing the use case Hamburg, "*Future Urban Taxi*" focuses on two main challenges: (i) how the taxi as a vehicle has to adapt to user demand and specific urban contexts, and (ii) how the taxi as a system can be integrated into the mobility system of a city in a more effective and sustainable way. A qualitative methodology consisting of the collection and qualitative assessment of expert interviews, as well as a scenario and gap analysis, was used to assess the potential of various taxi concepts. Three future scenarios for the year 2025 were built around them to arrive at three taxi concepts—the electric taxi, autonomous taxi and shared taxis. Each of these can contribute to the sustainability of Hamburg's urban mobility system in varying degrees. The highest contribution lies in the implementation of shared-taxi services. They are rather easy to implement and can achieve quick benefits both for the customers and taxi operators. The electrification of taxis is rated second, since it

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requires investments in infrastructure and new forms of operations of the vehicles. The autonomous-taxi concept is least likely to be implemented soon, even though it could offer quite a few benefits. The reason is that there are still a lot of uncertainties (technical, spatial, legal) regarding this technology. By highlighting the need to rethink the taxi, this paper offers an insightful understanding of this mobility service in the specific urban system of the case study city of Hamburg.

Keywords Taxi · Mobility-on-demand service · Service innovation perspective Service design · Sustainable mobility

1 Introduction: Case Study of the Taxi in Hamburg

"*Ambient Mobility Lab*" is a research initiative funded by the Ministry of Economic Affairs, Labor and Housing of the federal state of Baden-Württemberg, Germany. Here the Fraunhofer Institute of Industrial Engineering IAO and the Massachusetts Institute of Technology (MIT) join forces for setting the course to improve the quality of life in cities through the research on innovative urban mobility concepts. The project "*Future Urban Taxi*" focuses on the taxi as a mobility mode situated between the private and public transport. The gap between these two transport modes is obvious. Public transport is generally characterized as being more efficient and environmentally friendly due to its high capacity, but not quite as comfortable and flexible as the private car (Beirao and Sarsfield Cabral 2007). However, the current dependence on private vehicles lead to high costs for cities in relation to air pollution, congestion, traffic accidents and climate change, just to name a few (Borroni-Bird 2012). This creates a high demand for solutions that will encourage more users to make a transition from private cars to more sustainable and efficient modes of transport. The taxi of the future could ensure high comfort and flexibility by, at the same time, being more efficient and more environmentally friendly than privately used cars: less parking space is needed and taxis possess a high potential for ride sharing and are more conducive to electrification. By operating taxis in fleets, introducing adequate business models and integrating new technologies and services, taxis could be an even more substantial alternative to private cars in the future. The taxi of the future could be capable of ushering in a new paradigm of sustainable mobility (Banister 2008; Wefering et al. 2014; Svítek 2015; Schatzinger and Lim 2017), whereby the project "*Future Urban Taxi*" focuses on two main aspects[1]:

i. how the taxi as a vehicle has to adapt to user demand and specific urban contexts;
ii. how the taxi as a system can be integrated into the mobility system of a city in a more effective, profitable and sustainable way.

[1]See: http://senseable.mit.edu/mobility/?page_id=84.

Being both a critical arena to address sustainability issues and the key domain for a sustainable future, cities are not only relevant but also serve as a key unit of analysis; however, they have different contexts and attributes that need to be taken into account when analyzing their mobility systems (Aarhaug and Skollerud 2014; Frantzeskaki et al. 2015; OECD 2015; Aarhaug 2016; Schatzinger and Lim 2017). Hence, mobility systems need to be understood and analyzed within their local contexts.

Therefore, the aim of the initial research phase of "*Future Urban Taxi*" was about choosing a use case in which the context of the taxi study could be conducted. Ten German cities, namely Berlin, Bochum, Frankfurt, Freiburg, Halle (Saale), Hamburg, Moers, Munich, Stuttgart and Ulm, were selected as a geographically representative sample. Using data-oriented methodology, the cities were analyzed according to their taxi systems and data availability. Due to good data availability and the municipality's reputation for embracing innovation in the taxi sector, Hamburg was chosen as a use case for the project (Lim and Schatzinger 2016; Schatzinger and Lim 2017).

In the latter stage of the project, a qualitative study to explore the fundamental requirements of designing sustainable mobility services in the urban context was undertaken which will be presented in this paper. Leveraging prior research work from the project "*Future Urban Taxi*" (Lim and Schatzinger 2016) and aiming to rethink the taxi, Hamburg's current taxi system had been analyzed while taking into consideration other interconnected urban systemic aspects (e.g., the legislative framework, governance processes and structures, existing infrastructure, demographics, etc.). In view of this, the remainder of this paper is subsequently structured as follows: the rest of this section puts the case study into perspective by describing the context which is highly relevant when studying urban systems (Schatzinger and Lim 2017). In the following sub-sections, Hamburg's local urban mobility and taxi system will be introduced. Section 2 then elaborates the research methods used. Next, the key findings are presented and discussed in Sect. 3. Finally, Sect. 4 concludes this paper by drawing on the insights from this case study to provide an outlook on future urban taxi and highlight the need to rethink the taxi as a transport mode with significant potential for enhancing sustainable mobility.

1.1 City Perspective: Hamburg

Hamburg is the second largest city in Germany with a population of nearly 1.8 million, with predictions that its urban population will increase 5% up to 1.9 million by the mid-2030s. This implies that the mobility needs of its urban inhabitants and traffic volume are also on the rise. As such, Hamburg possesses very specific mobility-related challenges linked to social (e.g., accessibility, mobility divides, social cohesion, safety), economic (e.g., increasing infrastructure costs, increasing congestion costs) and environmental policy (e.g., air quality, carbon emissions, noise pollution, land use) that together result in giving mobility high priority on the political agenda. Overall, Hamburg has an integrated and participative planning strategy coupled with a strong commitment towards a vision of sustainability (BSU 2011, 2012; BSU/SK 2011, 2013, 2015; BWVI 2013; SK 2013; BUE 2016; WBCSD 2016). For many years, Hamburg has pursued progressive policies focusing on environmental and climate change issues and was awarded the "European Green Capital 2011" —a prestigious title awarded by the European Commission. Hamburg's transport sector has undergone changes in the previous decades in an attempt to facilitate a transition to a more sustainable mobility system. Examples of this include the *Hamburger Verkehrsverbund* (HVV)[2] adapting to the changing mobility trends and behaviors by simplifying its ticketing system through cooperation with the smartphone mobility app, *moovel*. Hamburg was the first city in Germany where tickets for public transport could also be purchased using the app (Hamburg.de 2016). Furthermore, the city is also promoting environmentally friendly technologies such as electric mobility to reduce the carbon footprint of its transport sector.[3] Like many other cities, an important priority underlying Hamburg's approach has been increasing the capacity of the public transport system. Under certain circumstances, increasing capacity however can actually cause deterioration rather than improvement of the transport system's performance, according to Braess's Paradox (Murchland 1970; Goldman and Gorham 2006). Hence, system thinking should be employed to avoid thinking too narrowly about mobility challenges. In order to enhance the city's urban systems towards sustainability, Hamburg will need to rethink mobility in new ways for its transformation towards a sustainable future with mobility services such as the taxi being better integrated into its mobility system.

1.2 Hamburg's Taxi Sector

Taxis are a vital feature of cities' urban mobility system because they provide flexible, mobility-on-demand services to complement the shortcomings of public transport systems (Aarhaug and Skollerud 2014; Aarhaug 2016; Lim and Schatzinger 2016). The landscape of taxi service providers is very diverse, ranging from single entrepreneurs to enterprises with many taxis and employees. Most taxi operators use the service of local dispatch centers. Authors and institutions, such as Linne and Krause (2007); the department for Urban Planning and Environment of the City of Hamburg (BSU/SK 2011); the Federal Ministry of Transport and Digital Infrastructure (BWVI 2013); and the State Chancellery Hamburg (SK 2013),

[2]The city's local transport association and the overall coordinating body responsible for public transport in and around the city. See: http://www.hvv.de/ueber-uns/der-hvv/uebersicht.

[3]Currently accounting for about 25% of the city's carbon emissions.

provide overviews of the status quo of Hamburg's mobility and thus its taxi system, including data on, e.g., operators, pricing, regulations and economic performance.

In Hamburg, there are three big dispatch centers. *Autoruf GmbH-Taxiruf Hamburg* is one of the city's largest taxi dispatch centers with more than 1000 affiliated vehicles at its disposal. *Hansa Funktaxi eG* is Hamburg‘s second largest taxi dispatch center with a taxi fleet of 800 affiliated vehicles at its disposal. *DAS TAXI Funk und Service eG* is also one of the city's considerably large taxi dispatch centers with more than 100 affiliated vehicles at its disposal. The regulatory authority responsible for taxi licenses and taxi operation is the Department for Economy, Traffic and Innovation BWVI of the City of Hamburg.[4]

What is unique about Hamburg is the so-called *Hamburger Modell*, a new way of renewing taxi concessions launched in 2006. The de facto revenues of taxi enterprises had been consistently higher than officially reported and the total number of concessions rising constantly. Hamburg is one of the few administrative areas in Germany where the total number of taxi concessions is not limited (Taxi Times 2014). As such, the city administration implemented stricter controls of the taxi business while at the same time also introduced the fiscal taximeter on a voluntarily basis, thereby making Hamburg a pioneering city in this regard (Taxi-Heute 2009). The device continuously records driving performance and directly transfers the data to the regulatory authority. Soon after, a clearing up of the taxi market was observed, i.e., the total number of taxis concessions dropped (Taxi Times 2014; Taxi-Heute 2015). This improved the competitive environment for those operators who fulfil all requirements and have a solid financial track record. Furthermore, an improved quality and efficiency of the taxi services in the city was evident (Schlesiger and Kroker 2014). Since the beginning of 2017, the fiscal taximeter is mandatory for all taxi operators throughout Germany.

Moreover, ridesharing is a rising mobility trend in Hamburg whereby a few taxi operators and new mobility service providers have started offering services where taxi patrons can share taxi trips and the related costs (Schmidt 2017): *Hansa Funktaxi eG* plans to introduce ridesharing service in the Hamburg metropolitan region starting mid-year 2017. Developers at *mytaxi-The Taxi App* also announced being ready to launch into a ridesharing test phase. In addition, HVV offers special shared taxi services—*Anruf-Sammel-Taxi* (AST) and *Anruf-Sammel-Mobil* (ASM)—in some selected districts or counties. However, these services are offered only at certain times of day (e.g., off-peak hours, late evening) in an attempt to offer mobility-on-demand service.

Hamburg has a strong commitment to advance electric mobility and has already installed 200 charging points in the city. The first four electric taxis have been operating since April 2013. One of the city's flagship projects is the "*eco-taxi*". The initiative saw the introduction of environmental labelling for taxis (i.e., exclusive rights for qualified taxis to advertise with the slogan "Hamburg Eco-Taxi" and to use the "European Green Capital" logo). At present, about 18% of Hamburg's taxi

[4]See: https://www.hamburg.de/behoerdenfinder/hamburg/11318407.

fleet comprises eco-taxis, contributing to an average annual saving of about 3.6 tons of CO_2. The project is still active and will operate as part of another public-private joint initiative: “Partnership for Air Quality and Low-Emission Mobility” established in 2012 and extended to 2020, since beginning in 2016.

2 Qualitative Research Methods

The overarching research questions of the project “*Future Urban Taxi*” are: (i) how to better adapt the taxi to user demand and specific urban contexts, and (ii) how to better integrate the taxi into a city’s mobility system in a sustainable, profitable and effective way. A qualitative methodology, based on the occurrence and evaluation of expert interviews and an expert workshop, was used. This laid the foundation for a qualitative scenario building, which was followed by a gap analysis. Using these methods, the potential of various different taxi services to enhance Hamburg’s mobility system towards sustainability was assessed.

2.1 Data Collection

Expert Interviews

Mobility services are strongly based on expert knowledge built through continuous interaction with end users (Margherita et al. 2012). A qualitative approach consisting of expert interviews was deemed an effective means to gain deeper insights into the status quo of the taxi sector, as well as future perspectives. In total, 20 taxi experts from the following institutions were interviewed:

– Autoruf GmbH (taxi dispatch center, Hamburg, private limited company)
– Hansa Funktaxi eG (taxi dispatch center, Hamburg, cooperative)
– DAS TAXI Funk und Service eG (taxi dispatch center, Hamburg, cooperative)
– Rhein-Taxi (taxi company, Düsseldorf, private limited company)
– Hüseyin Candangil Taxibetrieb (taxi enterprise, Hamburg, private limited company)
– Moovel (mobility service provider, Germany, private limited company)
– Uber Germany (mobility service provider, Germany, private limited company)
– Vispiron Carsync GmbH (enterprise, engineering service provider, also active in a taxi project)
– Austria Tech GmbH (Austrian state-owned enterprise, analyzing and providing mobility solutions)
– Mytaxi-The Taxi App (mobility service provider, private limited company)
– GefoS Gesellschaft für offene Systeme mbH (software provider, private limited company)

– Behörde für Wirtschaft, Verkehr und Innovation: Verkehrs-und Infrastrukturentwicklung Hamburg (taxi authority Hamburg)
– Taxen-Union Hamburg Hansa e.V. (taxi association, Hamburg)
– Taxiverband Deutschland e.V. (taxi association, Germany)
– Deutscher Taxi-und Mietwagenverband e.V. (taxi association, Germany)
– Industrie-und Handelskammer (IHK)—Abteilung Verkehr (Chamber of Commerce, Hamburg).

The interviews were semi-structured to provide room to explore relevant topics more in-depth. This also allowed adaptations of questions according to the flow of the interview or the interviewee’s profile (e.g., specific expertise, the represented organization, role in the organization). Each interviewee was asked the same set of questions related to the following categories: personal information, legal framework of the taxi sector, taxi as a business, taxi market and competitive environment, taxi of the future, technical innovations in the taxi sector, taxi infrastructure and some rather sensitive questions at the end, such as “What do you expect from other stakeholders in the business?”.

Each interview lasted approximately 45–75 min and was either done face-to-face or by telephone. All interviews were conducted over a period of six months, between August 2015 and January 2016, including a three-day research stay in Hamburg 17–19 January 2016. The transcripts were used to facilitate the subsequent data-analysis process.

Expert Workshop

After the evaluation of the interviews, some of the taxi experts were brought together in a workshop at the event “*Morgenstadt-Werkstatt*” organized by the Fraunhofer IAO on 28 September 2016. The findings derived from the first round of the qualitative data analysis were presented to the expert group in the form of preliminary scenarios. Feedback from the workshop participants was then collected as data to facilitate the subsequent qualitative data-analysis process and to fine-tune the eventual scenario development. Since the preliminary scenarios are inferred from expert interview data, this second data collection step acts as a credibility control for the interpretation of scenarios based on the initial findings from the first analysis.

2.2 Data Analysis

Following the common approach for qualitative data analysis as the foundation for qualitative scenario building (Fink 2001; Brauers and Weber 2006), all collected data were iteratively and systematically analyzed. The data were coded in two rounds: first using in vivo codes that are closely aligned to the qualitative data, followed by using theoretical codes that are based on the theoretical framework of Margherita et al. (2012) as an analytical lens.

This framework not only supports defining new ways to deal with sustainable mobility challenges through a service innovation perspective, but it is also useful for planning a more sustainable mobility system in urban contexts. The respective coding strategies that were used are, first of all, a qualitative thematic analysis through the in vivo coding method. In vivo codes were created from main/ interesting concepts or striking themes found in the qualitative data, then categorized and recoded to generate recurring key themes. Next, a second round of coding through the theoretical coding method—with reference to Margherita et al.'s (2012) framework—was used to perform qualitative content analysis of the collected data. The respective findings served as further input data for scenario building.

2.3 Scenario Building

The first key themes within the interviews and respective contributing factors were identified by the in vivo coding method. These were then used as initial input data for scenario building and presented in the form of preliminary scenarios with relevant aspects briefly described in each respective scenario. After the second round of theoretical coding, a scenario workshop comprising four Fraunhofer experts with expertise in mobility and urban systems had been held, where the results of the coding were evaluated and three scenarios—the electrification, automatization and sharing of taxi fleets—were developed and discussed. The scenario technique as a qualitative method enables the prediction of plausible future situations, which are derived through qualitative expert judgments while taking into account the integral parts of a complex (urban) system. This approach can also be used as a basis for planning future developments because the focus is on ”what might happen” as opposed to "what will happen" (Muskat et al. 2012; Weimer-Jehle 2014). The scenarios had been inferred from the collected data of the interviews to project taxi service concepts in Hamburg, and each one is briefly described in Sect. 3.1. It must be emphasized that, while the scenarios are prognoses based on primary data collected from expert interviews and a workshop, this paper does not guarantee their accuracy because these scenarios are not intended to make precise forecasts. Rather, they merely serve as a projection into the future—here, the 2025 context—for demonstrating the range of possible developments in Hamburg's urban mobility system.

2.4 Gap Analysis and Assessment of Scenarios

Based on Margherita et al.'s (2012) theoretical key concepts, a gap analysis of the developed scenarios was performed to assess how the respective taxi service can enhance Hamburg's urban mobility system towards sustainability. Margherita et al.'s (2012) integrative framework for service design and sustainable mobility

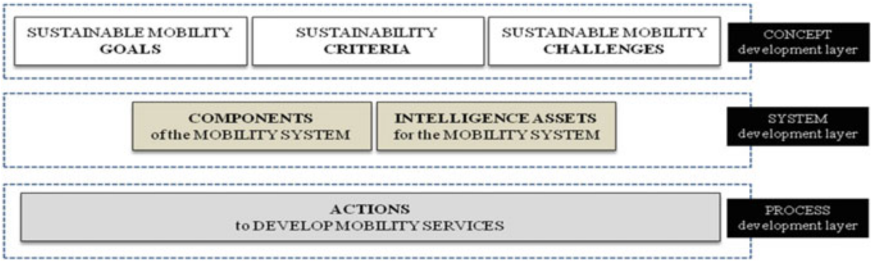


Fig. 1 Margherita et al.'s (2012: 5) framework for the design of sustainable mobility services

(see Fig. 1) comprises six core elements that facilitate the design of new and/or more effective services that, in turn, can aid the development of a sustainable mobility system.

The following core- and sub-elements (italic) are related mostly to service concept development:

i. Nine goals that define the long-term directions for the sustainable mobility system: *increase accessibility, increase mobility opportunities, enhance communication, develop trade, develop relationships, integrate transport solutions, reduce mobility divides, reduce noise and emissions, reduce road crashes/congestion.*
ii. Five criteria providing the perspectives for action and the performance metrics: *transportation and capacity/utility/functionality, safety and human protection, cost and infrastructure/resource demand, environment and land impact, socio-cultural behavior.*
iii. Three challenges to be addressed by an integrated and participative approach of actions for achieving the set out goals: c*ognition, coordination, cooperation.*

The following elements are related to system development:

iv. Five components of a mobility system that have to be set up: *means, carriers, networks, objects, actors*.
v. Three intelligence assets that facilitate the development of new or more effective services/solutions: *Individual intelligence, community intelligence, artificial intelligence*.

The following element is strictly related to service process development:

vi. Four actions required to build sustainable mobility services/solutions: *to build the required technology infrastructure and tools, to define the mobility* *service-related economic, policy and regulatory framework, to develop the social behavior, education and human capital competencies required to deliver the mobility service, to develop the public/private business and entrepreneurship setting for launching the mobility service*.

The results of the gap analysis are described in Sect. 3.2.

3 Findings and Discussion

3.1 Future Scenarios for Hamburg's Taxi Sector in 2025: Electric, Autonomous and Shared Taxi Fleets

Based on the results of the expert interviews and workshop derived through the qualitative data-analysis methods, three possible scenarios were developed in a scenario workshop with the Fraunhofer experts.

Electrification of Taxi Fleets Scenario

As one of the former eight German model regions for electric mobility, Hamburg is still highly committed to advance this technology whereby it also aims to lower its environmental impacts through electric mobility. Attributed to such strong commitment to support the rapid uptake of EVs in Hamburg, the expansion of electric mobility is realized through fleet electrification. There is an excellent charging infrastructure, including fast chargers and some inductive charging spaces. There was considerable progress in the electric propulsion systems enabling higher performance with lower energy consumption and notable improvements in battery technology. Therefore, EVs became much more affordable and thus accepted widely by taxi operators. EVs replace at least partially, or at best entirely, the existing ICE taxi fleets, thereby meeting the ever rising mobility demand. Carbon emissions are reduced due to the use of a well-balanced energy mix mainly from renewable energy. Accelerated growth of the EV market in Hamburg not only contributes to an improved economic situation of the city's taxi sector, but also has ripple effects on the overall urban situation in Hamburg. The vehicle-to-grid (V2G) technology may support electric/energy utilities whereby Hamburg's urban communities can then benefit from smart tariffs. The electric taxi service concept would still likely remain a niche and be rolled out only by 2025 in parts of the city where charging points are installed.

Automatization of Taxi Fleets Scenario

Hamburg has expressed its intention to introduce in the future technologically advanced vehicles for its complementary mobility—including taxi operations—so as to better integrate mobility-on-demand transport modes into its urban mobility system for supporting multimodality. As such, the autonomous taxi fleets can be combined with the use of public transport to better serve the public at large.

Autonomous vehicles (AVs) are most likely to remain as prototypes for deployment in test-phase projects, whereby the halting development of this new drive technology will keep the vehicle prices very high in the premium sector, resulting in the city authorities having to cooperate closely with local taxi operators—public-private partnerships (PPPs)—providing significant funds and attractive subsidies to urge them to adopt this technology for their taxi fleets. On the whole, the sustainable mobility contributions of this autonomous taxi service remain largely uncertain because of unclear long-term goals and lacking directions for its deployment, as it is still in a very early phase of development and testing. Semi-automatization will support the transition process to full automatization, with regards to e.g., automated moving up of queueing vehicles. Considering the technical and social complexity of both the autonomous and the semi-automated drive technology, these taxi concepts would be a niche and roll out as test phase projects soon in the next decade with some applied use cases in 2025.

Shared Taxi Fleets Scenario

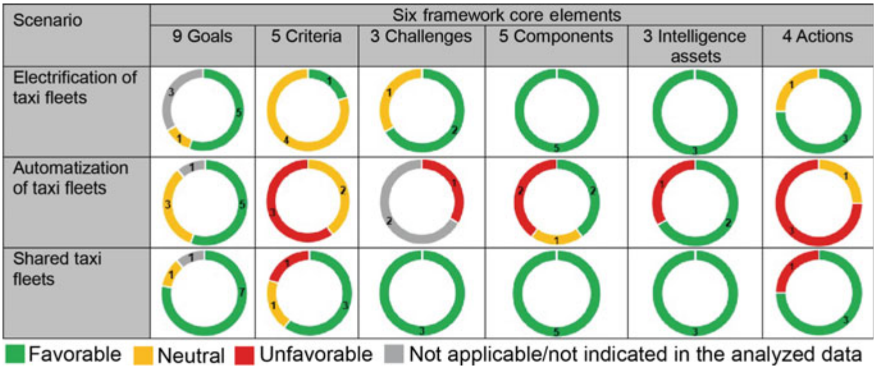
The rising mobility trend of ridesharing in Hamburg stirs up such great interest among the local taxi operators that it motivates the majority of them to introduce taxi-ridesharing service in the entire city. Due to increasing digitalization in Hamburg and close cooperation with ICT developers, these shared taxi fleets can become smarter by taking advantage of intelligent networking such as Internet of Things, sensors etc. Occupancy rates especially during off-peak hours are steadily increasing due to attractive offers and prices. Ride-sharing also leads to a better integration of taxis into the urban mobility system to promote multimodality and support mobility-on-demand. When combined with the use of public transport, HVV starts to offer its taxi ridesharing service—*AST* and *ASM*—on a more regular basis to better serve the public at large. Moreover, depending on the vehicle propulsion system of the shared taxi fleets, they can lead to lower carbon emissions when they are eco-taxis. Taxi-ridesharing service contributes to an efficient and resource-optimizing mobility system because it leverages existing fleets to meet increasing mobility demands without undermining the existing urban space, and therefore it enables maintaining a high quality of life for Hamburg's urban communities. This shared taxi service concept could be fully rolled out in the entire city by 2025.

3.2 Gap Analysis: Sustainable Urban Mobility Implications of the Three Scenarios

Results of the Gap Analysis

Based on the developed scenarios and using the core elements of Margherita et al.'s (2012) integrative framework for service design and sustainable mobility, results of the gap analysis are summarized in Table 1 to provide an overview of the implications of these three scenarios on sustainable urban mobility in Hamburg by

Table 1 Overview depicting the performance of respective taxi service concept in each developed scenario



depicting how the respective taxi service concept in each scenario can perform in contributing to the sustainability of the city's urban mobility system (see Appendix for more details).

Assessment of the Three Scenarios

As described in Sect. 2. 4, the framework of Margherita et al. (2012) consists of six core elements with 29 sub-elements. Based on the statements of the interviews and workshop with the taxi experts, as well as the ensuing scenario workshop with the Fraunhofer experts, the three scenarios were evaluated within all elements.

In summary, all three taxi service concepts of the respective developed scenarios entail potential for contributing to a sustainable urban mobility system. The assessment of the core element 'goals' showed five favorable sub-elements for each the electrified and the autonomous scenario and seven favorable sub-elements for the shared taxi scenario.

Shared taxi fleets appear to be the most promising scenario (24 of the total 29 elements rated 'favorable') and feasible, without incurring huge start-up costs. Moreover, it can be fully implemented rather easily within a short timeframe with some extent of PPPs. The next most-promising is the electrification of taxi fleets (19 out of the total 29 elements rated as 'favorable'). While the local politics are in favor of, and strong supporters of electric mobility, this taxi service concept is nonetheless subject to crucial factors, such as market forces and significant costs involved (e.g., research and development, charging infrastructure). Thus, in comparison to shared taxi fleets, it is less feasible, regarding the complexity of factors that requires relatively close PPPs and resulting in the longer timeframe needed for a full rollout. Finally, the automatization of taxi fleets is the least promising and least feasible among the three taxi-service concepts (nine out of the total 29 elements rated as 'favorable'). In view of various factors such as social and political concerns, as well as potentially significant costs involved (e.g., human safety, regulations, research and development, infrastructure), this approach requires very close PPPs and also clearly needs a long timeframe for eventual (full) rollout. A detailed overview of the scenario assessment can be found in the appendix.

4 Conclusion

While it is necessary to rethink mobility, the taxi often tends to be overlooked, thereby causing a failure to realize its potential in contributing to a sustainable urban mobility system through innovative and environmentally friendly mobility concepts. As such, this paper takes a closer look at the taxi in an urban context to gain deeper insights into Hamburg's existing taxi service and its potential for the shift towards sustainability in the context of 2025. The research identified key drivers and three future scenarios (electric taxi, autonomous taxi and shared taxi) that could be implemented to enhance Hamburg's urban mobility system so as to attain sustainability. The shared taxi fleet scenario was shown to be the most promising, followed by the electric taxi fleets scenario. The automated taxi could substantially contribute to the urban mobility system of the future. However, the technology is still in its early phase of development and testing. Thus, the predictions of when and how it could be implemented in the taxi system, as well as what effects it will have on the job market for the taxi drivers and operators, are very uncertain.

Since introducing the *Hamburger Modell* in 2005, Hamburg is today a role-model city regarding the cooperation between the city administration and taxi businesses. Many innovative approaches in the taxi market first took place in Hamburg, such as the fiscal taximeter, ridesharing concepts, more flexible pricing during off-peak hours, as well as the concept of eco-taxis. The scenarios and their evaluation reported in this paper underline that the city is already heading in the right direction. In the move towards a sustainable future, PPPs are highly recommended to promote synergies among relevant stakeholders for improving the quality of urban life through innovative and value-adding mobility solutions. The case of Hamburg can be transferred to other German cities. The willingness of the city administration and authorities is an essential prerequisite, as well as setting a clear strategy and roadmap for a future taxi system, in which ride-sharing could be one of the initial projects to be set up.

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Appendix

Detailed overview of taxi-service performance in each developed scenario

Scenario/framework core elements		Electrification of taxi fleets scenario	Automatization of taxi fleets scenario	Shared taxi fleets scenario
Goals				
1	To increase accessibility	√	√	√
2	To increase mobility opportunities	√	√	√
3	To enhance communication	–	0 (depends on the format: conventional individualized taxi ride or ridesharing)	√
4	To develop trade	√	√	–
5	To develop relationships	–	–	√
6	To integrate transport solutions	√	√	√
7	To reduce mobility divides	–	0 (depends on the format: conventional taxi ride or ridesharing)	√(typically cheaper than conventional taxi rides due to shared costs; thus service is available to more people because it is more affordable)
8	To reduce noise and emissions	√	√(assumption: vehicles use low-emission, innovative propulsion technologies)	0 (depends on the vehicle propulsion system)
9	To reduce road crashes/congestion	0 (unless the existing fleets are replaced or else risks putting more vehicles on the road)	0 (unless the existing fleets are replaced or else risks putting more vehicles on the road)	√(optimizing existing fleets)
Criteria				
1	Transportation and capacity/utility/ functionality	0 (this taxi service may not yet contribute to an effective and well-performing system but improvements are in progress)	X (not yet in place)	√(this taxi service contributes to an effective and well-performing system)

(continued)

(continued)

Scenario/framework core elements		Electrification of taxi fleets scenario	Automatization of taxi fleets scenario	Shared taxi fleets scenario
2	Safety and human protection	0 (subject to human error, current system may be adequate but improvements are ongoing)	X (an adequate human-oriented system is not yet in place)	0 (subject to human error, current system may be adequate but there is still room for service improvement: vocational training of taxi drivers/ service providers)
3	Cost and infrastructure/ resource demand	0 (this taxi service may still involve moderately high costs particularly for infrastructural set-ups, but may contribute to an efficient and resource-optimizing system: higher performance with low energy consumption, use of renewable energy)	0 (this taxi service may involve costly vehicles and infrastructural set-ups, but may also contribute to an efficient and resource-optimizing system assuming the vehicles use low-emission, innovative propulsion technologies)	√(this taxi service contributes to an efficient and resource-optimizing system: leverage existing fleets to meet increasing mobility demands)
4	Environment and land impact	0 (this taxi service may contribute to a location-friendly system, unless the existing fleets are replaced or else urban space is undermined: more vehicles on the road)	0 (this taxi service may contribute to a location-friendly system, unless the existing fleets are replaced or else urban space is undermined: more vehicles on the road)	√(this taxi service contributes to a location-friendly system: optimize existing fleets to create more urban space)
5	Socio-cultural scenario and behavior	√(this taxi service respects the values and ethics of the local community: sustainable development, Energy Transition/ *Energiewende* in Germany)	X (this taxi service may violate the values and ethics of the local community: human safety, social issues such as putting taxi drivers out of work)	X (this taxi service may violate the values and ethics of the local community: criminal activities, irregular low wages with reference to *Uber*'s controversial business model)
Challenges				
1	Cognition	0 (shared meaning but inconsistent judgment on mobility problem/ challenge: reduce	X (various meanings and inconsistent assessment of mobility problem/ challenge: part of	√(shared meaning and consistent assessment of mobility problem/ challenge: reduce

(continued)

(continued)

Scenario/framework core elements		Electrification of taxi fleets scenario	Automatization of taxi fleets scenario	Shared taxi fleets scenario
		carbon emissions at the expense of urban space, "obvious" solution to overcome unsustainable transport emissions but could lead to unintended consequences of inherently shifting carbon emissions from transport to energy sector)	smart mobility trend, reduce carbon emissions at the expense of urban space when existing fleets are not replaced but more vehicles are put on the road instead)	carbon emissions by means of optimizing the existing fleets)
2	Coordination	√(this taxi service leverages a coordinated approach to embark on a shared course: reduce carbon emissions)	–	√(this taxi service leverages a coordinated approach to embark on a shared course: reduce carbon emissions by means of optimizing the existing fleets)
3	Cooperation	√(currently able to create mutual advantage through close cooperation but there is still room for improvements: roll-outs with larger fleets to encourage rapid uptakes, expansion of charging infrastructure, subsidies)	–	√(currently able to create mutual advantage through some cooperation but there is still room for improvements: integrate into public transport chain for supporting multimodality and mobility-on-demand)
Components				
1	Means (tools to deliver mobility service)	√(vehicles and infrastructure are available but there is still room for improvements: innovations for vehicle propulsion systems, charging infrastructure)	X (vehicles and infrastructure are not yet widely available since the technology is still in its early phase of development and testing)	√(leverage existing fleets)

(continued)

(continued)

Scenario/framework core elements		Electrification of taxi fleets scenario	Automatization of taxi fleets scenario	Shared taxi fleets scenario
2	Carriers (persons and/or organizations)	√(extensive range of expertise especially technical expertise to professionally and systematically carry out the system development process)	X (related expertise is limited to an exclusive group with the capacity to professionally and systematically carry out the system development process)	√(extensive range of expertise to professionally and systematically carry out the system development process)
3	Networks (physical and/or virtual pathways)	√(networks are in place but may be subject to improvements: remote sensors and monitoring devices, V2G technology)	0 (networks are in place but is subject to improvements since the technology is still in its early phase of development and testing)	√(networks are in place but may be subject to improvements: GIS, Internet of Things)
4	Objects (to be transported)	√(passenger transport/courier/ medication/blood banks/logistics)	√(passenger transport/courier/ medication/blood banks/logistics)	√(passenger transport)
5	Actors* (directly/indirectly impacted by the overall mobility system) **not an exhaustive list*	√(realizing this taxi service will involve city authorities, local policymakers/ regulators, taxi companies/ cooperatives/call centers, taxi drivers, new mobility service providers, smartphone app developers, end-users/local communities[a], electric utilities/ energy providers, charging infrastructure providers, technology providers)	√(realizing this taxi service will involve city authorities, local policymakers/ regulators, taxi companies/ cooperatives/call centers, taxi drivers, new mobility service providers, smartphone app developers, end-users/local communities, technology providers)	√(realizing this taxi service will involve city authorities, local policymakers/ regulators, taxi companies/ cooperatives/call centers, taxi drivers, new mobility service providers, smartphone app developers, end-users/local communities)

(continued)

(continued)

Scenario/framework core elements		Electrification of taxi fleets scenario	Automatization of taxi fleets scenario	Shared taxi fleets scenario
Intelligence assets				
1	Individual intelligence	√(extensive expert knowledge on electric vehicles)	√(limited expert knowledge on autonomous vehicles)	√(extensive expert knowledge on shared mobility)
2	Community intelligence	√(large expert communities for electric vehicles)	√(currently remains as exclusive expert communities for autonomous vehicles)	√(large expert communities for shared mobility)
3	Artificial intelligence	√(adequate virtual infrastructure in place, but improvements are ongoing: V2G technology, sensor technology)	X (inadequate virtual infrastructure because the technology is still in its early phase of development and testing)	√(adequate virtual infrastructure in place, but improvements are ongoing: GIS, big data analytics, Internet of Things)
Actions				
1	To build the required technology infrastructure and tools	0 (current infrastructure and tools are inadequate and constant service improvements are in progress)	X (proper infrastructure and tools are not yet in place for this taxi service)	√(current infrastructure and tools are moderately adequate, but there is still room for service improvement: smartphone app development)
2	To define the mobility service-related economic, policy and regulatory framework	√(current policies and regulations may be adequately defined for this taxi service but improvements are ongoing)	X (respective policies and regulations are not yet in place for this taxi service)	X (current policies and regulations are inadequately defined for this taxi service, thus the call for ongoing improvements: human safety, data security, privacy issues, flexible pricing models)
3	To develop the social behavior, education and human capital competencies required to deliver the mobility service	√(current initiatives may be adequate but more are constantly developed to deliver and promote this taxi service)	X (respective policies and regulations are not yet in place for this taxi service)	√(current initiatives may be adequate, but there is still room for further development to deliver and promote this taxi service)

(continued)

(continued)

Scenario/framework core elements		Electrification of taxi fleets scenario	Automatization of taxi fleets scenario	Shared taxi fleets scenario
4	To develop the public/private business and entrepreneurial setting for launching the mobility service	√(current setting is adequate, but more are constantly developed to launch and advance this taxi service)	0 (current setting may be inadequate, but there is room for further development to launch and promote this taxi service: smart mobility)	√(current setting may be adequate, but there is still room for improvement to launch and advance this taxi service: ICT innovations, big data analytics, Internet of Things)

[a]Can refer to individuals or public/private organizations such as university, hospital, company, etc.
Legend based on the analyzed data
- "√": favorable
- "X": unfavorable
- "0": neutral
- "—": not applicable/not indicated in the analyzed data

References

Aarhaug, J. (2016). *Taxis as a part of public transport. Sustainable urban transport technical document #16*. Eschborn: Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ). http://www.sutp.org/files/contents/documents/resources/B_Technical-Documents/GIZ_SUTP_TD16_Taxi_EN.pdf. Accessed 10 January 2017.

Aarhaug, J., & Skollerud, K. (2014). Taxi: Different solutions in different segments. *Transportation Research Procedia, 1,* 276–283.

Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy, 15,* 73–80.

Beirao, G., & Sarsfield Cabral, J. A. (2007). Understanding attitudes towards public transport and private car: A qualitative study. *Transport Policy, 14*(2007), 478–489.

Borroni-Bird, C. E. (2012). Personal urban mobility for the 21st century. In: O. Inderwildi & D. King (Eds.), *Transport and the environment* (313–334).

Brauers, J., & Weber, M. (2006). A new method of scenario analysis for strategic planning. *Journal of Forecasting, 7*(1), 31–47.

BSU. (2011). *The Hamburg climate action plan 2007–2012: A brochure on the update 2011*. Hamburg: Behörde für Stadtentwicklung und Umwelt (BSU). http://www.hamburg.de/contentblob/4028914/data/booklet-englisch).pdf. Accessed 21 January 2017.

BSU. (2012). *Hamburg—European green capital 2011: Final report*. Hamburg: BSU. http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2011/04/Doku-Umwelthauptstadt-engl-web.pdf. Accessed 21 January 2017.

BSU/SK. (2011). *Communication of the senate to the Hamburg parliament: Update of the Hamburg climate action plan 2007–2012*. Hamburg: Behörde für Stadtentwicklung und Umwelt (BSU)/Senatskanzlei (SK). http://www.co2olbricks.eu/fileadmin/Redaktion/Press/Documents/Hamburg_Climate_Action_Plan_2007-2012_Update_2011_2012.pdf. Accessed 21 January 2017.

BSU/SK. (2013). *Status quo report Hamburg*. Hamburg: BSU/SK. http://urbantransform.eu/wp-content/uploads/sites/2/2015/07/Status-Quo-Report_Hamburg.pdf. Accessed 21 January 2017.

BSU/SK. (2015). *City transformation agenda Hamburg*. Hamburg: BSU/SK. http://urbantransform.eu/wp-content/uploads/sites/2/2015/07/D2.2_Transformation-Agenda-Hamburg.pdf. Accessed 21 January 2017.

BUE. (2016). *Hamburg—European green capital: 5 Years on—The city takes it further*. Hamburg: Behörde für Umwelt und Energie (BUE). http://ec.europa.eu/environment/europeangreencapital/wp-content/uploads/2011/04/Hamburg-EGC-5-Years-On_web.pdf. Accessed 21 January 2017.

BWVI. (2013). *Mobilitätsprogramm 2013: Grundlage für eine kontinuierliche Verkehrsentwicklungsplanung in Hamburg*. Hamburg: Behörde für Wirtschaft, Verkehr und Innovation (BWVI). http://www.hamburg.de/contentblob/4119700/data/mobilitaetsprogramm-2013.pdf. Accessed 21 January 2017.

Fink, A. (2001). Nicht voraussagen, sondern vorausdenken. Mit "Szenario-Management" in ungewissen Umfeldern navigieren. *Marketing Journal, 4,* 176–179.

Frantzeskaki, N., Bach, M., Hölscher, K., & Avelino, F. (2015). *Urban transition management: A reader on the theory and application of transition management in cities*. SUSTAIN Project (www.sustainedu.com). Rotterdam, DRIFT, Erasmus University Rotterdam (Creative Commons).

Goldman, T., & Gorham, R. (2006). *Sustainable urban transport: Four innovative directions*. *Technology in Society, 28,* 261–273.

Hamburg.de. (2016, April 26). *HVV kooperiert mit moovel*. http://www.hamburg.de/hvv/6054554/hvv-moovel. Accessed 10 January 2017.

Lim, C. Y. R., & Schatzinger, S. (2016). *Urban data report 2015*. Stuttgart: Fraunhofer IAO. Boston: MIT.

Linne, K., & Krause, T. (2007). *2 Zwischenbericht: Gutachten über die wirtschaftliche Lage des Hamburger Taxigewerbes*. Hamburg: Linne + Krause Marketing-Forschung GbR. http://www.hamburg.de/contentblob/2987770/56fdf28726f0d7e409a07ab5323cfc24/data/taxi-zwischenbericht02-download.pdf. Accessed 15 February 2017.

Margherita, A., Elia, G., Secundo, G., & Passiante, G. (2012). Sustainable mobility: An integrative framework and its application for new service design. *International Journal of Technology Management & Sustainable Development, 11*(1), 31–49.

Murchland, J. D. (1970). Braess's paradox of traffic flow. *Transportation Research, 4,* 391–394.

Muskat, M., Blackman, D., & Muskat, B. (2012). Mixed methods: Combining expert interviews, cross-impact analysis and scenario development. *The Electronic Journal of Business Research Methods, 10*(1), 9–21.

OECD. (2015). *Taxi services: Competition and regulation*. In *competition policy roundtables publication series, DAF/COMP(2007)42*. http://www.oecd.org/regreform/sectors/41472612.pdf. Accessed 08 January 2017.

Schatzinger, S., & Lim, C. Y. R. (2017). Taxi of the future: Big data analysis as a framework for future urban fleets in smart cities. In: A. Bisello, D. Vettorato, R. Stephens & P. Elisei (Eds.), *Smart and sustainable planning for cities and regions: Results of SSPCR 2015. Book series: Green energy and technology* (pp. 83–98). Switzerland: Publisher: Springer International Publishing.

Schlesiger, C., & Kroker, M. (2014). Die Abgründe des Taxi-Gewerbes. http://www.wiwo.de/unternehmen/dienstleister/unwuerdiges-geschacher-die-abgruende-des-taxi-gewerbes/10724474.html. Accessed 04 February 2016.

Schmidt, H. (2017, January 5). *Ridesharing—Neu in Hamburg: Gemeinsam mit fremden Menschen Taxi fahren*. Hamburger Abendblatt. http://www.abendblatt.de/hamburg/article209175465/Neu-in-Hamburg-Gemeinsam-mit-fremden-Menschen-Taxi-fahren.html. Accessed 10 January 2017.

SK. (2013). *Notice from the Senate to the Hamburg parliament: Master plan for climate protection*. Hamburg: Senatskanzlei (SK). http://www.hamburg.de/contentblob/4316146/data/master-plan-for-climate-protection.pdf. Accessed 21 January 2017.

Svítek, M. (2015). Urban transport—a big challenge. *International Transportation, 67*(1), 3.

Taxi-Heute. (2009). *Warum das Hamburger Modell bisher nur in der Hansestadt funktioniert*. http://www.taxi-heute.de/Das-bundesweite-Taxi-Magazin/5402/Artikel/Warum-das-Hamburger-Modell-bisher-nur-in-der-Hansestadt-funktioniert. Accessed 04 February 2016.

Taxi-Heute. (2015). *In Hamburg sinken die Taxizahlen weiter*. http://www.taxi-heute.de/Taxi-News/News/11847/In-Hamburg-sinken-die-Taxizahlen-weiter. Accessed 21 January 2017.

Taxi Times. (2014). *Schlussbilanz der Hamburger Fiskaltaxameter-Förderung*. http://www.taxi-times.com/schlussbilanz-der-hamburger-fiskaltaxameter-foerderung. Accessed 09 January 2017.

WBCSD. (2016). *Sustainable urban mobility report Hamburg*. Geneva: World Business Council for Sustainable Development (WBCSD). http://www.wbcsd.org/Projects/Sustainable-Mobility-Project-2.0/Resources/Sustainable-Urban-Mobility-Report-Hamburg. Accessed 08 January 2017.

Wefering, F., Rupprecht, S., Bührmann, S., & Böhler-Baedeker, S. (2014). *Guidelines: Developing and implementing a sustainable urban mobility plan*. Brussels: European Commission. http://www.eltis.org/sites/eltis/files/guidelines-developing-and-implementing-a-sump_final_web_jan2014b.pdf. Accessed 08 January 2017.

Weimer-Jehle, W. (2014). *Introduction to qualitative systems and scenario analysis using cross-impact balance analysis*. Stuttgart: Interdisciplinary Research Unit on Risk Governance and Sustainable Technology Development—University of Stuttgart (ZIRN). http://www.cross-impact.de/Ressourcen/Guideline_No_1.pdf. Accessed 05 January 2017.

A Review Methodology of Sustainable Urban Mobility Plans: Objectives and Actions to Promote Cycling and Pedestrian Mobility

Francis Cirianni, Cosimo Monterosso, Paola Panuccio and Corrado Rindone

Abstract In the previous decade, the European Commission, among its policies to increase sustainability and the quality of life in European cities, has introduced the Sustainable Urban Mobility Plan (SUMP). The concepts brought forward in this novel planning approach further focus on sustainable transport modes, such as cycling and pedestrian mobility, which are two of the main issues included in SUMP. The European challenge is to integrate long-term planning perspectives and short-term actions. In this context, the aim of this paper is to analyze and classify the objectives and actions proposed in the SUMP adopted by European cities, focusing on the policies for improving cycling and pedestrian mobility. Therefore a review methodology is proposed in order to verify their coherence with the European guidelines, classifying objectives and actions for the promotion of cycling and pedestrian mobility. The research required that each of a set of SUMPs, adopted by various European cities, be analyzed and classified in order to identify the objectives and the planned actions and to verify the presence of qualitative and quantitative indicators, therefore presenting a first application of the proposed methodology. The results show how the cities follow the European policies relative to urban mobility in terms of objectives and actions and, in particular, in relation to cycling and pedestrian mobility. All cities in the sample set goals to improve safety for pedestrians and cyclists by means of: the modernization and adaptation of the existing cycling paths and pedestrian walkways; and the construction of new long-distance cycle paths and of new pedestrian walkways and public areas that are comfortable for pedestrians. This work can be useful in order to verify the implementation of the sustainable urban planning process, establishing a benchmark process useful for other cities to follow.

Keywords Integrated urban planning · Walkable cities · Innovative and integrated infrastructures

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1 Introduction

Urban sustainability is one of the main challenges at a global level. The United Nations has included *sustainable cities and communities* among the 17 Sustainable Development Goals (SDGs) to pursue at global level in 2030 (UN 2017). The European Innovation Partnership on Smart Cities and Communities (EIP-SCC) indicated *sustainable urban mobility* as one of the three priority areas of a smart city in order to make progress across the energy, ICT and transport sectors (EC 2013a), while the integrated planning approach is one of the recommended actions to implement in a smart city. In this context, the promotion of *public transport and soft modes, especially walking and cycling,* is strongly recommended (EC 2014). The suggested integrated planning approach is introduced in the European guidelines to Sustainable Urban Mobility Plans (SUMP), which describe a planning process indicating a set of objectives and actions (EC 2013b).

The aim of this paper is to analyze and classify objectives and actions to improve Cycling and Pedestrian (C&P) mobility at the European level. Given as reference the concepts expressed in the European guidelines, a set of adopted SUMPs in European cities are compared. In particular, a review methodology is proposed to verify their coherence with the guidelines and to define parameters to assess objectives and actions for the promotion of C&P mobility.

The proposed methodology is based on a qualitative research approach that includes the collection of data and their analysis and reporting (Williams 2007). In particular, this regards methodologies for assessing the quality of plans (Berke and Godschalk 2009). Many European networks, projects and reports have reviewed existing SUMPs (e.g., ELTIS 2014). In respect to published reviews, the proposed methodology reviews SUMPs pertaining to objectives and actions oriented to C&P mobility.

A first prototypical application of the proposed methodology is presented in order to verify its feasibility. The SUMPs adopted in a defined set of European cities are analyzed in order to obtain common planned objectives and actions related to C&P mobility. The final aim is a C&P benchmark on European Sustainable Urban Mobility Plans.

The paper, presents a the state of the art on the theory and published guidelines on sustainable mobility planning (Sect. 2), a method is proposed to analyze and to benchmark SUMPs in relation to C&P mobility (Sect. 3). The method is applied to a case study (Sect. 4), therefore presenting conclusions and future perspectives (Sect. 5).

2 Literature Review

The papers and publications present in the literature are here classified into two sections, theories and methods of urban mobility planning relative to scientific references (Sect. 2.1) and European policies for urban mobility (Sect. 2.2).

2.1 Scientific References

Jacobs (1961), who introduced the need to include social phenomena into city planning theory and development, highlighted quality of life as the ultimate goal of urban planning. Social interactions increase in pedestrian-friendly cities, where walking, biking and public transit is favored over cars (Esztergár-Kiss and Rózsa 2015). Today, sustainable mobility is becoming a new theoretical paradigm that introduces an alternative approach to conventional transportation planning (Banister 2008). Following this new paradigm, people are at the center of the planning goal set, and then integrated actions (to reduce the need to travel or to encourage modal shift in the transport system) have to be planned and realized (Gehl 2013). Some attempts to introduce common standards into spatial planning have been the subject of experiments (Cirianni et al. 2013). The smart city model is considered a possible perspective where theories, rules and practice could converge to improve the urban quality of life (Russo et al. 2016; Cirianni and Leonardi 2011). Decision-making, models and technologies have to combined in an integrated planning process (Chilà et al. 2016). Moreover, *the implementation gap* in the transport and land-use planning process has to be closed (Cordera et al. 2016; Silva et al. 2017).

In this context, some authors recognize the economic value of active transport modes (walking, cycling, and their variants) (Litman 2017).

Then, it is useful to study how European cities are implementing its urban mobility policies in relation to these issues.

2.2 European Policies for Urban Mobility

At the European level, new theoretical transportation planning approaches are translating into guidelines, rules and good practices. European Commission (EC) is working to define policies to improve urban mobility. The two editions of *White Paper* on sustainable mobility (EC 2011), the *Green Paper* on urban mobility (EC 2007) and the *Action Plan* on urban mobility (EC 2009), constitute the principal reference for European policies to promote sustainable urban mobility. With the *Urban Mobility Package,* the EC invites all Member States to promote coordinated action in the area of urban transport across the Union in order to overcome existing fragmentation (EC 2013c, 2017). Policies have become urban mobility-planning guidelines. In recent years, some guidelines to address urban transport planning are available at the European level. Some of these resulted from European projects concerning urban mobility.

Recently, a broad consensus between stakeholders and planning experts converged on the concept of SUMP. The SUMP represents a possible approach for integrated urban planning to effectively create *synergies and links between transport, energy and ICT in urban transport and engage citizens* (EC 2013b). The European guidelines describe SUMP as an urban integrated-planning process in order to contribute to improve *accessibility of urban areas* and to provide *high quality and sustainable mobility*. The process is organized into four main phases: *1. preparing well*; *2. rational and transparent goal setting*; *3. elaborating the plan; and 4. implementing the plan*. Each phase should be developed and implemented following specific sequential steps, each step encompassing a set of activities.

In this paper, the focus is on the second phase, *rational and transparent goal setting* and the relative objectives and actions.

The long-term vision has to translate into objectives and relatively measurable targets to meet the policy challenges of a specific urban area (Phase 2—*Steps 4. Develop a common vision and Step 5. Set priorities and measurable target*). To achieve the objectives, a set of integrated actions and measures are suggested (*Step 6. Develop effective package of measures*). The actions suggested by guidelines are grouped into seven classes of measures, each of them relative to a specific mobility component. The implementation of an integrated package of measures is recommended as opposed to single, isolated measures. The seventh class *less car-dependent mobility options* includes specific actions and measures relative to C&P mobility. As indicated in the guidelines, there is a strong connection between actions related to C&P mobility (C&P actions) and all urban policy challenges.

The aim of this paper is to analyze the objectives and C&P actions indicated in SUMPs already adopted in European cities. For this reason, a two-step methodology illustrated in the following section is proposed.

3 The Review Methodology: Survey and Benchmarking

The planning practices in each Member State should reflect and implement the concepts of the European SUMP guidelines. In order to verify how European city plans are adopting the SUMP concept, a review methodology is proposed. The principal aim is to evaluate how cities are translating European indications for C&P mobility in their SUMPs. The methodology has two steps:

- in the first step, a survey is carried out to select cities that have adopted a SUMP; analyzing for each selected city the objectives and actions in the SUMP and verifying the coherence with SUMP guidelines (Sect. 3.1);
- in the second step, several elements for benchmarking among the selected SUMPs are derived to obtain a ranking and some reference elements useful for other cities; the objectives and actions are synthesized through keywords used for their classification (Sect. 3.2).

The derived classes are useful to compare the SUMP objectives and actions of the selected cities and to obtain a benchmark for other cities.

A schematic representation of the proposed methodology is shown in Fig. 1.

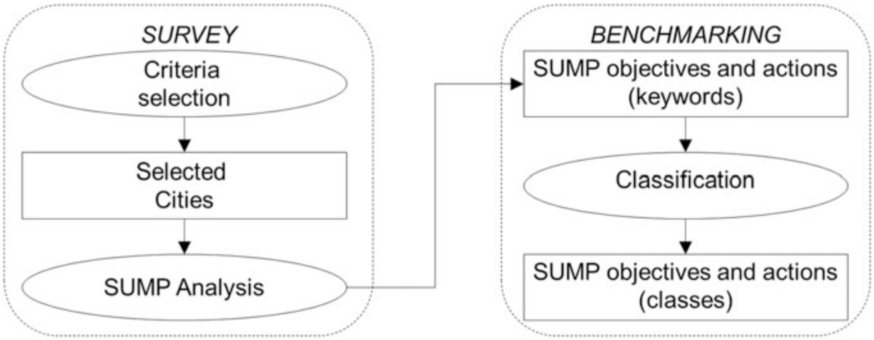

Fig. 1 The review methodology

3.1 Survey

The objective of this step is to obtain a sample of best practices for SUMPs. Since the criteria chosen for the selection of the set of cities doesn't affect the process of the proposed methodology, different criteria can be adopted in the survey selections. It is possible to refer to European statistics, which produce annual rankings, e.g., in relation to quality of life or smartness; otherwise, reference can be made to the awards assigned by the European urban mobility observatory (ELTIS).

Starting from the sample, each SUMP is analyzed identifying principal keywords representing objectives and actions related to C&P mobility.

Objectives keywords are analyzed to verify their coherence with policy challenges in urban transport (*health, congestion, safety and security, participation, strategic planning, climate change*) developed in the CiViTAS CATALIST guide and recalled in SUMP guidelines (CIVITAS 2012). It is possible to verify whether the achievement of objectives is measured through a quantitative indicator.

C&P actions and relative keywords are analyzed in relation to the following proposed classification:

- *material* actions, including measures that modify the physical asset of urban spaces, roads and places; these can be grouped into subsets concerning specific elements of the transport network (pedestrian or bike *node*, *link* or entire *network*);
- *immaterial* actions including measures that define telematics and tools influencing user behavior; these can be grouped into subsets including *encouragement* measures (e.g., advertising campaigns), *education* measures (e.g., training courses) or Intelligent Transport System (*ITS*) measures (e.g., safety technologies);

- *governance* actions including measures for identifying responsibilities and rules to regulate the urban transport system; these can be grouped into subsets including *institutional* measures (e.g., definitions of rules) and *enforcement* measures (e.g., respecting rules);
- *equipment* actions including measures for acquiring means of cycling mobility.

It is possible to analyze the quantity and quality of measures proposed in the selected SUMPs in order to verify the extension and the relevance of action and relative measures.

3.2 Benchmarking

In the second step, keywords representing SUMP objectives and actions are used for their classification.

From the SUMP analysis, two synthetic tables are obtained:

- a table for objectives classification with the rows corresponding to the keywords identifying CIVITAS policy challenges and with a column for each selected SUMP; each element of the table indicates if the selected SUMP has been included among objectives the policy targets and if there is a quantitative indicator.
- a table for actions classification with the rows corresponding to the keywords identifying B&P actions and with a column for each selected SUMP; each element of the table indicates if the selected SUMP has been included and if there is a quantitative indicator.

The two tables show common elements among selected SUMPs in relation to the objectives and C&P actions. Furthermore, it is possible to identify one or more SUMPs that fulfill objectives and classified C&P actions set by European guidelines. Through this classification, a benchmark reference is established that is useful for local authorities in planning and for national administrations, such as EC departments, to monitor policy implementation at the national or European level.

4 A Case Study: European Benchmarking

An application of the methodology to a limited set of cities is presented. In Sect. 4.1, the principal results of a web survey are presented. In Sect. 4.2, some elements of a benchmarking among the selected samples are illustrated.

4.1 Web Survey

The web survey started with a selected set including six cities in various European countries. Two selection criteria were adopted: the first criterion was based on the population size (OECD 2012); the second criterion was based on acknowledgments awarded to the cities during the last five years. These are SUMP awards (ELTIS 2014) or international rankings for quality of life (EC 2016). The SUMP of each city is analyzed, selecting keywords identifying objectives and actions. These keywords are inputs for a classification of objectives and actions.

Table 1 contains the selected cities and relevant information.

4.2 First Benchmarking

The collected data are elaborated in order to identify common objectives and C&P actions in the selected cities. The first elements for a benchmarking between two SUMP components emerge.

SUMP objectives are synthetized in Table 2, in relation to CIVITAS challenges.

In relation to objectives reported in the selected SUMPs, it is possible to note that *health*, *congestion, safety and security* are common objectives to all cities. In some cases, the achievement of these objectives is measured by means of quantitative indicators.

SUMP C&P actions are synthetized in Table 3, in relation to the proposed classification introduced in the Sect. 3.1.

The following examples describe specific C&P actions, identified accordingly to the proposed classification.

Material class. All selected cities are promoting and implementing the development of C&P networks. For instance, the city of Wien, with the investments for upgrading the Getreidemarkt area, would complete C&P networks working at the same time into nodes (e.g., improving traffic lights) and into links (e.g., introducing roads classification); the city of Rivas Vaciamadrid in expanding its pedestrian network (*vías saludables)* intends to promote sustainable mobility.

Immaterial class. All selected cities aim to promote encouragement actions. For instance, the city of Malmö aims at increasing active mobility with specific awareness campaigns (see *Cykla fint*). Implementation of ITS pertains to specific C&P immaterial actions. For instance, the city of Aberdeen would install counters to monitor C&P mobility; the collection of data enables the City Council to identify the most frequented routes, and it demonstrate benefits of improvements such as localized path widening and lighting.

Governance class. All selected cities are promoting and implementing institutional actions. For instance, the city of Bremen introduced several restricted traffic areas encompassing large sections of the major road network.

Table 1 Cities in the sample

City	Country	Surface (km^2)	Density (inhabitants/km^2)	Selection criteria		
				Population (inhabitants)	OECD classification	Acknowledgment
Aberdeen	UK	184	1,169	220,420	Medium-sized urban area	▲
Bremen	DE	326	1,680	548,547	Metropolitan area	▲
Rivas Vaciamadrid	ES	67	4,000	80,000	Small urban area	▲
Malmö	SK	355	882	313,000	Medium-sized urban area	▲
Vienna	AT	415	4,293	1,781,105	Large metropolitan area	♦
Marseille	FR	605	1,723	850,636	Metropolitan area	♦

Legend
▲ SUMP awards
♦ International classification on quality of life

Table 2 Objective in the selected SUMPs

Objectives keywords	Aberdeen		Bremen		Rivas		Malmö		Wien		Marseille	
Health	◆	■	◆	■	◆	■	◆	■	◆	■	◆	■
Congestion	◆	■	◆	■	◆	■	◆	■	◆	■	◆	■
Safety and security	◆	■	◆	■	◆	■	◆	■	◆	■	◆	■
Participation									◆			
Strategic planning			◆	■	◆				◆		◆	
Global climate change							◆	■			◆	■

Legend
◆ Objective keyword
■ Objective quantitative indicator

Table 3 C&P actions in the selected SUMPs

Action class keywords	Actions keywords	Aberdeen		Bremen		Rivas		Malmö		Wien		Marseille	
Material	Bike node	♦	■	♦	■	♦	■	♦	■	♦	■	♦	■
	Pedestrian node	♦		♦		♦		♦		♦		♦	
	Bike link	♦		♦		♦						♦	
	Pedestrian link			♦		♦				♦			
	Bike network	♦	■	♦	■	♦	■	♦	■	♦	■	♦	■
	Pedestrian network	♦	■	♦	■	♦	■	♦	■	♦	■		■
Immaterial	Encouragement	♦		♦		♦		♦		♦		♦	
	Education					♦		♦					
	ITS			♦		♦		♦		♦		♦	
Governance	Institutional	♦		♦		♦		♦		♦		♦	
	Enforcement	♦		♦		♦		♦				♦	
Equipment	Bike	♦		♦		♦		♦		♦		♦	

Legend
♦ Action/measure keyword
■ Action/measure quantitative indicator

Equipment class. The majority of the selected cities promote actions to increase the number of available bikes. For instance, in the city of Vienna 1500 bikes are currently available at 121 locations (terminals), and the number is set to increase. The city of Rivas aims to install new bicycle racks and charging stations for electric bikes.

5 Final Considerations and Perspectives

Sustainability and quality of life are common goals of the European strategy for urban areas. The promotion of C&P mobility is one of the main elements that contributes to the achievement of these goals. To pursue these goals, European guidelines for SUMPs propose an integrated planning approach. This integration concerns various levels of the planning process (e.g. territory and transport) and potential cooperation among stakeholders, such as Public Administration, enterprises, citizens and interest groups.

Coordinated action to promote C&P mobility is needed.

This study represents a first approach to finding common elements to set objectives and C&P actions in SUMPs. For this reason, the proposed review methodology contributes to underlining these common elements. Prototypical results, obtained from the methodology application, indicate that European cities are working to improve C&P mobility with various classes of actions. An integrated transport system where all components play their specific roles is the benchmark to follow. The added value in the proposed methodology consists of the benchmarking of effects on C&P mobility based on the integrated review of the policies and actions proposed in the SUMPs.

Urban planners and local and national authorities can use the proposed methodology to design, to implement and to monitor activities. The follow-up to the present study is envisioned as an extension of the survey to define quantitative rating indicators in order to improve ranking and benchmarking. Finally, it will be useful to verify the effects on the cities of actions introduced by SUMPs and the impact on sustainability and quality of life.

References

Banister, D. (2008). The sustainable mobility paradigm. *Transport Policy, 15,* 73–80.

Berke, P., & Godschalk, D. (2009). Searching for the good plan. A Meta-Analysis of plan quality studies. *Journal of Planning Literature., 23*(3), 227–240.

Chilà, G., Musolino, G., Polimeni, A., Rindone, C., Russo, F., & Vitetta, A. (2016). Transport models and intelligent transportation system to support urban evacuation planning process. *IET Intelligent Transport Systems, 10*(4), 279–286.

Cirianni, F., & Leonardi, G. (2011). Road traffic noise prediction models in the metropolitan area of the strait of Messina. *Proceedings of the Institution of Civil Engineers: Transport, 164*(4), 231–239.

Cirianni, F., Panuccio, P., & Rindone, C. (2013). A comparison of urban planning systems between the UK and Italy: Commercial development and city logistic plan. *WIT Transactions On The Built Environment, 1*, 785–797.

CiViTAS (2012). CIVITAS guide for the urban transport professional results and lessons of long-term evaluation of the CIVITAS initiative. Retrieved April 2017, from www.civitas.eu/guide_ebook/index.phpandwww.Civitas—initiative.eu/docs/2086/CIVITAS_Guide_For_The_Urban_Transport_Professional.pdf.

Cordera, R., Coppola, P., Dell'Olio, L., & Ibeas A. (2016). Is accessibility relevant in trip generation? Modelling the interaction between trip generation and accessibility taking into account spatial effects. *Transportation*, 1–27.

ELTIS (2014). Do the right mix, SUMP award. Retrieved September 2017, from http://www.eltis.org/mobility-plans/project-partners/do-right-mix-sump-award.

Esztergár-Kiss, D., & Rózsa, Z. (2015). Simulation results for a daily activity chain optimization method. *2015 International conference on models and technologies for intelligent transportation systems* (pp. 259–264). MT-ITS 2015 7223265.

European Commission EC. (2007). Green paper. Towards a new culture for urban mobility. Retrieved April 2017, from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52007DC0551&from=EN.

European Commission EC. (2009). Communication from the commission to the European Parliament, the council, the European economic and social committee and the committee of the regions. Action plan on urban mobility. Retrieved April 2017, from http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:52009DC0490.

European Commission EC. (2011). White Paper. Roadmap to a single european transport area—Towards a competitive and resource efficient transport system. Retrieved April 2017, from http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52011DC0144&from=EN.

European Commission EC. (2013a). European innovation partnership on smart cities and communities. Strategic Implementation Plan. Retrieved April, 2017, from http://www.ec.europa.eu/eip/smartcities/files/sip_final_en.pdf.

European Commission EC. (2013b). Guidelines. Developing and implementing a sustainable urban mobility plan. Retrieved April 2017, from http://www.eltis.org/sites/eltis/files/guidelines-developing-and-implementing-a-sump_final_web_jan2014b.pdf.

European Commission EC. (2013c). Urban mobility package. Retrieved September 2017, from https://ec.europa.eu/transport/themes/urban/urban_mobility/ump_en.

European Commission EC. (2014). European innovation partnership on smart cities and communities. Operational Implementation Plan. Retrieved April, 2017, from http://ec.europa.eu/eip/smartcities/files/operational-implementation-plan-oip-v2_en.pdf.

European Commission EC. (2016). Quality of life in European cities 2015. Retrieved April 2017, from http://ec.europa.eu/regional_policy/sources/docgener/studies/pdf/urban/survey2015_en.pdf.

European Commission EC. (2017). Urban mobility package. Retrieved September 2017, from http://ec.europa.eu/energy/en/news/europe-move-commission-launches-new-transport-package.

Gehl, J. (2013). *Cities for people*. ISBN: 9781597269841. Island: Press.

Jacobs, J. (1961). *The death and life of great American cities*. New York: Random House.

Litman, T. A. (2017). Evaluating active transport benefits and costs. guide to valuing walking and cycling improvements and encouragement programs. Columbia: Victoria Transport Policy Institute, Retrieved April 2017, from http://www.vtpi.org/nmt-tdm.pdf.

OECD (2012), List of urban areas by country. Retrieved September, 2017, from http://www.oecd.org/cfe/regional-policy/all.pdf.

Russo, F., Panuccio, P., & Rindone, C. (2016). European plans for the smart city: from theories and rules to logistics test case. *European Planning Studies*, Taylor e Francis Group, ISSN: 0965–4313. https://doi.org/10.1080/09654313.2016.1182120.

Silva, C., Bertolini, L., te Brömmelstroet, M., Milakis, D., & Papa, E. (2017). Accessibility instruments in planning practice: Bridging the implementation gap. *Transport Policy, 53,* 135–145.

United Nations. (2017). Sustainable Development Goals (SDGs), Retrieved April, 2017, from http://www.un.org/sustainabledevelopment/sustainable-development-goals/.

Williams, C. (2007). Research Methods. *Journal of Business & Economic Research, 5*(3), 65–72.

Erratum to: Europe's Building Stock and Its Energy Demand: A Comparison Between Austria and Italy

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