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Smart City implementation and discourses: An integrated conceptual model. The case of Vienna

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ABSTRACT

In recent years many initiatives have been developed under the Smart City label in a bid to provide a response to challenges facing cities today. The concept has evolved from a sector-based approach to a more comprehensive view that places governance and stakeholders' involvement at the core of strategies. However, Smart City implementation requires lowering the scale from the strategy to the project level. Therefore, the ability of Smart City initiatives to provide an integrated and systematic answer to urban challenges is constantly being called into question. Stakeholder involvement in both the projects and the city strategy is key to developing a governance framework that allows an integrated and comprehensive understanding. This can only be done if Smart City strategies take the stakeholders' opinion into account and seek a compromise between their views and the implementation of the strategy.

Multiple attempts have been made to analyse Smart Cities, but tools are needed to understand their complexity and reflect the stakeholders' role in developing Smart City initiatives and their capacity to face urban challenges. This paper pursues two objectives: (A) to develop a conceptual model capable of displaying an overview of (a) the stakeholders taking part in the initiative in relation to (b) the projects developed and (c) the challenges they face; and (B) to use this model to synthesise the opinion of different stakeholders involved in Smart City initiatives and compare their attitudes to the key projects implemented in a corresponding SC strategy. The methodology combines project analysis with surveys and interviews with different groups of key stakeholders (governments, private companies, universities and research centres, and civil society) through text analysis. The conceptual model is developed through discussions with different European stakeholders and is applied to the case of the Vienna Smart City strategy.

1. Introduction

Cities are places where agglomeration economies attain their highest yields, producing cultural, economic and social benefits (United Nations, 1996). However, growing urbanisation patterns create a series of problems that reduce quality of life in urban settlements, such as inequality, pollution, ageing population, insecurity and others. The Smart City concept first emerged in the 1990s (Alawadhi et al., 2012) as an alternative to traditional planning modes, using new technologies (specially ICT) to tackle these problems. Smart cities are usually seen as a tool to solve urban challenges in an increasingly urbanised world (Albino, Berardi, & Dangelico, 2015; Chourabi et al., 2012; De Santis, Fasano, Mignolli, & Villa, 2014; Meijer & Bolivar, 2015; Nam & Pardo, 2011b).

The lack of consensus as to the definition of a Smart City has led to specific research on this topic. Several authors have designed conceptual and typological approaches to provide a systematic understanding of Smart City concepts and policies. Some authors focus on the essential components of Smart Cities, understanding the balance between people, technology and institutions (Ben Letaifa, 2015; Colldahl, Frey, & Kelemen, 2013; Nam & Pardo, 2011b) as crucial for a city to be considered Smart. Other proposals for classifying Smart City concepts and policies are based on schools of thought (Kummitha & Crutzen, 2017) or a spatial approach, and suggest other strategic choices without any specific spatial reference (focusing on society, innovation or business models) (Angelidou, 2014). However, when the focus is on

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governance, authors such as Meijer and Bolivar (2015) align themselves with the ideas of Ben Letaifa (2015) and Colldahl et al. (2013). Meijer and Bolivar (2015) classify Smart City definitions in terms of technology, human resources and collaboration, incorporating a fourth option that combines the three together in a holistic approach. According to this last perspective, urban developments should consider the interrelations between infrastructure, society and institutions. Many authors apply this concept of holistic Smart City in their research proposals (Alawadhi et al., 2012; Caragliu, Del Bo, & Nijkamp, 2011; Chourabi et al., 2012; Fernández-Güell, Collado-Lara, Guzmán-Araña, & Fernández-Añez, 2016; Giffinger et al., 2007; Leydesdorff & Deakin, 2010).

Basically, two main approaches can be identified among Smart City scientists and practitioners. On the one hand, the scientific literature seeks to go beyond sector-specific approaches by proposing a comprehensive conceptualisation of the Smart City; and on the other hand, Smart City initiatives are developed though sector-based initiatives and projects in one or a few specific areas (Fernández-Güell et al., 2016; Mattoni, Gugliermetti, & Bisegna, 2015). The implementation of Smart Cities is still related to these sector-specific and partial understanding, in part because of the limitations of governance and financing tools. It is therefore necessary to bridge the gap between the theoretical comprehensive perspective and the sector-wide implementation of the Smart City concept.

In this goal of making the Smart City a comprehensive concept, governance is gradually placed at the core (Meijer & Bolivar, 2015), and authors endorse the link between Smart governance and the need for integrated approaches (Castelnovo, Misuraca, & Savoldelli, 2015). Stakeholder involvement and engagement in decision-making is essential for Smart governance, and the key element for becoming a Smart City (Albino et al., 2015; Giffinger & Lü, 2015; Nam & Pardo, 2011a). However, stakeholders reveal different visions of the Smart City in their discourses (Fernandez, 2015; Fernandez-Anez, 2016). There are also differences between the image of the Smart City and its implementation (De Santis et al., 2014) and between the vision of the stakeholders in Smart City development and the initiatives carried out (AlAwadhi & Scholl, 2013). It can therefore be assumed that narrowing the gap between the stakeholders' vision of Smart City initiatives and the implementation of certain projects may make a decisive difference to the success of Smart City strategies.

This study has a dual objective: first, to develop a conceptual model capable of considering the most important topics discussed in this introduction: (a) stakeholders in the initiative, in relation to (b) the projects developed, and (c) the challenges they face; and second, to use this model to synthesise the opinion of the different agents involved in Smart City initiatives and compare their attitudes to a comprehensive overview of the most relevant projects implemented in a corresponding SC strategy.

After the Introduction explaining the problems and identifying the research gap, this second section focuses on Smart City conceptual models to define a state of the art on the topic. The next section (Section 3) contains the definition of the conceptual model and shows the relationship between the different stakeholders and the basic elements and subsystems of a generic Smart City. The aim of this model is to facilitate the analysis of the complex and comprehensive Smart City strategies designed by municipalities from an integrative perspective.

The next section (Section 4) describes the methodology for developing the conceptual model and its application to the case study. In the following section (Section 5), and based on this methodology, the model is used to represent both the implementation of, and discourses on, Smart City strategies. Considering these two aspects –the actual implementation of Smart City projects and the vision of the different stakeholders– it proposes a methodology to extract guidelines to bridge the gap between them. In the fifth section the conceptual model is applied to the case study of Vienna, deriving information on the strengths and weaknesses of the strategy. Vienna was selected because of the maturity of its Smart City Strategy, with a high level of implementation and implication of the various stakeholders. Following this methodology, this section provides guidelines for narrowing the gap between stakeholders' opinions and Smart City implementation in Vienna. Finally, the sixth section ends with conclusions about the use of the model and possible further steps.

2. State of the art: Smart City conceptual models

In recent years, a range of conceptual approaches to the Smart City have led to different interpretations and thus to differences in its conceptualization.

Some authors have used the triple helix conceptual model (Deakin, 2014; Etzkowitz & Zhou, 2006; Lombardi et al., 2011) to understand the role of the stakeholders in the Smart City. The triple helix was used to examine the knowledge base of urban economies, and Leydesdorff and Deakin (2010) proposed it as an instrument to study the meta-stabilising potentials of urban technologies in Smart Cities. The work of Lombardi et al. (2011) expanded its scope to include civil society in a modified triple helix, and a subsequent work (Lombardi, Giordano, Farouh, & Yousef, 2012) crossed this concept with five city clusters (Governance, Economy, Human Capital, Living and Environment). These relations are used to structure an analysis of interrelations within the Smart City and to extract guidelines for policies.

Nam and Pardo (2011b) conceptualised the Smart City in a model that combined institutional, technological and human factors. They applied the model to formulate strategic guidelines for the success of Smart City initiatives. To explore these concepts further, some researchers (Chourabi et al., 2012) increased the complexity of the model. In their proposal, they placed Smart City initiatives at the core. They identified a set of internal factors that affected the Smart City more directly: Technology, Organisations and Policy. The external factors (Governance, People and Communities, Natural Environment and Infrastructures) were on a second level of impact. The purpose of this model was not only to explain the Smart City concept but also to develop a tool to analyse the proposals of local governments and extract guidelines for practitioners and researchers.

The proposal of Dameri (2013) highlighted the need for a theoretical approach for a concept (Smart City) developed from empirical experience, and included a multiscale focus on the goals of the Smart City rather than on the means to attain these goals. It placed a set of basic Smart City components (Citizens, Land, Technology and Governance) at the core. The spatial level was the next step, as the multiscale scope was considered essential for the Smart City, with different influences at the city, regional, city network, national and global scales. Finally, the model proposed a third level with the goals of the Smart City, defined as Environmental Sustainability, Quality of Life and Wellbeing, Participation, and Knowledge, and Intellectual Capital. The model sought to support local governments and public administrations in the implementation of Smart City initiatives focusing on these ultimate goals.

The ASCIMER Project Team also developed a model for their research as a result of experiences in Smart City projects. Based on the work of Giffinger et al. (2007), the model understands the Smart City as the confluence of the dimensions of “Governance”, “Economy”, “Environment”, “Mobility”, “People” and “Living” articulated by ICT and technology tools (Monzon, 2015), and proposes a classification of Smart City projects and their integration through a comprehensive and integrative approach.

Recent conceptual visions of Smart Cities have focused on governance as the key issue for the success of the initiatives (Meijer & Bolivar, 2015). Conceptual models such as the proposal of Castelnovo et al. (2015) reflect this point of view and propose a citizen-centric approach to Smart governance, placing “Community Building and Management” at the centre of the model. This concept involves four additional dimensions (Vision and Strategy Formulation, Public Value Generation,

Asset Management, and Economic and Financial Sustainability), and proposed an integrative approach to the assessment of urban participatory policy-making.

Finally, the work of Fernández-Güell et al. (2016) proposed an approach to cities based on systems theory. It places urban demand at the core of the system, surrounded by four subsystems (societal, economic, political and environmental). The city exists in response to the spatial subsystem, including different infrastructures and facilities, and a technological subsystem that supports this spatial subsystem. At another scale, economic, societal, technological and geopolitical changes affect the city and modify the system. The paper conceives the model as a forecasting tool for describing present and future scenarios.

The findings in regard to the conclusions and gaps in these conceptual models have been organised into three topics: (a) stakeholders and governance, (b) identification of projects and dimensions, and (c) relationship with urban challenges.

The evolution of the models reflects the growing importance of governance, the shift to citizen-centric approaches (Castelnovo et al., 2015; Dameri, 2013; Fernández-Güell et al., 2016), and the key role assigned to stakeholders (Dameri, 2013; Fernández-Güell et al., 2016; Leydesdorff & Deakin, 2010; Lombardi et al., 2011). Despite the growing importance of governance, in the models analysed this cluster has the same importance as other clusters and dimensions (Chourabi et al., 2012; Dameri, 2013; Lombardi et al., 2012; Monzon, 2015), and sometimes takes a central role (Dameri, 2013) or is understood as an external factor (Chourabi et al., 2012). However, the relationships established between the elements of the different models can be implicitly understood as reflecting governance. Stakeholders play a central role in the work of Leydesdorff and Deakin (2010) and Lombardi et al. (2011), but their analysis focuses mainly on the weighting of indicators rather than on a deeper analysis of the discourses (Lombardi et al., 2012). Stakeholders are mentioned in a more generic way in other conceptual models, as “citizens” (Dameri, 2013), “organisations” (Chourabi et al., 2012), and in concepts such as “community building” (Castelnovo et al., 2015), and do not even appear in some models (Monzon, 2015). Fernández-Güell et al. (2016) started a classification of demand that is closer to the work of Lombardi et al. (2011).

The focus on governance is combined with the focus on real projects organised into different dimensions (Chourabi et al., 2012; Fernández-Güell et al., 2016; Lombardi et al., 2011; Monzon, 2015). Most of the models analysed include clusters and dimensions that help classify not only Smart City objectives but also their initiatives and projects. The exception is the work of Dameri (2013), which directly presents only the objectives. In most cases these clusters appear as separate groups (Chourabi et al., 2012; Fernández-Güell et al., 2016; Lombardi et al., 2012) or focused on one area (Castelnovo et al., 2015), but the relationships between them are identified and reflected. These clusters only overlap in the case of Monzon (2015), which can be seen as a step towards integrating the elements in the model.

The work of Dameri (2013) and Fernández-Güell et al. (2016) highlights the need for a multi-scale perspective to include the inputs, scope and impacts of the projects and their effects on urban challenges. However, the Smart City is not considered as an answer to urban challenges in most of the models, but related to the goals identified by Dameri (2013) and Castelnovo et al. (2015), and linked to the external changes identified by Fernández-Güell et al. (2016). The proposal of Monzon (2015) is the one that clearly reflects the challenges and relates them to the dimensions of the Smart City.

Finally, another topic of interest when analysing the gaps in current conceptual models is their application to real case studies. The objectives of conceptual models do not only focus on the description of the concept, but rather on their possible use as a support for decision-making. Very few of the models were applied to real cases, with the exception of Fernández-Güell et al. (2016), which was used generically for Spanish cities. It would be useful to apply them in combination with analytical-statistical assessment, as occurs in the proposal of Lombardi et al. (2012).

3. The Smart City conceptual model

After analysing the use of conceptual models in the scientific literature on Smart Cities, a new model is proposed. This research understands the Smart City as an integrated and multi-dimensional system that aims to address urban challenges based on a multi-stakeholder partnership. The conceptual model proposed follows a comprehensive and integrative approach to Smart Cities that links the three main issues identified: (a) the key role of governance and stakeholders' involvement (see Section 3.1); (b) the importance of displaying a comprehensive vision of Smart City projects and dimensions (see Section 3.2); and (c) the understanding of the Smart City as a tool to tackle urban challenges (see Section 3.3). Finally, in Section 3.4, the three parts of the conceptual model are shown interrelated. The model is described from the centre to its outer limits, but not necessarily in a linear sequence, in order to aid its understanding.

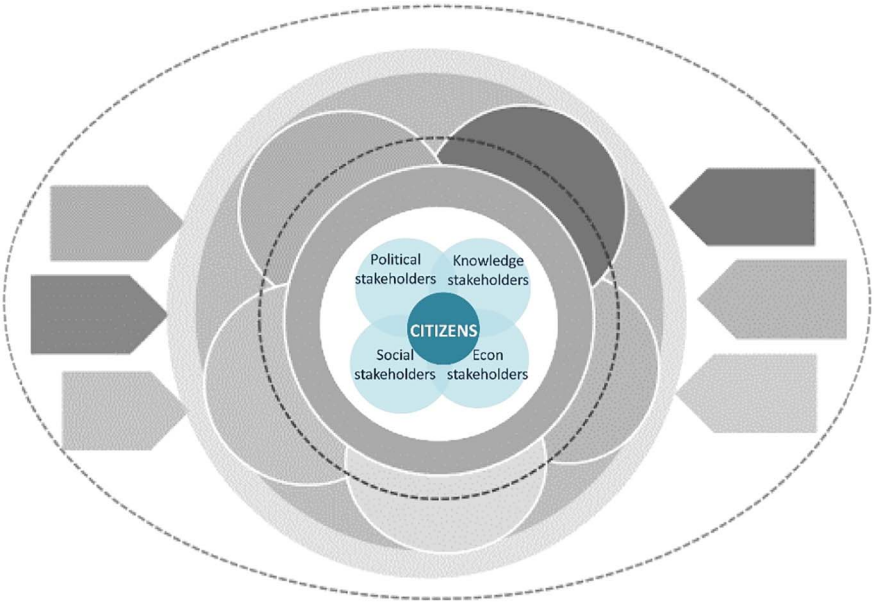


Fig. 1. Basis for the conceptual model.

3.1. Subsystems and stakeholders

The model places the stakeholders at the centre (Fig. 1), as governance structures are considered the core of the Smart City. Several authors (Albino et al., 2015; Batagan, 2011; Castelnovo et al., 2015; Fernández-Güell et al., 2016; Nam & Pardo, 2011a) consider citizen-centric approaches to be at the heart of governance in the Smart City. Other authors view quality of life as the main goal for Smart Cities in a human-centric vision (Caragliu et al., 2011; Dameri, Negre, & Rosenthal-Sabroux, 2016; Misuraca, Ferro, & Caroleo, 2010). Citizens are therefore placed at the centre of the model.

The literature on Smart Cities uses the university-industry-government triple helix model (Leydesdorff & Deakin, 2010) to study the stakeholder structures operating within it. Some authors also include civil society as one of the groups in an extended triple helix model (Etzkowitz & Zhou, 2006; Lombardi et al., 2011). Four stakeholder groups are therefore at the core of the conceptual model: political, social, economic and knowledge stakeholders (Fig. 1). Political stakeholders include government institutions and political parties; social stakeholders are civil society experts and institutions; economic stakeholders comprise a wide range of public and private companies; and finally knowledge stakeholders are universities and research centres in the city. All these groups overlap, and experts and institutions may belong to more than one. Citizenship overlaps all the subsystems.

3.2. Smart City dimensions and initiatives

The Smart City stands at the confluence of the spatial and technological subsystems as an answer to urban challenges. Many authors use the work of Giffinger et al. (2007) as the basis for systematising the approach to the complexity of the Smart City. This work conceptualises six Smart City dimensions: “Governance”, “Economy”, “Environment”, “Mobility”, “People” and “Living”. Smart City initiatives are organised around stakeholder groups and urban challenges to respond to the requirements of different stakeholders (Fig. 2). Initiatives can (and should if they aim to be integrative) affect more than one group, thus increasing efficiency in urban management. Governance issues gradually move to centre stage in discussions on the Smart Cities (Meijer & Bolivar, 2015), and some authors identify them as essential for their success (Albino et al., 2015; Nam & Pardo, 2011a). SC governance initiatives are placed at the centre of the conceptual model since they tend to lead the development of other SC dimensions.

This structure is the basis for classifying the projects to be included in Smart City Initiatives (Monzon, 2015). A Smart City initiative can combine projects belonging to more than one group and more than one of the dimensions defined in Monzon (2015).

Stakeholders are at the core of the city system and are supported by two main urban functional subsystems–spatial and technological–, where the city is understood as the confluence of these two spaces (Castells, 2004) (Fig. 2). The elements in the human-built urban environment form the urban spatial subsystem: streets and urban infrastructures, housing, buildings, facilities, open spaces, etc. The technological subsystem consists of the various technological tools developed in the city, and –in the Smart City literature– is mainly based on ICT and information transfer (Batty et al., 2012). It articulates and connects the elements in the spatial subsystem. In the next step, the Smart City is seen as the confluence of these two different subsystems. Lastly, the environmental subsystem remains outside the model as the basis and support for any urban development.

3.3. Challenges and global trends

Smart Cities are implemented to respond to a multitude of challenges in an increasingly urbanised world (Albino et al., 2015; Anthopoulos, Janssen, & Weerakkody, 2015; Chourabi et al., 2012; De Santis et al., 2014; Meijer & Bolivar, 2015; Nam & Pardo, 2011b). The conceptual model of a Smart City can only be defined by understanding the challenges and trends that affect the city. Citizenship and stakeholder groups pose important challenges that the different urban functional subsystems need to answer.

The main global trends and challenges affecting cities in the European region were identified in the literature review (European Commission, 2011; Fernández-Güell et al., 2016; Nijkamp & Kourtit, 2013) and compared with the opinions of the stakeholders interviewed to complete the selection. The challenges raised by the stakeholder groups are entered in the model as a new element that surrounds these groups (Fig. 3), and are closely related to more general global trends also affecting European cities, which are identified and placed outside the model. Table 1 shows the list of identified challenges grouped by global trends.

3.4. Diagram of the global vision

Based on the discussion above, the conceptual model shows the

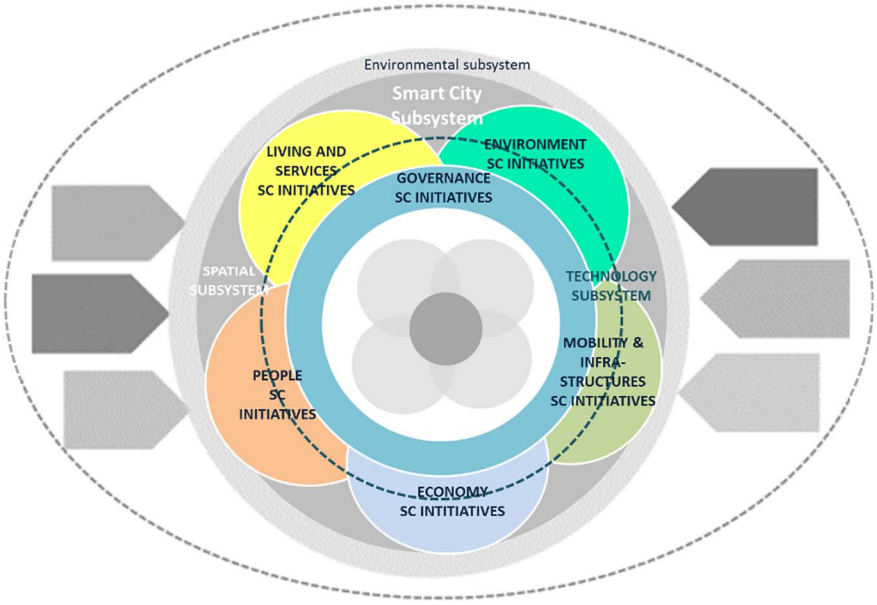


Fig. 2. Smart City dimensions and initiatives.

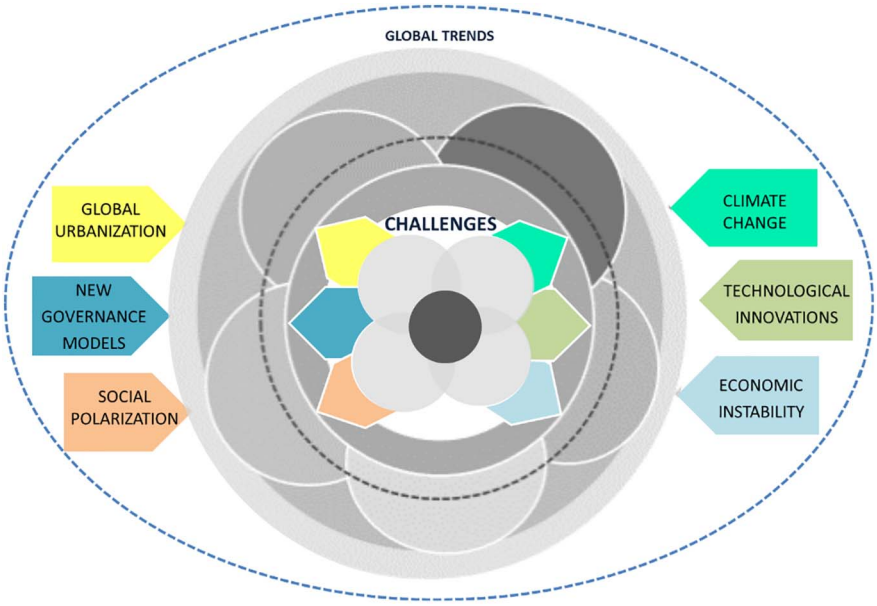


Fig. 3. Global trends and urban challenges affecting the conceptual model.

Table 1
Global trends and associated urban challenges identified in the literature review (European Commission, 2011; Fernández-Güell et al., 2016; Nijkamp & Kourtit, 2013) and modifications according to the suggestions of the experts interviewed.

Global trends	Urban challenges
1. Climate change	1.1. Reducing ecological footprint and pressure on ecosystems, promoting ecological functions of land
	1.2. Increasing efficiency in resource management (energy, water, etc.) and promoting a circular economy
	1.3. Fostering cities' resilience to climate change and disaster risks
	1.4. Developing eco-friendly urban environments and responding to growing environmental concerns
	1.5. Implementing a holistic approach to environmental issues
2. Social polarisation	2.1. Promoting social inclusion, cohesion and equity
	2.2. Enhancing the inclusion of migrants and refugees
	2.3. Adapting the city's economic and social life to an ageing population while attracting young people and children
	2.4. Promoting equity in access to the labour market and the work-life balance
	2.5. Eradicating spatial exclusion and promoting equity in access to housing and quality urban environments
	2. 6. Enhancing social diversity as a dynamic asset
3. Need for new governance models	3.1. Changing to a more participative and inclusive democracy
	3.2. Promoting citizenship via urban co-creation and co-management combining top-down and bottom-up models
	3.3. Increasing the flexibility and resiliency of governance models
	3.4. Improving the effectiveness of institutions, coordination among public bodies and multilevel governance (leading to more integrated sector policies)
	3.5. Incorporating and regulating innovative management systems at the local level while improving capacity building (i.e. PPP or PPPP, e-governance, etc.)
	3.6. Enhancing territorial cohesion
4. Global urbanisation	4.1. Managing the urban population growth while reducing negative externalities
	4.2. Maintaining quality of life in cities, ensuring access to services in line with changes in demand (education, health, culture, safety, etc.)
	4.3. Promoting interurban variety and cities' identity by protecting cultural heritage
	4.4. Developing new planning tools for sustainable development (less urban sprawl, polycentric plans, increased density and diversity, mixed land use, urban refurbishment…)
	4.5. Fostering sustainable accessibility in cities and promoting sustainable, inclusive and healthy mobility when needed
	4.6. Balancing urban growth and territorial development (managing the urban-rural balance)
5. Economic instability	5.1. Improving the resilience of economic systems and adaptation to changes in global and local economies
	5.2. Improving the sustainability and diversity of local economies in balance with cities' specialisation
	5.3. Managing adaptation to innovation and knowledge-based economies while providing solutions to a broad skill base
	5.4. Fostering human and social capital as source of innovation
	5.4. Enhancing integration in global economies, promoting cooperation among cities and territories
	5.5. Fostering employment creation with high quality standards
	5.6. Achieving balance between competitiveness and quality of life
6. Increasing importance of new technologies	6.1. Enhancing the adaptation of society, governance and economy to transformation through ICT
	6.2. Coordinating new technologies for energy saving and reducing emissions through planning and governance tools
	6.3. Articulating mobility planning tools and policies with innovations in the sector
	6.4. Promoting technological innovation driven by social and human capital
	6.5. Reducing externalities in the implementation of new technologies (i.e. cybersecurity)

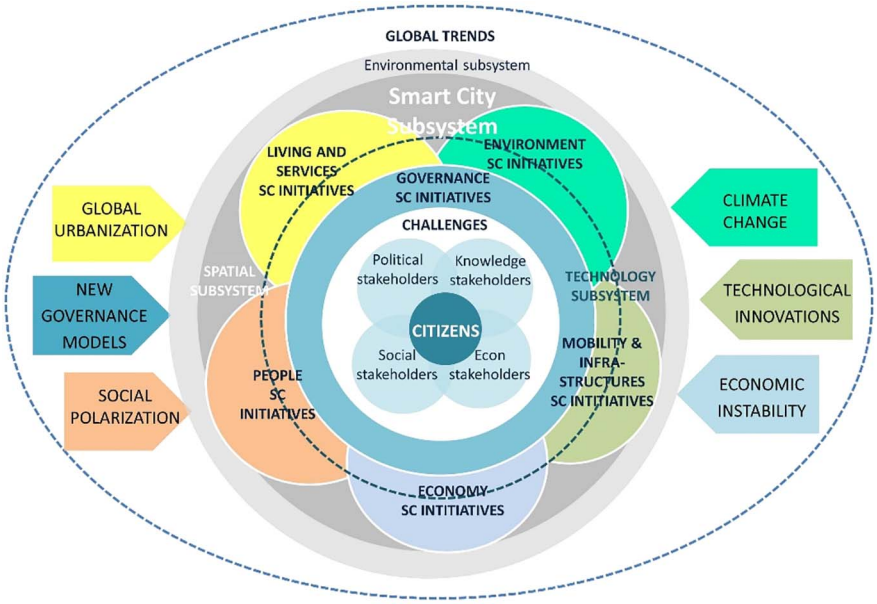


Fig. 4. Smart City conceptual model.

various stakeholders and urban subsystems in relation to the different Smart City dimensions and initiatives and the contextual challenges affecting cities (Fig. 4).

This model offers a comprehensive vision of a city and serves as an instrument to achieve greater coherence in Smart City initiatives. The report “Mapping smart cities in the EU” defines a Smart City as a “multi-stakeholder, municipally-based partnership” (Manville et al., 2014), and highlights the engagement of multiple stakeholders, co-ordinated by a municipality, as a key factor for the Smart City. The pre-validation phase of this research also confirms that local government stakeholders are the main potential users of SC initiatives.

4. Methodology

Fig. 5 shows the methodology for the development of the conceptual model and its application divided into an initial step (Step 0) and two stages (A. Conceptual model, and B. Application for analysis), each including two different steps.

Step 0. A literature review was undertaken to identify key ideas, and revealed two significant gaps: (A) the need to develop more integrative conceptual models, and (B) the need to bridge the gap between the implementation of the Smart City and stakeholders' discourses on it. Three main ideas were extracted to build the conceptual model: (a) the importance of involving stakeholders and the central role of governance; (b) the implementation of Smart Cities in projects in different fields or dimensions; and (c) the orientation of the Smart City towards facing urban challenges. These guidelines were articulated to form the basic structure of the proposal.

Step A. Conceptual model.

Step A1. Development. These key ideas became the backbone of this study and led to the development of a conceptual model (Section 3).

Step A2. Pre-validation. The conceptual model was pre-validated by a group of experts, and changes were made. The purpose of this was twofold: to validate the survey methodology and to validate the conceptual model. The methodology uses text analysis

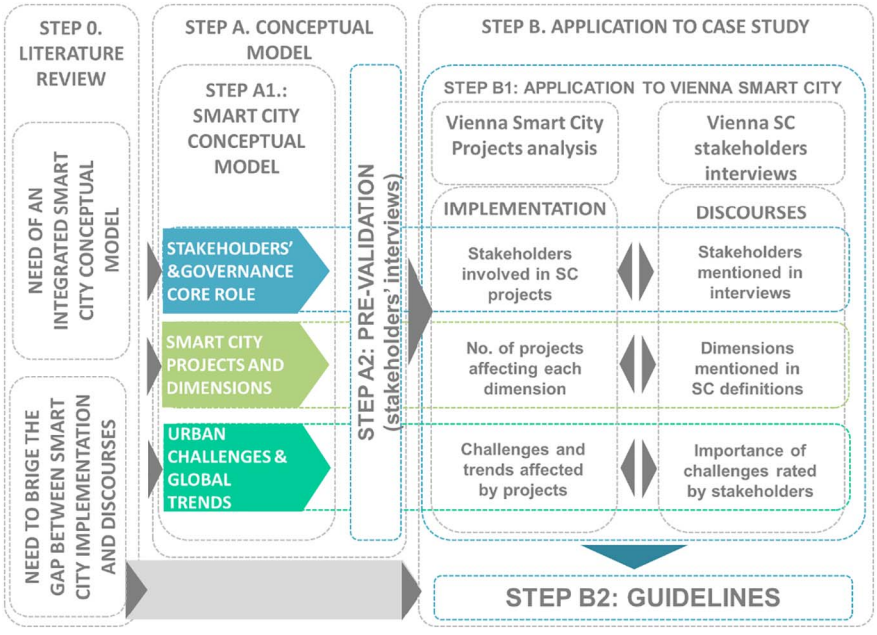


Fig. 5. Research structure.

through coding and is based on the work of AlAwadhi and Scholl (2013), using a set of semi-structured interviews (Callejo Gallego, Del Val Cid, Gutierrez Brito, & Viedma Rojas, 2009) as the main instrument, in what is usually considered a participatory method. Stakeholders were rationally selected to work with a small but representative sample (Mitchell, Wood, & Agle, 1997) The interviews focused on the three main ideas previously described (a, b and c) and on validating the first version of the conceptual model. They were semi-structured to allow the identification of additional concepts. The sample was composed by selecting a group of stakeholders following two criteria: they belonged to different stakeholder groups in similar numbers; and they were specialised in different Smart City dimensions and in transversal areas of technology and planning (at least one expert in each dimension (6) and area (2)). A total of nine experts were chosen from international and local government institutions, universities and research centres, private companies of different sizes, and national and international NGOs. The experts interviewed came from Spain, Austria, Luxembourg and France. Data was collected through interviews in person or via videoconference, lasting between 50 and 70 min. They were audiotaped and partially transcribed and coded (questions on definitions, challenges and goals), and notes were taken to support the conclusions. 23 codes and 79 different sub-codes were used for data coding. The codes (with their respective sub-codes) were extracted from previous works (Fernandez-Anez, 2016; Fernández-Güell et al., 2016) (11 codes), from the theoretical basis of this work (6 codes) and from data (6 codes). The main results were the modification of the model according to the results of these nine interviews to obtain the final vision presented in this paper, and the definition of the interviews and surveys to apply the model.

Step B. Application to the case study.

Step B.1. Application to the Vienna Smart City. The model was applied to the Vienna Smart City to compare the ongoing implementation of the initiative and the discourses of relevant stakeholders on the concept and the initiative.

The current projects in the municipal strategy for the implementation of the Smart City were analysed in terms of the stakeholders, type of projects developed and the challenges and the global trends they were addressing. A total of 64 projects were analysed according to the official site (City of Vienna, 2016). Information was extracted on (a) the project stakeholders, (b) the projects in each dimension, and (c) the challenges and trends addressed by the projects.

To study the stakeholders' visions, a new sample of interviews was conducted following the methodology used in the pre-validation, modified by incorporating the lessons learned in the previous phase. A combination of fixed and open questions in a semi-structured interview was combined with a survey in which respondents were asked to provide their own definitions of the Smart City concept and answer a similar set of questions to the previous phase. The two main additions were a new question on other relevant stakeholders to identify the respondents' view of the main agents involved in the initiative; and a survey with scores of 1 to 5 for each challenge in Table 2 (Section 3.3) to determine the importance of the challenges and trends. The sample consisted of 14 interviews with relevant stakeholders in the city of Vienna. The stakeholders were selected following similar criteria to the previous phase (Table 2) from among experts in the various institutions participating in the municipal strategy. A new selection criterion was their involvement in the Vienna Smart City strategy. The participants in the Vienna Smart City projects were analysed and selected according to the number of projects they were involved in, together with the two criteria described in step “A.2. Pre-validation”. Data was collected as in the previous phase. Data analysis and coding consisted of partially analysing the interviews (definitions) though text analysis techniques following the methodology described in the pre-validation phase. The survey results and stakeholders' identification were classified, and conclusions were extracted. Three types of results were obtained: the identification and classification of the stakeholders in the initiative into groups (quantitative/qualitative); the survey results (quantitative); and the identification of the terms corresponding to each dimension from the analysis of the Smart City definitions (qualitative/quantitative). This last step allowed the qualitative information to be transformed into quantitative information. These results are shown in Section 5 of this paper, and used to modify the conceptual model. Further conclusions can be drawn from the complete analysis of the interviews and will be described in future work.

Step B.2. Guidelines. The analysis of the implementation was compared with the discourses of the relevant city stakeholders and conclusions were drawn in the form of guidelines for a Smart City Strategy that narrows the gap between the visions of the different stakeholders with the actual implementation of the strategy.

5. The case of Vienna

The Vienna Smart City strategy was launched in 2011. In 2013, the municipality of Vienna started the strategic process by involving stakeholders from different municipal departments and various experts in the city. This process led to the “Smart City Wien Framework Strategy” in 2014 (City of Vienna, 2014), aimed at providing guidelines for the development of Smart City initiatives and projects. This strategy has three lines: “Quality of living”, “Resources” and “Innovation”, which structure specific associated topics and goals. The process of stakeholder involvement continued though a range of forums on topics related to the Smart City with different levels of success. The maturity of the project and the level of implementation and stakeholder implication led to the selection of Vienna as a case study for this research.

Two and a half years after the publication of the strategy document, the conceptual model proposed in Section 3 has been applied to this case study to compare the projects developed in the Smart City strategy with the opinions of the different stakeholders. Guidelines are then proposed for a revision of the strategy. These propositions evidently do not only focus on attaining the objectives, but also on increasing the engagement of the various stakeholder groups as the key to success in developing future projects. The methodology therefore compares the analysis of the Smart City projects implemented in Vienna and the results of the interviews and surveys with 14 key stakeholders in the city.

Following the methodological considerations in Section 4, the following steps were taken to compile the empirical evidence and modify the conceptual model:

In the first stage (5.1.), the conceptual model must be modified to include the various city stakeholders. The number of stakeholders per project in each subsystem (political, knowledge, social and economic) (Fig. 6, implementation), and the number of stakeholders mentioned in the interviews are indicated (Fig. 6, discourses).

It is crucial to compare two aspects, namely which dimensions are being affected by current projects (Fig. 7, implementation), and the key elements of a Smart City according to the stakeholders, so they can be classified into different dimensions to reveal their relative importance (Fig. 7, discourses). The number of projects affecting each dimension is then compared with the terms used in the definitions given by the stakeholders in their interviews, producing two different versions of the model.

The number of projects addressing each challenge and trend (columns) was compared to the survey results regarding their importance in the case of Vienna (points) (Graph 1). The results of global trends will be analysed explicitly, and the results of specific challenges will be used to support the guidelines in Section 5.4.

The modifications of the model are described from the centre to its outer limits in order to aid its understanding. The final phase presents a synthesis of all the modifications to the conceptual model (Fig. 8). This

Table 2
Selection of stakeholders in Vienna, according to three criteria: they belong to different stakeholder groups; they specialise in different Smart City dimensions and in the transversal areas of technology and planning, and the number of Vienna Smart City projects the stakeholders are participating in.

		Government institutions	Universities and research centres	Private companies	Civil society
Dimensions	Governance	(1) Politician and member of SCW Advisory Board	(6) Professor and head of research centre		
	Economy		(7) University professor and researcher		
	Environment	(2) Manager in a public company	(8) Researcher at a public research institute		
	Mobility		(9) University professor and researcher		(13) Urban project community member
	People	(1) Politician and member of SCW Advisory Board			(14) Project manager in a social media company
	Living	(3) Director of a municipal department			(15) Head of department in a social enterprise
Transversal subsystems	Technology	(4) Project leader in the ICT department		(10) Research and development manager in a large corporation	
	Planning	(5) Urban planning manager		(11) Expert in urban and regional planning, medium-sized company (12) Project manager in a public-private company	

(1) Member of Parliament for Vienna - Member of the Social City Wien Expert Advisory Board; (2) Public Affairs Management of TINA VIENNA Urban Technologies & Strategies GmbH; (3) Director of the Municipal Department of Economic Affairs, Labour and Statistics in the City of Vienna; (4) Responsible for the Digital Agenda Vienna. Office of the CIO of Vienna City Council; (5) Director of Urban Planning at Vienna City Council; (6) Research Institute for Urban Management and Governance. Head of Research Institute. Professor at the Vienna University of Economics and Business; (7) Research Area Leader, Institute for Ecological Economics. Professor at the Vienna University of Economics and Business. (8) Senior Research Engineer. Energy Department. Sustainable buildings and cities. Austrian Institute of Technology. (9) Researcher at the Institute of Transport Science, Vienna Technical University. (10) R&D Manager at Siemens AG Austria. (11) Expert in urban and regional development and regional economics at the Austrian Institute of Spatial Planning (OIR); (12) Project manager Environmental Impact Assessment and transport, Wien 3420; (13) Member and resident of the car-free district; (14) Head of Wiengestalten, Dialogplus (15) Economist and head of the municipal policy department at the Vienna Chamber of Labour.

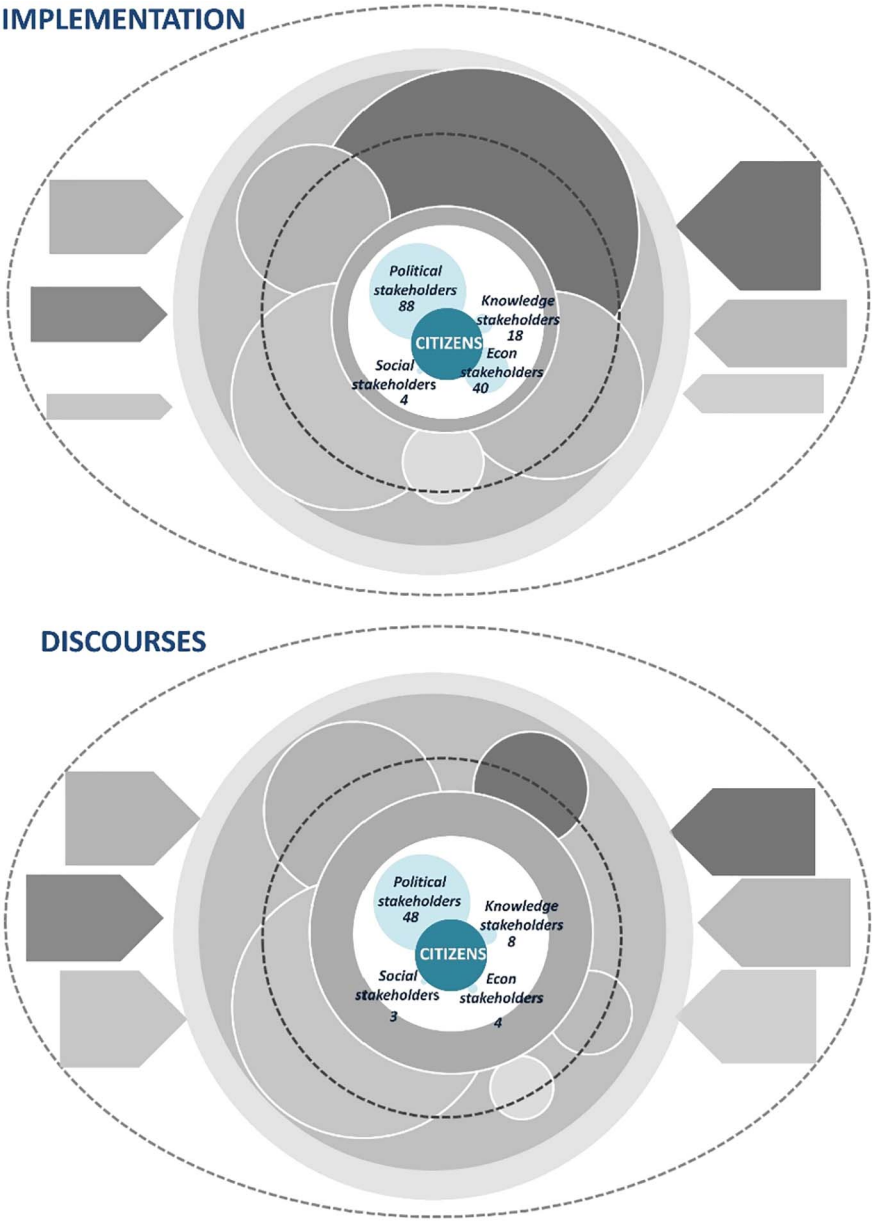


Fig. 6. Conceptual model. Stakeholders involved according to the project analysis (implementation) and the interview analysis (discourses).

model combines the three analyses (stakeholders, projects and dimensions, and challenges) and establishes relationships between the elements. It is important to note that this visualisation shows the relative weights of each of the three parts of the analysis separately (stakeholders, challenges and projects and dimensions), but does not allow numerical comparisons between these parts.

5.1. Subsystems and stakeholders in the Vienna Smart City initiative

The public sector unquestionably takes the central role in the strategy in both models (Fig. 6). The combination of public companies, municipal government departments and national companies in the political subsystem conforms the largest stakeholder group. Municipal government members had the same weight as public companies in these groups, although public companies were mentioned less frequently as key stakeholders. There is some disagreement in regard to the other stakeholder groups. The stakeholders interviewed made more frequent mention of members of research institutions than of private companies. However, the project analysis revealed that far more private companies are involved in the projects than universities and research centres. Both the implementation and stakeholder discourses on the strategy agree that civil society is not involved in the Vienna Smart City.

5.2. Vienna Smart City projects and dimensions

There are common points and differences between these two versions of the conceptual model in terms of the importance of the dimensions (Fig. 7). The greatest number of projects address the environmental dimension, which is the fourth most important in the stakeholders' definitions. “Governance” is the most important dimension in these definitions, followed by “People”. These dimensions are second and third in regard to number of projects, so there is some coincidence between discourses and implementation. “Living” comes next in the discourses, and is the fifth most important dimension according to the number of projects affecting it. The experts interviewed did not often mention mobility topics, although it is an important feature of the Vienna Smart City Strategy. Both results show a low weight for the “Economy” dimension in the Vienna Smart City. The terms relating to this dimension are the least mentioned by the stakeholders and it is the one addressed by the fewest projects.

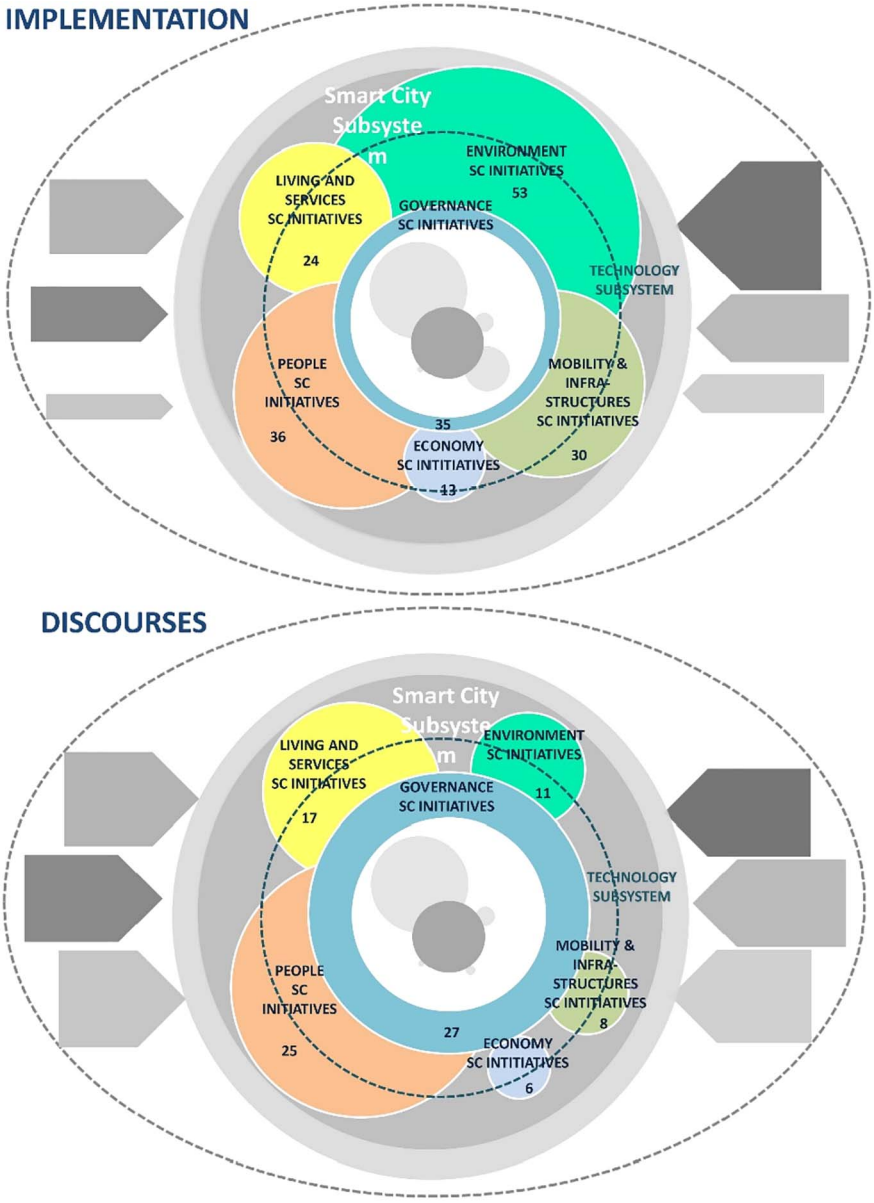
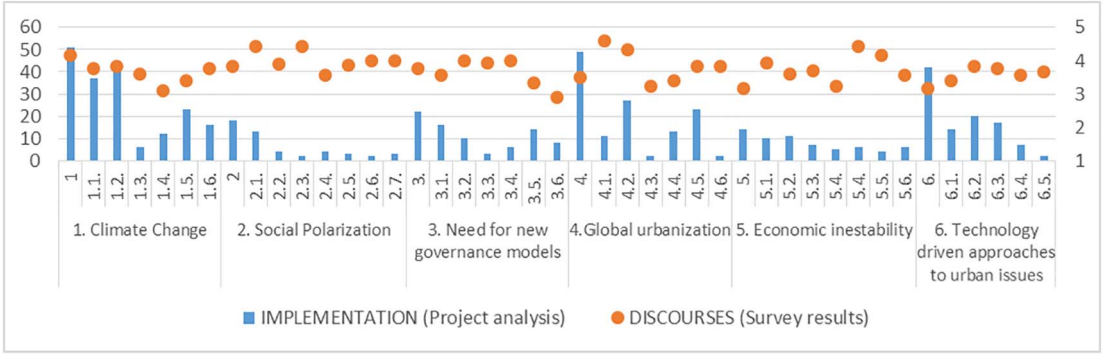


Fig. 7. Conceptual model modified according to the number of projects in each dimension (implementation) and the terms appearing in the Smart City definitions by different stakeholders (discourses).

5.3. Global trends and urban challenges for Vienna

The comparison of the results of both groups of trends and challenges in Graph 1 shows agreement on “climate change” as the most important global trend, but a strong disagreement between the experts' opinion and the number of projects dealing with “social polarisation” and “economic instability”. In the project analysis, this global trend is closely followed by “global urbanisation”, while there are fewer



Graph 1. Comparison of the number of projects addressing each challenge and trend (columns; left y-axis: number of projects addressing each challenge or global trend) and the results of the survey of their importance in the case of Vienna (points; right y-axis: importance value provided by experts (1–5)).

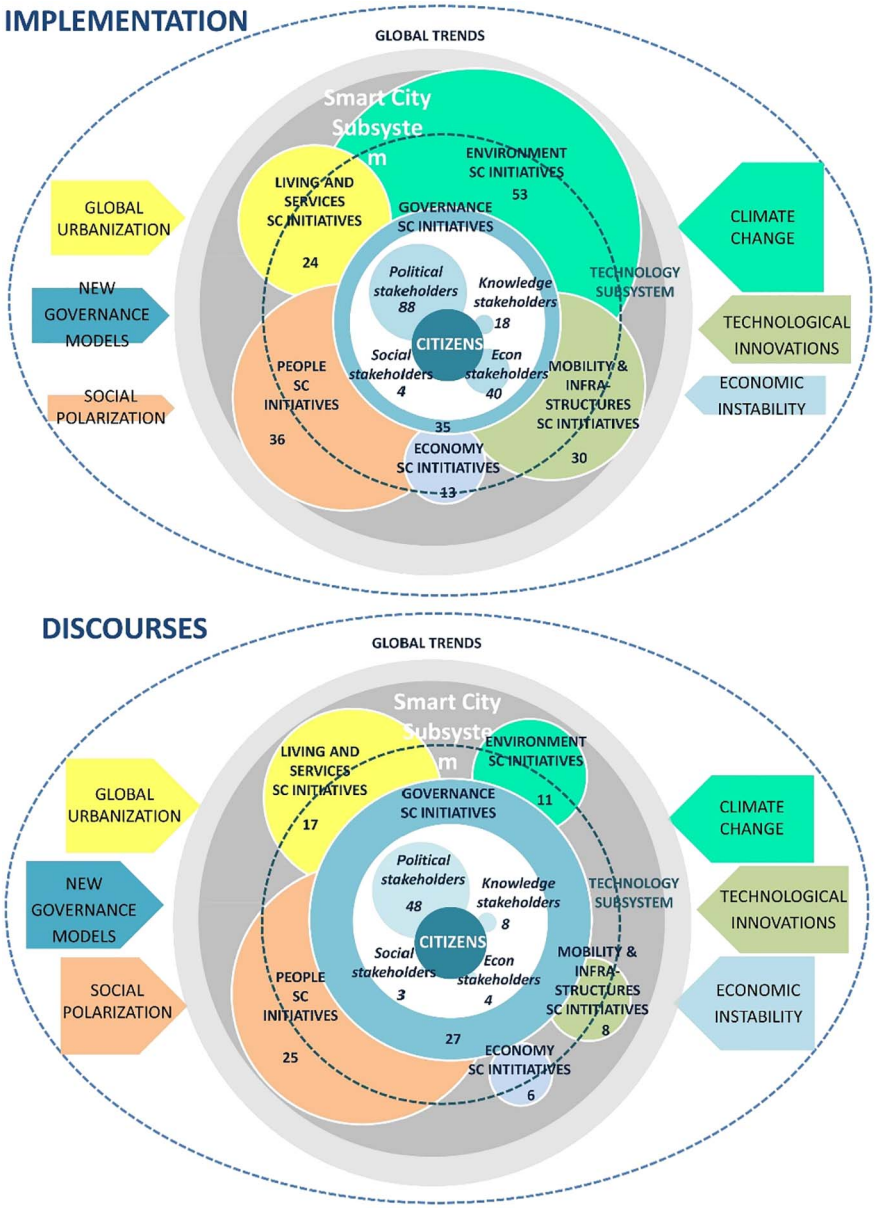


Fig. 8. Synthesis of the modifications made to the conceptual model in the analysis of both implementation and discourses. Values explained in Sections 5.1, 5.2 and 5.3.

projects to tackle "economic instability". "Social polarisation" and "need for new governance models" come after "climate change" in the survey results, and the least important trends are "technology driven approaches" and "economic instability". The importance given to "climate change" concurs with the high number of projects that address this topic. "Social polarisation" and "economic instability" are considered quite important, although there are very few projects dealing with these global trends.

5.4. Global vision and guidelines

Finally, the comparison in Fig. 8 allows guidelines to be drawn to improve the Vienna Smart City strategy. These guidelines aim to narrow the gap between the actual implementation of the Smart City and the visions of the different stakeholders, and to promote the inclusion of citizens and the political, social, economic and knowledge stakeholder groups.

- **Smart Cities are not predominantly understood as technology-driven entities in the stakeholders' discourses**. Half the stakeholders interviewed clearly express this vision, and only three mention ICT in their definitions. In the project analysis, although most of the projects use technology, only 16 use ICT (excluding those that publish information on a webpage). This trend is the third most important in the global trends addressed by the different projects. However, it is rated as one of the least important global trends. Technology, though important, does not play a key role in the Vienna Smart City, and this tendency should hence be maintained.
- **More balanced stakeholder involvement**. There is clear agreement on the key role of the public sector, and especially the municipality and local public companies in developing the initiative. However, the stakeholders' subsystems are fairly unbalanced, and the results of the initiative could be improved by increasing the collaboration between them. Only four definitions mentioned the citizen-centric vision. This appears to contradict the fact that social polarisation and inclusion are among the key global trends and challenges for Vienna. To reduce the gap between the stakeholders' vision and implementation it is necessary to raise awareness among stakeholders of the need to involve civil society stakeholders.

- **Maintaining efforts and increasing strategies for social awareness in environmental projects.** There is also consensus as to the importance of "tackling climate change" as one of the main global trends affecting the city of Vienna, although with certain contradictions. When the challenges are assessed separately, climate change is not considered very important by the stakeholders, and the environment does not appear to play a key role in their view of the concept in their definitions of the Smart City. Although efforts in this direction should be continued, other aspects of the city were considered to have a higher priority. This suggests the possibility of increasing the awareness of specific challenges linked to climate change.

Mobility projects usually include an environmental component, and this topic follows the same tendency as the "Environment" dimension. There are therefore far more projects affecting this dimension than the number of times it is mentioned by stakeholders in their definitions. However, they consider challenges linked to mobility to be very important (4.5., 6.3), so these must still be addressed. Mobility projects should therefore also continue to be developed.

- **Increasing focus on governance**. The "Governance" dimension is crucial in the discourses and is the third dimension in terms of number of projects dedicated to this aspect. However, there is still a large gap between the low number of projects addressing governance issues and the proliferation of projects on the "Environment" dimension. A more balanced initiative could be achieved by increasing the number of projects on governance. The number of projects on governance challenges is quite low in any case. An increase in the focus on governance is therefore recommended.
- **Greater effort to promote social inclusion and foster human and social capital**. The "People" dimension is rated second in importance and is also second in terms of the number of initiatives on this subject. However, as in the case of governance, there is still a significant gap between the few projects on issues related to the "People" and the ones related to the "Environment" dimension. "Social polarisation" is the second trend according to the stakeholders surveyed, and the one with the most important challenges, and yet it is among the trends with the fewest projects addressing it. This contradiction must be resolved by increasing the number of projects to tackle social inclusion. There are very few projects aimed at fostering human and social capital despite its importance to stakeholders. Promoting human and social capital is therefore an essential element for achieving social inclusion.
- **Increasing efforts in the "Economy" dimension by promoting social and human capital**. The economic dimension is relatively unimportant in terms of the number of projects addressing it and the visions of the stakeholders, and is clearly unbalanced in the system. The global trend of "economic instability" is the subject of fewest projects, as occurs with the challenges related to this trend. The trend is also considered among the least important by the stakeholders. However, this trend includes what the stakeholders consider to be one of the most significant challenges: "5.4. Fostering human and social capital as a source of innovation". Efforts must therefore be increased to ensure a greater weight of the economic dimension in the system, and this can be achieved by fostering social and human capital.

In conclusion, the Vienna Smart City Strategy should place the focus on social and human capital to reduce social polarisation. Governance must play a key role, promoting the inclusion of different stakeholders. The environmental and mobility dimensions show agreement between implementation and discourses, and should thus maintain their relevance. An improved balance in the system could be achieved by increasing efforts in the 'Economy' dimension by focusing on human and social capital.

6. Conclusions

The aim of this paper was twofold: (A) to design an integrative and comprehensive conceptual model for Smart Cities, and (B) to propose a methodology to analyse the implementation of Smart Cities and the discourses to extract guidelines to develop initiatives in the field.

The proposed conceptual model meets the requirements of an integrated Smart City conceptual model, and establishes relationships between the three topics identified: (a) the importance of governance and stakeholders, (b) the integration of dimensions linked to the projects and initiatives implemented, and (c) the connection of these elements with the cities' challenges. The model highlights the importance of a comprehensive view of the Smart City that takes all these different aspects into account. Due to this complexity, a step-by-step development is necessary to extract conclusions and integrate them in a final phase.

The conceptual model proved to be useful for showing the current state of implementation and stakeholders' opinions/perceptions/assessments of the Vienna Smart City Strategy in order to compare the implementation and discourses and identify the common points and differences between them. It also demonstrated the usefulness of the tool for displaying all the interrelated elements in the conceptual model and extracting guidelines to narrow the gap between the two visions. The model succeeds in representing the stakeholders in the initiative and their perceptions of their involvement. However, future research should pay special attention to public participation, and to future visions of stakeholder involvement. Stakeholders' opinions of the challenges facing Smart Cities shows a more balanced perception of the importance of the different dimensions. This idea is present in the literature and can be seen in actual implementation. The conceptual model highlights the lack of correspondence between the equal prioritisation of challenges and the unbalanced development of the dimensions.

The model was also effective at representing a complex vision to the different stakeholders interviewed. It supported the debate with the stakeholders and was a useful tool for guiding the analysis of a thoroughly complex topic. It was especially valuable for local governments and private companies who have a comprehensive vision of the Smart City system in their work. They confirmed that the conceptual model reflects their complex vision with its interrelated elements in a systematic way, and considered the model could help them express their ideas more clearly to others.

However, the model must be developed with differing levels of complexity to reach other groups. For technology experts it should include new dimensions focused on technological tools. For research, it can be taken as a starting point for developing further layers of complexity. Finally, for civil society groups, it must be simplified for easy communication with the public.

Finally, we should emphasise that these conclusions must be supported by analytical-statistical data. Future research should concentrate on systematising the connection between the conceptual model and data analysis to enable its widespread use. Text analysis software will be programmed based on the text analysis code in this research and used as a supportive tool. The research also suggests the possibility of applying quantitative indicators for a deeper analysis of the impacts and perceived impacts of Smart City initiatives. The model has been structured to allow it to be connected with various current assessment methodologies that use a similar structure of dimensions or clusters (Giffinger et al., 2007; Monzon, 2015). Systematisation and connection to statistical data will allow the development of comparative case studies of cities with a Smart City strategy.

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