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Smart City Projects Assessment Matrix: Connecting Challenges and Actions in the Mediterranean Region

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ABSTRACT

There is much enthusiasm about smart city development, but the actual implementation of smart projects creates a need for specific methodologies to assess smart city projects. This paper proposes a holistic framework for assessing and interrelating smart city projects and urban challenges in a specific region and for evaluating the projects' potential to generate effects. A generalized Smart City Projects Assessment Matrix (SC[PAM]) is proposed as a tool and applied to the South and East Mediterranean Region at both the regional and project levels. The tool is validated through its application to five case studies. Guidelines for project implementation in the area are extracted.

KEYWORDS

Smart city projects; urban challenges; Mediterranean Region; project assessment

Introduction

There are numerous definitions of “smart cities”, among them, those by Albino et al. (2015); Allwinkle and Cruickshank (2011); ITU (2014); Marsal-Llacuna et al. (2015); and Fernandez-Anez (2016). There are also numerous approaches to analyzing the performance of smart cities in addressing urban challenges (Chourabi et al. 2011; Lombardi et al. 2012; Caragliu et al., 2011). Lately, the concept of “holistic” smart cities has been gaining traction among varied scholars (Alawadhi and Aldama-Nalda, 2012; Caragliu et al., 2009; Castelnovo et al., 2015; Chourabi et al., 2011; Fernández-Güell et al., 2016; Giffinger et al., 2007; Leydesdorff and Deakin, 2010). In fact, these works were seminal to and built upon by the ASCIMER (Assessing Smart Cities in the Mediterranean Region) project, a three-year research effort that was funded by the EIB Institute under its EIBURS program, framed within the H2020 R&D EU initiative on smart cities (<http://www.eiburs-ascimer.transyt-projects.com/>). In a paper describing the project, Monzon (2015: 20) defined

an integrated system in which human and social capital interact using technology-based solutions. It aims to efficiently achieve sustainable and resilient development and a high quality of life [by] addressing urban challenges based on a multi-stakeholder, municipality-based partnership.

A study of smart cities, then, should include a discussion of what urban challenges are being addressed and how those efforts are being implemented. Smart cities are not usually

built from scratch but rather result from the execution of smart city projects that must be strategically inserted into a smart city strategy (Angelidou, 2014). Traditionally, cities attempt to solve problems using a “silo” approach, which has municipal departments working separately (Fernández-Güell et al., 2016; Marsal-Llacuna and Segal, 2016; Nam and Pardo, 2011; The Scottish Government, Scottish Cities Alliance, and Urban Tide, 2014). In this approach, cities that aim to become “smart” focus on enhancing specific socio-economic aspects of everyday living, such as business, housing, commerce, governance, health, education, or community (Angelidou, 2014; Komninos et al., 2011). This sectorial approach is largely the result of the dispersed allocation of resources and financing solutions for specific types of projects. An example would be the kind of project that aimed for optimal energy and resource efficiency, preferably by integrating technologies in the fields of transport, energy, and governance (Urban Europe, 2015; EUREKA, 2017). Nevertheless, complexity in cities must be approached with integrated strategies (Fernández-Güell et al., 2016), and the smart city approach is gradually focusing on addressing urban problems with a holistic approach. Therefore, smart city projects are increasingly coordinated by smart city strategies in cities, as in the case of Vienna (City of Vienna, 2014).

The 2016 UN Habitat conference on Housing and Sustainable Urban Development highlighted the importance of understanding cities as a solution for challenges, focusing particularly on those that developing and middle income countries are facing (UN-Habitat III, 2016). It also highlighted the importance of facing these challenges from a multi-scalar perspective, from regional to local. This study addresses cities in the Mediterranean Region, where we can distinguish two different areas in terms of technology and urban development: the northern cities belonging to the European Region, and the South and East Region (North Africa and the Middle East from Morocco to Turkey). The regions face different challenges, and smart cities should, therefore, be designed differently. Solutions conceived for cities in the northern area do not necessarily fulfill the urban requirements of the southern ones because technology applied to different types of cities should also be different (Bolan and Kern, 2011). To this end, a review of the Southern Mediterranean challenges is necessary.

The aim of this paper is to present a holistic framework for the assessment of smart city projects (SCPs). Doing so requires resolving the two main gaps identified in the literature: (a) the understanding of SCPs as tools for implementing smart city initiatives that must be combined using a holistic approach; and (b) the understanding of how SCPs and initiatives address the specific urban challenges facing a region. Then we present the state of the art in assessment methodologies, describing the main features of a group of selected methodologies and identifying the gap to be filled by the proposed assessment framework. After that, we explain the tools and methods used for the development of this study—a combination of best practices and a literature review, combined with validation through focus groups and individual experts. Next, we describe the proposed taxonomy of SCPs. Then we present the Mediterranean Region and the challenges that cities of the area face. The following section synthesizes the relationships among SCPs and challenges in the Smart City Project Assessment Matrix (SC[PAM]). The Matrix is validated through its application to five case studies. Guidelines for the development of smart city projects in the Mediterranean Region are also developed in this section. Finally, conclusions and further steps are addressed. The result of the study is a holistic assessment framework for smart city projects that focuses on the relationships between SCPs and the region’s

specific challenges. This framework can serve as a basis for a more complete assessment methodology for SCPs that considers the levels of achievement of a city's different priorities and the objectives of the initiatives.

Smart City Assessment: The State of the Art

To select which project or strategy performs better in a smart city context, it is necessary to provide an assessment of its effect on cities. However, there are few standardized tools to assess the effects of implementing specific smart city projects in specific cities or regions.

There are two approaches concerning smart city assessment methodologies. On the one hand, benchmarking procedures have been applied to produce a comparative analysis. On the other hand, a number of more conceptual assessment procedures are oriented toward measuring city effects with a multidimensional approach. The first group could be labelled ranking methods because they provide the possibility of ranking cities according to their performance level. Examples include the Networked Society Index, developed by Ericsson (Networking Society Lab, 2016), and the Smart Cities Index, developed by the Smart City Council (Cohen, 2014). There are also works of national interest such as the smart ranking of Italian cities (EY, 2016), conducted every year since 2013, and the IDC Smart City Analysis for Spanish Cities (Achaerandio et al., 2012). These studies measured city performance using a large number of indicators. They evaluate improvements in separate performance areas of smart cities, heterogeneously identified.

An improved ranking methodology is the work "Smart Cities Ranking of European Medium-Sized Cities" (Giffinger et al., 2007). This ranking uses a set of indicators to evaluate the performance of a group of European cities that meet certain requirements in terms of size and accessibility of data and facilities (universities). This work classified the indicators into six dimensions. Since then, this classification has been used in many scientific and consulting works (Cohen, 2014; Lombardi et al., 2012; Manville et al., 2014; Mattoni et al., 2015)

The second group of assessment methodologies attempts to correlate the basic elements of the smart city concept. Leydesdorff and Deakin (2010) proposed a triple helix approach considering three pillars: university, industry, and government. Triple helix methodologies are used to analyze the dynamics of knowledge-based systems. Other authors such as Lombardi et al. (2012) extend this approach by adding civil society and crossing indicators to the areas defined by Giffinger et al. (2007) by using ANP (Analytic Network Process) models. Giffinger established relationships among the different areas and components, providing an integrated assessment that attempted to include the opinions of decision makers. Lazaroiu and Roscia (2012) also apply the dimensions proposed by Giffinger et al. (2007) to design a methodology that uses fuzzy logic to include the opinions of experts. The Kourtit et al. (2012) analysis looks at the influence of creative cities and on economic growth as a departure point (Florida, 2003), assimilating the concept of smart cities into the analysis. Kourtit reduced the number of indicators used with principal component analysis, focusing on economic indicators, and produced an analysis focusing on the temporal evolution of cities.

As described in the introduction, smart cities are implemented through projects that should be launched under an integrated urban strategy (Angelidou, 2014). However, the assessment tools analyzed fail to consider relevant aspects of the real implementation

of smart cities through specific projects. The methodologies in both the first and second groups provide general sets of indicators aimed at analyzing the general performance of the city in generic dimensions, rather than related to real smart city initiatives. Therefore, there is a need for tools capable of measuring the effects of SCPs to make informed decisions about smart city development and implementation. These tools should be able not only to analyze isolated projects but also to provide a comprehensive overview of the different projects in, and articulated by, the initiative.

Some attempts are being made in the direction of including the project scale in smart city assessment methodologies. The report “Mapping Smart Cities in the EU” (Manville et al., 2014), or the methodologies developed by Mattoni et al. (2015) or Branchi et al. (2014), become relevant examples in the field. The report assesses the performance of smart city projects implemented in different European cities with respect to their capability to affect the six dimensions proposed by Giffinger et al. (2007) and to reach the Horizon 2020 objectives. The methodology proposed by Mattoni et al. (2015) modifies and adapts these six dimensions to five groups of actions (Energy, Economy, Mobility, Community, and Environment) but also includes the scale as a key element of the assessment. The proposal of Branchi et al. (2014) develops a matrix in which different urban technologies are evaluated concerning objectives organized into six different aspects: user, social, urban, environmental, economic, and energy requirements. The first two proposals are based not on indicators but on the interrelationships between areas or actions (Mattoni, 2015) or on the interrelationships of these areas with objectives (Manville et al., 2014). The last proposal is not based on city indicators but rather on a specific project analysis method.

As explained in the introduction, smart cities must be understood as a tool to solve urban challenges. However, none of the assessment methodologies analyzed provides a sound multiple-objective assessment of smart cities or smart city projects in terms of the specific challenges facing cities. Almost all organize their objectives according to implementation areas (Acharandio et al., 2012; Branchi et al., 2014; Cohen, 2014; EY, 2016; Giffinger et al., 2007; Kourtit et al., 2012; Lazaroiu and Roscia, 2012; Lombardi et al., 2012; Manville et al., 2014; Mattoni et al., 2015) but do not establish clear relationships with the real problems of urban areas around the world. When they do, they do so generically—the Networked Society Index proposed by Ericsson (Networking Society Lab, 2016) focused on three challenges: climate change, air pollution, and fossil-free energy consumption. In other words, they are unable to adapt to the challenges of different areas or regions, because they propose sets of indicators to be used universally and which usually focus on the challenges facing cities in the developed world.

There is, therefore, a clear need for an assessment tool that addresses these two gaps in combination: first, the need to assess smart city initiatives through SCPs as the main tool for their implementation; and second, the need to establish relationships between the effects of smart city strategies and the challenges facing cities today, which differ among urban areas and regions.

Tools and Methods

For the development of the assessment tool, a set of methodological steps was implemented (See Figure 1).

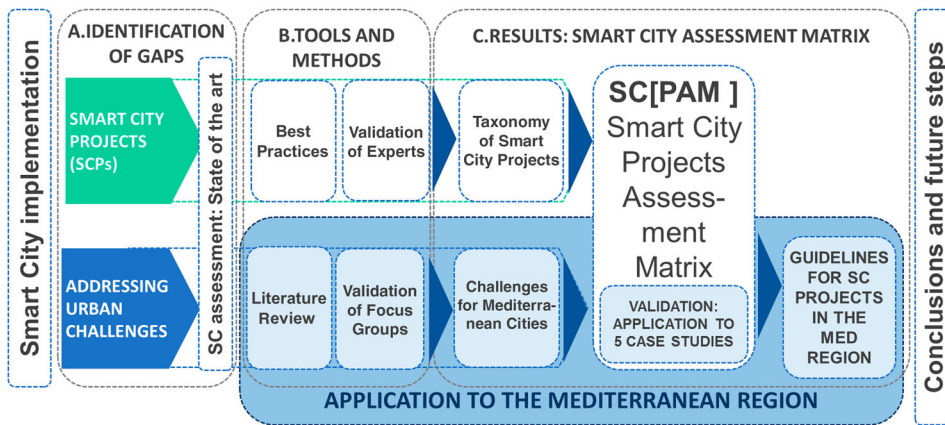


Figure 1. Structure of the study presented in this paper

Identification of Gaps

The first step, as explained in the introduction and state of the art of this paper, was to identify gaps in existing research concerning smart city implementation. Two main gaps were identified: (1) the need to assess smart city projects as the main implementation tool for the smart city, and (2) the need to address the urban challenges specific to a particular region or city. The need for assessment methodologies that consider these two aspects was confirmed in the state of the art of smart city assessment as developed in this paper.

Inputs

In a second phase, research was conducted to identify inputs for the assessment tool: the general inputs and the specific inputs for the development of the case study of cities in the Mediterranean Region.

A taxonomy of SCPs was developed and organized into three levels (See Table 1). The taxonomy was developed in three steps: the selection and analysis of best practices, the development of an initial SCP taxonomy, and its validation by external experts. In the first stage, an international workshop was held in 2014. It was attended by 37 experts from different fields (e.g., transport, energy, ICT, and urban planning), who provided relevant examples of SCPs in their fields of study. The output was a variety of SCPs in the different areas defined by Giffinger et al. (2007). This selection considered 22 projects in 21 cities around the world that apply urban technology solutions. The second stage consisted of compiling a taxonomy based on these projects. In the third stage, the taxonomy was sent to the 15 experts who later took part in a second workshop (described in the next paragraph). Their feedback and proposals were used to modify the structure by adding or changing specific project actions (See next section of the paper).

The identification of the South and East Mediterranean urban challenges also occurred in three different stages. In the first stage, a literature review was developed based on research articles and international organization reports. The main guidelines were taken from “The State of African Cities” report (UN, 2014). The second stage elaborated an

Table 1. Taxonomy of project actions grouped by project areas, corresponding to each smart city dimension

Dimensions	Project areas	Project actions			
Smart Governance	SGo1. Participation	Complaints and suggestions	Participation in decision making	Collaborative production of services	
	SGo2. Transparency and information access	Open data	Governmental transparency	Representation and access to information	
	SGo3. Public and Social Services	Online public and social services	Services integration and interconnection	Public entities in social networks	
	SGo4. Multi-level governance	Integration of governmental levels	Interconnectedness of governmental levels		
	SGo5. Efficiency in municipal management	Efficiency in management, regulations and instruments	Efficiency in the provision of services		
Smart Economy	SEc1. Innovation	Policies and plans for enhancing innovation	Physical infrastructure for innovation	Services for innovation	New business based on innovation
	SEc2. Entrepreneurship	Entrepreneurial education and training	Creation of entrepreneurial environments	Entrepreneurial support policies and actions	
	SEc3. Local & Global interconnectedness	City internationalization	Business and commerce networks	Presence of business in the Internet	Globalization risk management
	SEc4. Productivity	Physical and technological infrastructure for productivity	Management for adaptation		
	SEc5. Flexibility of labor market	Measures to improve accessibility to labor market	Measures to combat unemployment	Technological improvements for flexibility	
Smart Mobility	SMo1. Traffic management	Strategic corridor and network management	Incident management	Safety enhancement	Real-time traveler information
	SMo2. Public Transport	Real-time traveler and operator information	Safety and security enhancement	Public transport alternatives	Integrated payment systems
	SMo3. ICT Infrastructure	Systems for data collection	Systems and protocols for data communication	Systems and procedures to ensure quality of the data	Payment systems & ticketing
	SMo4. Logistics	Improvement on the traceability of goods	Fleet tracking & management	Stock management	
	SMo5. Accessibility	Enhancing physical accessibility	Enhancing digital accessibility	Enhancing socio-economical accessibility	Enhancing cultural accessibility
	SMo6. Clean and non-motorized options	Clean energy in traffic and parking	Cycling options	Walking options	Alternative motorized options
	SMo7. Multimodality	Passenger multimodality	Freight multimodality		

Smart Environment	SEn1. Network and environmental monitoring	Environmental monitoring	Network monitoring	Applications to visualize the information collected	
	SEn2. Energy efficiency	Smart grids	Renewable energy	Energy efficiency in buildings and districts	Energy efficiency in public devices
	SEn3. Urban planning and urban refurbishment	Urban planning in new developments	Urban refurbishment	Urban management related to planning	Participation in urban management and planning
	SEn4. Smart buildings and building renovation	Sustainability in new buildings	Sustainability in building renovation		
	SEn5. Resources management	Waste management	Water management	Food management	Consumption patterns
	SEn6. Environmental protection	Natural resource protection	Ecosystems protection	Biodiversity protection	
	SEn7. Awareness and behavioral change	Tools for behavioral change	Awareness-raising tools	Involvement in sustainable measures in buildings and urban spaces	
Smart People	SPe1. Digital education	Technology and learning methods	Skills for technology		
	SPe2. Creativity	Fostering creative activities	Creative networks	Partnerships including creative entities	
	SPe3. ICT-Enabled working	Measures and platforms for employment	Home-based work and workplace flexibility	Timetable flexibility	
	SPe4. Community building and urban life management	ICT-enabled bottom up initiatives	Community-based organizations networking and platforms	Community and urban life information spreading and sharing	
	SPe5. Inclusive society	Human rights watch	Inclusion policies and measures	Civil society organization support	
Smart Living	SLi1. Tourism	Tourism information via Internet	Tourism accommodation facilities	Online tickets or tourist card	Integration of tourism with urban activities
	SLi2. Culture and leisure	Culture information via Internet	On-line tickets, reservations and inscriptions	Cultural heritage management	Participation in municipal cultural program
	SLi3. Healthcare	Disease prevention	Promoting healthier lifestyle and well-being	Improve access to healthcare	Health information and education
	SLi4. Security	Urban security	Security services online	Digital security	
	SLi5. Technology accessibility	Accessibility to people with disabilities and functional limitations	Overcoming technological barriers	Measures to solve environmental factors	Measures to solve cultural and income limitations
	SLi6. Welfare & social inclusion	Improving accessibility to labor market	Gender inclusion; family and child aid	Services for immigrants	online volunteering and interconnection with services
	SLi7. Public space management	Integration and connection of uses in public space	Adaptation of public space to users	Public space management	

initial list of 20 challenges (Monzon, 2015) and related them to the different dimensions identified by Giffinger et al., (2007): governance, economy, mobility, environment, people, and living. Finally, the discussion of the challenges occurred through focus groups in the second workshop held in 2015. The workshop participants worked on validating and prioritizing these challenges for Mediterranean cities and discussed the potential of smart city projects to address city challenges. A group of 15 stakeholders, belonging to municipalities of the Mediterranean Region, international agencies and institutions (European Investment Bank, Union for the Mediterranean, Agence Française de Développement, and the World Bank), networking organizations (like Medcities), and universities, worked in two separate focus groups. Experts came from nine countries: Austria, Croatia, Egypt, France, Italy, Lebanon, Morocco, Spain, and Tunisia.

As a result of the workshop, 12 new challenges and three types of SCP were included, four challenges and two SCPs were renamed, and three challenges were rejected or included in other challenges. Conclusions were extracted to establish relationships between SCPs and the challenges they are able to face, which led to the development of the matrices in the results.

Results: The Smart City Project Assessment Matrix (SC[PAM])

This matrix has a double aim. The first objective is to provide conclusions on the capacity of different types of smart city projects to address urban challenges in the region. The second objective, which establishes the basis for future research, is to serve as a structured framework to assign assessment values for projects and prioritize challenges for different cities. The connections in the SC[PAM] consisted of three steps. First, they were developed by the authors based on a thorough review of the literature and the analysis of multiple projects identified as best practices in the different dimensions. Second, they were verified with the opinions of experts in workshops. Finally, they were tested in five different SCPs. Guidelines for the development of smart city projects in the Mediterranean region were extracted from the SC [PAM] connections and validated with the case studies.

Smart City Projects and Project Actions

A selection of smart city projects was analyzed with the aim of finding a means of systematizing their structure.

This paper proposes that a Smart City Project can be broken down and classified into different dimensions and that different types of project areas and project actions that are part of the project can be identified (See Table 1). A total number of 118 project actions were identified, grouped into 36 areas, and classified in six dimensions. The proposed taxonomy can be used for classifying projects and to develop proposals. It is intended to be flexible and modifiable, facilitating the inclusion of new solutions that might appear in the future.

Application of the Assessment Tool: The Mediterranean Region

The urbanization process in the South and East Mediterranean Region is producing a great number of negative externalities, according to the UN-Habitat report “The State of African

Cities 2014” (UN, 2014). Cities in the region face challenges linked to rapid urbanization, demographic pressures, and environmental problems. Smart city projects are beginning to be implemented in the region but are experiencing difficulties in adapting to the social, cultural, economic, and environmental particularities of cities in the area. Therefore, the South and East Mediterranean Region was selected as the application area. The identification of the specific challenges that cities in the region are facing is key to the development of models and tools that can be adapted and particularized to the needs of cities in the area.

A set of specific challenges in the region was developed using the proposed methodology (See Table 2). They are extremely complex, and challenges belonging to each different dimension are highly intertwined with the other dimensions. The 11 governance challenges identified are related to challenges from all other areas. The six economic challenges identified are largely linked to governance but also to mobility and people dimensions. Environmental challenges (seven identified) are also related to all other dimensions, particularly to mobility and governance. Among the eight challenges in the mobility dimension, there are also challenges that fall under all of the other dimensions but particularly under the environment dimension. People challenges (eight identified) are linked to all other dimensions, particularly to governance. The seven living challenges identified are related to challenges from all other dimensions, but particularly from governance and mobility.

Governance is the dimension in which the highest number of challenges was identified, and it is also the one with the strongest relationships to all of the other dimensions. The most transversal challenges, belonging to four of the dimensions, are related to governance and equity: CH25 and CH26. There is also a group of crosscutting challenges, belonging to three of the dimensions, related to urban planning and infrastructures: CH27, CH5, CH9, and CH10.

Smart City Projects Assessment Matrix

The different project actions listed in Table 1 were related to the challenges (See Table 2) that they could potentially address. This connection became the core of the developed assessment tool because the goal of smart city projects is to cope with urban challenges. To simplify this analysis and extract comprehensive conclusions, the connections were established among challenges and the 36 project areas. Each project area could potentially affect more than one single challenge, always depending upon the perspective that the planner introduces when designing the solution. Otherwise, each challenge would be addressed through the implementation of different types of projects.

Thus, the Smart City Project Assessment Matrix (SC[PAM])—a complete matrix that shows the relationships between challenges and project areas in all fields—was developed with the aim of identifying the effects of actions at the level of the different project areas in challenges belonging to all dimensions. The Smart City Projects Assessment Matrix (SC [PAM]) (See Table 3) is a matrix that offers partial and global results on the project, acting as a summary of all elements and providing for the extraction of the information from the combinations. The SC [PAM] relates the different project areas to the urban challenges according to their capacity to address them. The colored squares in the matrix indicate that the implementation of actions included in the project area placed in that column

Table 2. List of urban challenges of the South and East Mediterranean Region showing (1) which of the identified dimensions they affect, (2) the total number of challenges per area, (3) the number of common challenges and the dimensions they affect

		Smart Governance	Smart Economy	Smart Mobility	Smart Environment	Smart People	Smart Living
South and East Mediterranean challenges							
CH1	Pollution			1	1		
CH2	Lack of quality of neighborhoods and public space			1			1
CH3	Lack of accessible and affordable public transport			1			
CH4	Increase in private car ownership and use			1			
CH5	High infrastructure deficit	1	1	1			
CH6	Important role of the informal economy		1				
CH7	Lack of diversification in urban economy		1				
CH8	Lack of competitiveness		1				
CH9	Uneven geographic development	1	1		1		
CH10	Lack of access to technology	1	1			1	
CH11	Low urban institutional capacities	1					
CH12	Excessive centralization & lack of institutional coordination	1					
CH13	Instability in governance	1					
CH14	Lack of access to information	1					1
CH15	Gap between government and governed	1				1	
CH16	Urban poverty and inequality					1	
CH17	Low educational level and digital skills					1	
CH18	High obstacles to social mobility					1	
CH19	Threats to cultural identity and particularities					1	1
CH20	Urban violence and insecurity						1
CH21	Lack of accessible leisure facilities						1
CH22	Deficit of social services	1					1
CH23	Climate change effects				1		
CH24	Inefficient resources cycle management				1		
CH25	Lack of equity in access to opportunities and resources	1	1	1	1	1	
CH26	Lack of awareness, engagement & participation	1	1	1	1	1	
CH27	Very rapid urbanization			1	1		1
Common challenges with other dimensions	TOTAL	11	6	8	7	8	7
	Smart Governance	11	3	3	3	4	2
	Smart Economy	*	6	1	1	1	0
	Smart Mobility	*	*	8	4	2	2
	Smart Environment	*	*	*	7	2	1
	Smart People	*	*	*	*	8	1
	Smart Living	*	*	*	*	*	7

Table 3. Smart City Projects Assessment Matrix: SC[PAM]

		DIMENSIONS																																				
		Smart Governance					Smart Economy			Smart Mobility			Smart Environment			Smart People		Smart Living																				
CHALLENGES		PROJECT AREAS																																				
		SGo1. Participation	SGo2. Transparency and Information	SGo3. Public and Social Services	SGo4. Multi-level governance	SGo5. Efficiency in municipal	SE1. Innovation	SE2. Entrepreneurship	SE3. Local & Global	SE4. Productivity	SE5. Flexibility of labor market	SMo1. Traffic management	SMo2. Public Transport	SMo3. ICT Infrastructure	SMo4. Logistics	SMo5. Accessibility	SMo6. Clean, non-motorized options	SMo7. Multimodality	SEn1. Network and environmental	SEn2. Energy efficiency	SEn3. Urban planning and urban	SEn4. Smart buildings and building	SEn5. Resource management	SEn6. Environmental protection	SEn7. Awareness rising and	SPe1. Digital education	SPe2. Creativity	SPe3. ICT - Enabled working	SPe4. Community building and	SPe5. Inclusive society	SLi1. Tourism	SLi2. Culture and leisure	SLi3. Healthcare	SLi4. security	SLi5. technology accessibility	SLi6. Welfare & Social inclusion	SLi7. Public spaces management	
	Low urban institutional capacities																																			0		
	Deficit of social services																																				0	
	Instability in governance																																				0	
	Gap government - governed																																				0	
	Centralization & lack of coordination																																				0	
	Lack of awareness																																				0	
	Shortage in access to information																																				0	
	Lack of equity																																				0	
	Unbalanced geographical development																																				0	
	High infrastructures deficit																																				0	
	Shortage in access to technology																																				0	
	Lack of competitiveness																																				0	
	Lack of economy diversification																																					0
	Excess of Informal economy																																					0
	Lack of public transport																																				0	
	Increase of private car																																				0	
	Pollution																																				0	
	Very rapid urbanization																																					0
	Lack of quality on neighbourhoods																																					0
	Unefficient resources cycle																																				0	
	Climate change effect																																				0	
	Urban poverty and inequality																																				0	
	Threats to cultural identity																																				0	
	Low educational level and digital skills																																				0	
	High obstacles to social mobility																																				0	
	Lack of accessible leisure facilities																																				0	
	Urban violence and insecurity																																				0	
		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		

can positively affect the challenge placed in that row. Therefore, the matrix becomes a first step in the assessment process, allowing evaluation of the adequacy of the proposal to the real needs of the area in which it will be implemented.

Concerning the average number of challenges addressed by each project area in each dimension, in most cases, the higher rate occurs at the intersection between challenges and project areas in the same dimensions. The exceptions would be mobility project areas, which primarily affect environmental challenges, and living project areas, which primarily affect people challenges. Governance and economy establish weaker relationships with other areas and will require specific actions.

The general use of the SC[PAM] consists of developing the existing panel of project actions and areas of a project. The SC[PAM] identifies projects that will better balance and reach a higher number of challenges, but it also proposes improvements to one single project. To analyze the possible effects of a smart city project, it is useful to identify all possible relationships between the identified project areas and challenges beforehand to allow an assessment adapted to the context of the project analyzed.

Therefore, three possible uses have been identified for the matrix at three different scales:

- (1) At Project Level: the SC[PAM] can be used to evaluate the capacity of smart city projects to address urban challenges and to find possible improvements to address a higher

number of challenges. Therefore, it can be used for ex-ante assessment. Conversely, it can be used in the design phase to identify what types of project would be the most useful for specific urban contexts, specially if combined with specific indicators.

- (2) At City Scale: the SC[PAM] can be used to analyze comprehensively the existing project in a city and to identify the areas and challenges that are and are not being covered. It can therefore help to develop and improve smart city strategies for cities. This possibility will not be explored in this paper.
- (3) At Regional Scale: the SC[PAM] can be used to develop urban policies at a regional scale. Because the challenges of cities in a region have been identified as have the projects that are needed to address them, recommendations can be extracted for smart city projects for cities in a specific region. The results from using the tool at this level are revealed in the next section of this paper for the application area of the South and East Mediterranean Region.

Case Studies

We validate this research through the application of the analysis of five different case studies of the South and East Mediterranean Region. This validation has two objectives: to show the use of the matrix and to demonstrate that the project areas and challenges are correctly connected in real case studies, proving the validity of the SC[PAM]. These case studies were carefully selected to show the variety of projects that can be studied with the analysis, covering all of the different dimensions of the smart city.

Amman RFID Card: Amman, Jordan

The city of Amman has an above-average performance for multiple urban characteristics within its geographic scope in terms of size, access to technology, and human capital. In recent years, the city council has initiated multiple smart city projects with the aim of making the city and its citizens “smarter.” We selected a smart card equipped with RFID technology that is being tested on the national university campus, a multidimensional project. The RFID card makes it easier for users to pay for public transportation, offers access to urban services, and can be used to pay at local restaurants. As the usage data are gathered by the city council, the data offered better information on the actual use of services. This classification process would be executed as shown in [Figure 2](#).

The next steps in the analysis are done particularizing the SC[PAM] (See [Table 4](#)). The first step is to highlight the specific project areas affected by the project in the matrix (in yellow), revealing the challenges that could not possibly be improved by this intervention (shaded in gray on the left).

At this point, a very basic analysis could be used to understand the potential reach of the project and to compare it with the council’s objectives for the city. In the case of Amman, only three of the 27 challenges are not addressed by the proposal, which raises the initial consideration of the proposal’s degree of alignment with the urban priorities.

In the second step, the matrix is used to examine the challenges the project should be able to address according to our research and to analyze whether it is effective in each case. Again in [Table 4](#), this presentation has been translated into two sets of colored intersection

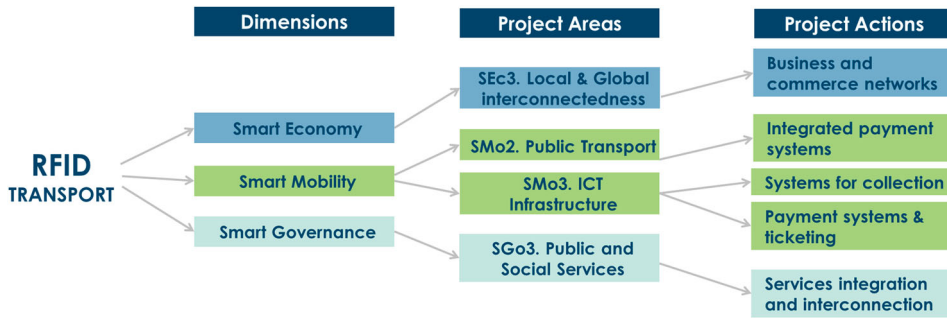


Figure 2. Dimensions and project areas for Amman’s RFID card

Table 4. Analysis of Amman’s RFID project, with potential (o) and achieved (x) effects

	DIMENSIONS																																							
	Smart Governance				Smart Economy				Smart Mobility				Smart Environment				Smart People				Smart Living																			
	PROJECT AREAS																																							
	SGo1. Participation	SGo2. Transparency and Information	SGo3. Public and Social Services	SGo4. Multi-level governance	SGo5. Efficiency in municipal	SEc1. Innovation	SEc2. Entrepreneurship	SEc3. Local & Global	SEc4. Productivity	SEc5. Flexibility of labor market	SMo1. Traffic management	SMo2. Public Transport	SMo3. ICT Infrastructure	SMo4. Logistics	SMo5. Accessibility	SMo6. Clean, non-motorised options	SMo7. Multimodality	SEn1. Network and environmental	SEn2. Energy efficiency	SEn3. Urban planning and urban	SEn4. Smart buildings and building	SEn5. Resources management	SEn6. Environmental protection	SEn7. Awareness rising and	SPe1. Digital education	SPe2. Creativity	SPe3. ICT - Enabled working	SPe4. Community building and	SPe5. Inclusive society	SLI1. Tourism	SLI2. Culture and leisure	SLI3. Healthcare	SLI4. Security	SLI5. Technology accessibility	SLI6. Welfare & social inclusion	SLI7. Public spaces management				
CHALLENGES	Low urban institutional capacities																																				4			
	Deficit of social services																																					4		
	Instability in governance																																						7	
	Gap government - governed																																						12	
	Centralization & lack of coordination																																						6	
	Lack of awareness																																						12	
	Shortage in access to information																																						6	
	Lack of equity																																							24
	Unbalanced geographical development																																							18
	High infrastructures deficit																																							13
	Shortage in access to technology																																							6
	Lack of competitiveness																																							19
	Lack of economy diversification																																							8
	Excess of informal economy																																							5
	Lack of public transport																																							8
	Increase of private car																																							11
	Pollution																																							15
	Very rapid urbanization																																							15
	Lack of quality on neighbourhoods																																							16
	Inefficient resources cycle																																							10
	Climate change effects																																							12
	Urban poverty and inequality																																							24
	Threats to cultural identity																																							15
	Low educational level and digital skills																																							4
	High obstacles to social mobility																																							16
Lack of accessible leisure facilities																																							12	
Urban violence and insecurity																																							7	
	8	8	8	6	6	3	8	10	1	7	7	11	7	5	12	12	10	6	6	15	10	11	8	12	12	3	9	11	14	4	8	7	7	13	13	11				

points. The first are shaded according to the city dimension to which they belong and filled with an (x). These intersections are the planned effects that are manifested in the Amman project. The second, shaded in dark gray and filled with an (o), show the intersections of the project with the challenges on which it could potentially have a positive effect but that are not present in the specific case of the Amman project. The analysis of these

intersections leads to additional failure to address challenges; we illustrate this failure in [Table 4](#) by shading the actual affected challenges in yellow, leaving those attainable but not actually affected ones in white.

The output of this process is a visual panel showing the project goals. The initiative's outreach can be seen at a glance, which is extremely helpful for understanding complex smart city initiatives that often affect multiple areas of a city. The matrix can be used as a framework to compare different smart projects with a more structured approach and to contrast them with the actual challenges of the city in which they will be implemented. Some of the challenges are affected by more than one colored intersection, meaning that the challenge is influenced by two or more aspects of the initiative.

The analysis of the case studies shows that 20 percent (6 out of 27) cannot be addressed by the proposal. In this example, challenges such as "Lack of access to information," "Pollution," "Climate change effects," or "High obstacles to social mobility" could be affected but have only gray intersections. In the case of Amman, there are another ten challenges that—according to our research—are susceptible to being affected but that are not affected by the proposal. For instance, the initiative could include the introduction of the aggregated information obtained from the municipal open data portal that affects "Lack of access to information," or it could introduce incentives/discounts to encourage the use of greener modes and thus affect "Pollution." This example shows how a project with a low level of complexity could be leveraged by including the improvements highlighted by the SC[PAM], thus proving its usefulness and the validity of the intersections among the elements.

Taparura New Sustainable Urban Development: Sfax, Tunisia

Taparura is a new urban development project based on the principle of sustainability. The proposal covers a number of areas such as enhanced deployment of public spaces, improvement of the public transport system, and refurbishment of the coastline. It also promotes green modes of transport through initiatives such as cycle paths and aims to reduce energy and water consumption by using more efficient materials in construction. The general goals of the development are to increase the quality of life, improve the local economy, and create user-friendly spaces, thereby adding value to the Tunisian city of Sfax. The project incorporates participatory mechanisms to include the local population. Its classification into the proposed taxonomical breakdown produced 13 differentiated actions in five of the six city dimensions. (See [Table 5](#))

An analysis of the gray squares (and the associated challenges related only to gray intersections and highlighted in white) offers an insight into the nearest areas of opportunity the project could reach if supplemented with extra developments. In this example, some challenges with only gray intersections could be affected, such as "Instability in governance," "Gap between government and governed," and "Low educational level and digital skills." The first two could be addressed by changes in the governance model to encourage involvement by new dwellers in the decision-making and design of public services, which would improve public and social services and increase efficiency in municipal management. The third challenge could be improved by providing infrastructures for digital education in the plan.

Table 5. Analysis of the Taparura new sustainable urban development project, with potential (o) and achieved (x) effects

		DIMENSIONS																																							
		Smart Governance			Smart Economy			Smart Mobility			Smart Environment			Smart People		Smart Living																									
		PROJECT AREAS																																							
		SGo1. Participation	SGo2. Transparency and information	SGo3. Public and Social Services	SGo4. Multi-level governance	SEc1. Efficiency in municipal	SEc2. Innovation	SEc3. Entrepreneurship	SEc3. Local & Global	SEc4. Productivity	SEc5. Flexibility of labor market	SMo1. Traffic management	SMo2. Public Transport	SMo3. ICT Infrastructure	SMo4. Logistics	SMo5. Accessibility	SMo6. Clean, non-motorised options	SMo7. Multimodality	SEn1. Network and environmental	SEn2. Energy efficiency	SEn3. Urban planning and urban	SEn4. Smart buildings and building	SEn5. Resource management	SEn6. Environmental protection	SEn7. Awareness rising and	SPe1. Digital education	SPe2. Creativity	SPe3. ICT - Enabled working	SPe4. Community building and	SPe5. Inclusive society	SLi1. Tourism	SLi2. Culture and leisure	SLi3. Healthcare	SLi4. Security	SLi5. Technology accessibility	SLi6. Welfare & Social Inclusion	SLi7. Public spaces management				
CHALLENGES	Low urban institutional capacities																																							4	
	Deficit of social services																																								4
	Instability in governance																																								7
	Gap government - governed																																								12
	Centralization & lack of coordination																																								6
	Lack of awareness																																								12
	Shortage in access to information																																								6
	Lack of equity																																								24
	Unbalanced geographical development																																								18
	High Infrastructures deficit																																								13
	Shortage in access to technology																																								6
	Lack of competitiveness																																								19
	Lack of economy diversification																																								8
	Excess of informal economy																																								5
	Lack of public transport																																								8
	Increase of private car																																								11
	Pollution																																								15
	Very rapid urbanization																																								15
	Lack of quality on neighbourhoods																																								16
	Inefficient resources cycle																																								10
	Climate change effects																																								12
	Urban poverty and inequality																																								24
	Threats to cultural identity																																								15
	Low educational level and digital skills																																								4
	High obstacles to social mobility																																								16
	Lack of accessible leisure facilities																																								12
Urban violence and insecurity																																								7	

The verification in this more complex project of the connections between the project areas and the challenges and possible modifications that could be made to the project according to the possibilities suggested by the matrix has proved the validity of the inter-sections in this example and the value of their use.

Zenata Eco-City: Mohammedia, Morocco

The Zenata Eco-City is a new urban development located between Casablanca and Mohammedia in Morocco. The city plan has been developed based on firm criteria of sustainability and integrated uses (industry, housing, facilities, and tourism). It is scheduled to accommodate 300,000 inhabitants and create 100,000 jobs. Developments include a primary health-care and education service, a commercial district, and a logistics center.

The Zenata project is very wide-ranging, so the actions in the projects cover multiple areas. They were classified into 16 different areas and entered in the matrix to find possible connections (See Table 6.) Although the project appears similar to the Taparura project, the structured analysis of its effects reveals many differences between the two. Although Taparura reveals higher effects on governance aspects, Zenata affects urban services. Although Sfax failed to address three possible challenges, Zenata is compact in the sense that it addresses the effects within its reach (all of the non-addressed challenges

Table 6. Analysis of the Zenata Eco-City project, with potential (o) and achieved (x) effects

		DIMENSIONS																																								
		Smart Governance			Smart Economy			Smart Mobility			Smart Environment			Smart People			Smart Living																									
		PROJECT AREAS																																								
		SGo1. Participation	SGo2. Transparency and Information	SGo3. Public and Social Services	SGo4. Multi-level governance	SGo5. Efficiency in municipal	SEc1. Innovation	SEc2. Entrepreneurship	SEc3. Local & Global	SEc4. Productivity	SEc5. Flexibility of labor market	SMo1. Traffic management	SMo2. Public Transport	SMo3. ICT Infrastructure	SMo4. Logistics	SMo5. Accessibility	SMo6. Clean, non-motorised options	SMo7. Multimodality	SEn1. Network and environmental	SEn2. Energy efficiency	SEn3. Urban planning and urban	SEn4. Smart buildings and building	SEn5. Resources management	SEn6. Environmental protection	SEn7. Awareness raising and	SPe1. Digital education	SPe2. Creativity	SPe3. ICT - Enabled working	SPe4. Community building and	SPe5. Inclusive society	SLI1. Tourism	SLI2. Culture and leisure	SLI3. Healthcare	SLI4. Security	SLI5. Technology accessibility	SLI6. Wellfare & social inclusion	SLI7. Public spaces management					
CHALLENGES	Low urban institutional capacities																																						4			
	Deficit of social services																					x																		4		
	Instability in governance																																								7	
	Gap government - governed																																								12	
	Centralization & lack of coordination																																								6	
	Lack of awareness							x													x		x	x																12		
	Shortage in access to information																																								6	
	Lack of equity							x																																	24	
	Unbalanced geographical development												x									x	x	x																18		
	High infrastructures deficit												x									x	x	x																13		
	Shortage in access to technology							x																																	6	
	Lack of competitiveness							x	x		x											x																			19	
	Lack of economy diversification							x	x																																8	
	Excess of informal economy																																								5	
	Lack of public transport												x									x	x																		8	
	Increase of private car												x									x	x																		11	
	Pollution												x									x	x	x																	15	
	Very rapid urbanization																					x	x	x																	15	
	Lack of quality on neighbourhoods																																									16
	Inefficient resources cycle																																									10
	Climate change effects																																									12
	Urban poverty and inequality																																									24
	Threats to cultural identity																																									15
	Low educational level and digital skills																																									4
	High obstacles to social mobility																																									16
	Lack of accessible leisure facilities																																									12
	Urban violence and insecurity																																									
		8	8	8	6	6	3	8	10	1	7	7	11	7	5	12	12	10	6	6	15	10	11	8	12	12	3	9	11	14	4	8	7	7	13	13	11					

are out of its scope and therefore colored in gray). The project addresses a greater range of areas than in the case of Amman. Four dimensions and 14 areas are included. Careful analysis of the project revealed 130 effects, which would allow improvement of up to 24 out of the 27 city challenges in the project lifecycle. Environmental challenges are most affected by the proposal. This effect should be assessed by local authorities, and the alignment of the environmental challenges contrasted with the regional development priorities for the Zenata region. In this case, the connections between challenges and project actions have been shown to be fully valid. All of the possible challenges indicated by the SC[PAM] were affected by the project.

Municipal GIS Platform: Ramallah, Palestine

The project analyzed for the city of Ramallah is a GIS platform developed by the municipality. The system collects, manages, compiles, reviews, analyzes, and displays spatial data describing different aspects of the city. Each department in the municipality has an application built on the platform data showing useful information for citizens. Data can be updated in real time to provide logistical support for municipal services.

The application is also available to the public through web applications such as the Interactive Tourist Map and Municipal Mapping. One very interesting feature is its

Table 7. Analysis of the Ramallah municipal GIS platform project, with potential (o) and achieved (x) effects

		DIMENSIONS																																					
		Smart Governance		Smart Economy		Smart Mobility			Smart Environment			Smart People			Smart Living																								
		PROJECT AREAS																																					
		SGo1. Participation	SGo2. Transparency and Information	SGo3. Public and Social Services	SGo4. Multi-level governance	SGo5. Efficiency in municipal	SEc1. Innovation	SEc2. Entrepreneurship	SEc3. Local & Global	SEc4. Productivity	SEc5. Flexibility of labor market	SMo1. Traffic management	SMo2. Public Transport	SMo3. ICT Infrastructure	SMo4. Logistics	SMo5. Accessibility	SMo6. Clean, non-motorized options	SMo7. Multimodality	SEn1. Network and environmental	SEn2. Energy efficiency	SEn3. Urban planning and urban	SEn4. Smart buildings and building	SEn5. Resources management	SEn6. Environmental protection	SEn7. Awareness rising and	SPe1. Digital education	SPe2. Creativity	SPe3. ICT - Enabled working	SPe4. Community building and	SPe5. Inclusive society	SLi1. Tourism	SLi2. Culture and leisure	SLi3. Healthcare	SLi4. security	SLi5. technology accessibility	SLi6. Wellere & Social inclusion	SLi7. Public spaces management		
CHALLENGES	Low urban institutional capacities																																					4	
	Deficit of social services																																						4
	Instability in governance																																						7
	Gap government - governed																																						12
	Centralization & lack of coordination																																						6
	Lack of awareness																																						12
	Shortage in access to information																																						6
	Lack of equity																																						24
	Unbalanced geographical development																																						18
	High infrastructures deficit																																						13
	Shortage in access to technology																																						6
	Lack of competitiveness																																						19
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	Pollution																																						15
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	Inefficient resources cycle																																						10
	Climate change effects																																						12
	Urban poverty and inequality																																						24
	Threats to cultural identity																																						15
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	High obstacles to social mobility																																						16
	Lack of accessible leisure facilities																																						12
	Urban violence and insecurity																																						7

participatory nature; users can provide information, post complaints about urban services, and give feedback using the application. The Ramallah project allowed us to contrast and validate the framework with a purely IT-based project. It also contained participation and governance items that were absent from the previous projects.

As seen in Table 7, the project effectively addresses the challenges affecting governance and innovation. Although it has fewer total effects, they are more evenly distributed and address 26 of the 27 urban challenges for the region. Some of the potential effects observed by the team for the Ramallah GIS project are marked as unleveraged (in gray), largely concerning the use of the available information to enforce policies on land use and activity management. The proposal does not address improvements in governmental transparency, which could easily be included. With these modifications, all of the connections between project actions and challenges proposed by the SC[PAM] would be validated for this project.

Casablanca Green Pole Living Lab Al-Amal: Casablanca, Morocco

The Al-Amal Living Lab is a small acupuncture project located at the center of Casablanca, Morocco. The project revives the uses of an existing sports infrastructure and endows it with new functionalities and services for the citizens in the area. The proposal includes the adaptation and refurbishment of the facilities for these new uses and transforms them into an example of sustainability.

Table 8. Analysis of the Casablanca Al-Ammal Living Lab, with potential (o) and achieved (x) effects

		DIMENSIONS																																					
		Smart Governance		Smart Economy		Smart Mobility			Smart Environment			Smart People			Smart Living																								
		PROJECT AREAS																																					
		SGo1. Participation	SGo2. Transparency and Information	SGo3. Public and Social Services	SGo4. Multi-level governance	SGo5. Efficiency in municipal	SEc1. Innovation	SEc2. Entrepreneurship	SEc3. Local & Global	SEc4. Productivity	SEc5. Flexibility of labor market	SMo1. Traffic management	SMo2. Public Transport	SMo3. ICT Infrastructure	SMo4. Logistics	SMo5. Accessibility	SMo6. Clean, non-motorised options	SMo7. Multimodality	SEn1. Network and environmental	SEn2. Energy efficiency	SEn3. Urban planning and urban	SEn4. Smart buildings and building	SEn5. Resources management	SEn6. Environmental protection	SEn7. Awareness rising and	SPe1. Digital education	SPe2. Creativity	SPe3. ICT - Enabled working	SPe4. Community building and	SPe5. Inclusive society	SU1. Tourism	SU2. Culture and leisure	SU3. Healthcare	SU4. Security	SU5. Technology accessibility	SU6. Welfare & social inclusion	SU7. Public spaces management		
CHALLENGES	Low urban institutional capacities	x																																				4	
	Deficit of social services																																						4
	Instability in governance	o																																					7
	Gap government - governed	x																																					12
	Centralization & lack of coordination									x																													6
	Lack of awareness	x																			x		x	x														12	
	Shortage in access to information																																					6	
	Lack of equity	x																																				24	
	Unbalanced geographical development										o																											18	
	High infrastructures deficit																																					13	
	Shortage in access to technology																																						6
	Lack of competitiveness																																						19
	Lack of economy diversification																																						8
	Excess of informal economy																																						5
	Lack of public transport																																						8
	Increase of private car																																						11
	Pollution																																						15
	Very rapid urbanization																																						15
	Lack of quality on neighbourhoods																																						16
	Inefficient resources cycle																																						10
	Climate change effects																																						12
	Urban poverty and inequality	x																																					24
	Threats to cultural identity	o																																					15
	Low educational level and digital skills																																						4
	High obstacles to social mobility	x																																					16
	Lack of accessible leisure facilities																																						12
Urban violence and insecurity																																						7	
		8	8	8	6	6	3	8	10	1	7	7	11	7	5	12	12	10	6	6	15	10	11	8	12	12	3	9	11	14	4	8	7	7	13	13	11		

In coordination with the framework for the 2015–2020 agreement to upgrade the social development plan for greater Casablanca, the new uses include sports activities, ICT access and education, green and sustainable education for all young people in Casablanca and for schools and families, the offer of a regular eco-education program for children, and the potential to broadcast courses to other education centers in Casablanca with the programs being co-defined through the proposals of neighborhood associations.

The project was entered in ASCIMER SC[PAM], and the results are shown in Table 8. For the Al-Ammal case, the project areas affected focus on the dimensions of “Environment,” “People,” and “Living,” with improvements in most of the corresponding challenges. Only four challenges remain beyond the reach of the proposal, with only one being out of the scope and therefore marked in gray. Of those, three could easily be incorporated. The intersections in the matrix were consistent with the previous work, and all of the different intersections were present but could be incorporated if desired. The validity of the intersections in the SC[PAM] was thus verified.

Conclusions of the Case Study Validation

The SC[PAM] validation process has enabled the matrix to be tested in five different case studies. The projects are widely diverse and affect the six city dimensions. The projects all

Table 9. Summary of results of the different case studies

Project	Project dimensions	Project areas	Affected challenges	Possible affected challenges	Effects	Possible effects (and % increase)
Amman RFID card: Amman, Jordan	3	4	13	21	18	36 (+100%)
Taparura New sustainable urban development: Sfax, Tunisia	5	13	24	27	117	123(+5%)
Zenata eco-city: Mohammedia, Morocco	4	15	24	24	130	130 (+0%)
Municipal GIS platform: Ramallah, Palestine	5	12	26	26	75	84 (+12%)
Casablanca Green Pole Living Lab Al-Amal: Casablanca, Morocco	5	12	23	27	87	105 (+20%)

belong to the Mediterranean Region and have either already been implemented or are currently being implemented.

The results show that the previous effort to synthesize challenges, project areas, and the potential interactions among them have been successful. The links of 29 of the 38 project actions with the selected challenges have proved to be correct and have demonstrated that they produce correlations between challenges and projects or can produce these connections by including minor modifications in the project. The other links can be inferred to be correct, although such an inference also must be proved. The identification of missing elements is also helpful to gain insights into the project's limitations and to address potential gaps in the proposal. The matrix has proved its value as a useful tool for understanding the project more visually and to check for potential synergies among initiatives.

Table 9 shows a summary of the results of the case studies. As the case studies increase in complexity, the number of challenges they address also increases. The case of the Amman RFID card only affects three dimensions and leaves a large number of possible challenges unaffected. The percentage of possible effects that are not being produced by a project increases as the number of project dimensions and areas diminishes. A comparison of the Zenata and Taparura case studies also reveals greater possibilities for increasing the number of challenges affected in Taparura, which has more complexity and affects five different areas, as opposed to the four affected by the Zenata project. However, a comparison of the Casablanca Green Pole Living Lab Al-Amal with the Ramallah municipal GIS platform, both affecting five dimensions and 12 project areas, shows that there are other factors to be considered because one has twice as much possibility of having new effects as does the other. However, in general terms, the increase in the project's complexity can be confirmed as increasing the potential for addressing increasingly varied urban challenges.

Guidelines for Smart City Projects in the Mediterranean Region

Based on general information extracted from the matrix, a set of guidelines for the implementation of smart city projects in the Mediterranean Region was developed. The analysis of the case studies has been used to demonstrate the potential of SCPs to follow these guidelines.

- *A holistic approach is necessary for the implementation of smart city projects in the Mediterranean Region, overcoming the sectoral approach.* This conclusion was extracted from the interactions between challenges and project areas in the different dimensions and confirmed in the conclusions of the application of the matrix to the five case studies explained in the previous section.
- *Urban planning instruments are key to achieving this holistic approach.* The project area “SEn5. Urban planning and urban refurbishment” is the area able to address the higher number of challenges.
- *Considering inequality issues is key to smart city projects to guarantee the inclusion of all.* Although different authors have noted the smart city’s capacity to foster inequality as a negative externality (Deakin, 2011; Hollands, 2008), challenges concerning inequality are those addressed by a higher number of project areas (CH3, CH9, CH15, CH16, CH18, and CH25), and project areas related to inclusion are among those able to address more challenges (SPe5, SLi5, and Sli6). In other words, if there is a focus on this issue and on how technology is adapted and implemented in a region, smart city projects can act as a tool to reduce inequality. All five case studies have been able to address between four and seven challenges related to inequality, thus confirming this potential. Some—such as the case of the Amman RFID card (6.3.2)—could increase the number of inequality challenges they affect by including some modifications highlighted by the matrix, such as including discounts for public transport or local services for people with fewer resources.
- *Smart Cities require a regional approach and coordination.* The matrix, designed to focus on a specific region, has proved successful in developing a tool that can help create smart city policies and guidelines for cities in the South and East Mediterranean Region. When reducing the scale to regional challenges, CH9 is one of the challenges that can be addressed by the highest number of project actions and is addressed by all five case studies, showing the potential of smart city projects alone to affect this regional approach.
- *An approach focused on rising awareness and on resources management is needed in environmental smart city projects in the South and East Mediterranean Regions.* For the studied region, the “Smart Environment” project actions that can address a greater number of challenges include Sen7 and Sen5. Four of the five case studies analyzed include Sen5, and all of them affect equality of access to opportunities and resources (CH25). However, although only the Casablanca project includes Sen7, four of the projects address the lack of awareness (CH27) and show the potential of this challenge to be addressed by smart city projects globally. Therefore, smart city projects have strong direct and indirect potential for success in this approach.
- *Smart Mobility Project Actions become central to addressing environmental challenges.* Concerning the connections established in the matrix, actions included in the project areas SMO6, SMO7, and SMO2 are crucial for addressing existing environmental challenges in the region. Among the case studies analyzed, Taparura and Zenata include all three project actions and directly affect all environmental challenges, confirming this relationship.
- *There is a strong connection between people challenges and living project areas that can lead to new approaches in facilities and social services delivery.* The Taparura project, including one living area, is already able to affect six people-related challenges,

whereas the Zenata, Ramallah, and Casablanca projects include three to four living project areas and address all people challenges. Among them, only the Casablanca project includes people project areas. The most important measures concerning the challenges in these dimensions should be approached at the same time through people and living projects; measures concerning SPe1 and SLi5 or those included in SPe5 and SLi6. are those with the highest potential according to the matrix.

- *Governance issues are transversal to all dimensions.* Eleven challenges are included in the Governance dimension, the highest number of all of the dimensions, with eight also classified as linked to other dimensions, showing its transversal nature. The relationship between Governance issues and the project areas affects a higher number of challenges, such as SPe4, SEn5, SEn7, or even SEc3 Interconnectedness. Almost all of the case studies include Governance project actions, affecting 6 to 10 of the challenges linked to Governance. However, the Zenata case study does not include any Governance project actions, although it can address nine of the governance challenges, showing the potential of project actions such as Sen5 to address problems linked to this area.
- *Economic challenges must be addressed mostly through specific actions.* Smart city project areas appear to have difficulties in holistically addressing specific problems belonging to a smart economy. There are no strong connections, directly or through other challenges. Economic challenges appear to be addressed mostly by project areas on the same dimension. All of the case studies include economy project areas and the economic challenges they address, along with the number of economy project areas they include.
- *Creativity and innovation act primarily as enablers.* Project areas SEc1 and SPe2 are among those able to affect a fewer number of challenges on their own. Therefore, they should not become goals in and of themselves; rather, these topics should be implemented through their consideration in projects belonging to all other dimensions. Many authors (Caragliu et al., 2009; Chourabi et al., 2011) have noted these two topics as key to the smart city, and we agree because they are the elements that introduce resiliency in the process in the mid-term, both increasing the number of and improving available project actions, supporting the development of better solutions that address new challenges. They appear in three out of five case studies and could also be introduced in the other two.

Conclusions

With the aim of bridging the gap between theoretical approaches to smart cities and real implementation of the concept, it is essential to understand the role of smart city projects and to understand cities' specific needs and challenges. This paper develops the SC[PAM] as a tool to interconnect smart city projects with their possible effects in specific urban challenges.

The main innovative features of the proposed tool are the following:

- (1) Working with smart city projects is the basis for implementing smart city initiatives. The tool provides a taxonomy of projects that was validated by different experts. The

proposal is also flexible; technological developments are moving fast, so in the future, new smart city project actions could be added to the SC[PAM].

- (2) To propose a tool that provides for particularization of the assessment for cities in a specific region. The SC[PAM] can be particularized to any specific region or area by identifying the most important challenges of the area and establishing the different project actions' potential to address them. It was particularized to the South and East Mediterranean Region by developing a set of challenges that were validated by experts.
- (3) To develop a multi-scalar prioritization tool that can be used with different scales to extract general guidelines, to analyze strategies, or to assess smart city projects. The tool was verified using five different case studies and demonstrated its usefulness and ability to extract guidelines for implementation.

Two research areas were opened for further research: developing a qualitative methodology and applying the tool to smart city strategies. To date, the assessment tool has been qualitatively developed. One possible further step would be to include the SC[PAM] in a complete smart city project assessment methodology, transforming it into a synthesis matrix capable of providing numeric values. In conclusion, this approach can provide a comprehensive index, facilitating comparison among different projects. This complete methodology should be validated by applying it to case studies in the region.

The other research area is the application of the methodology to the city level. The SC [PAM] can be used to analyze the projects included in a smart city strategy and to obtain a comprehensive overview. It can also help to identify gaps in the strategy.

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