

A Participative Method for Prioritizing Smart City Interventions in Medium-Sized Municipalities

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ABSTRACT

One of the most critical issues relating to smart cities is the selection of the most suited interventions, among numerous available options. Especially when medium-sized municipalities are concerned that typically have less capabilities and available expertise, the need for a methodological framework for supporting the selection of possible interventions is profound. The aim of this article is to propose such a participative method for investigating the sectors in which a municipality could take actions, and for deciding on possible interventions. The approach includes citizens' opinion, municipality policy, and the organizational, technological and economic status of the municipality, as well as best practices from other smart cities. This way, a multi-criteria decision support model was developed, in order to select the best application scenarios for a medium-sized municipality. The model was applied in Samos Island in Greece, revealing that citizens show great interest in the development of smart applications. The whole approach can be easily applied, with the proper modifications, in a large variety of cities, offering a useful tool to decision makers and societies.

KEYWORDS

Decision Support Model, Digital Public Services, Multicriteria Decision Making, Samos, Smart Cities

INTRODUCTION

Every vision for a project has to go through many constraints, difficulties and challenges to achieve the successful outcome. "Smart city's projects" could not be an exception to this. The success of a smart city depends on the desires of its residents, the local community, the willingness, active participation and initiative of local authorities in the implementation of new "smart city" interventions. But beyond the desires and initiatives of the residents and the municipality, the decision on the primacy of the initiatives to be implemented is also important and varies from city to city.

With a multiplicity of available options, the need for a methodological framework for supporting the selection of possible interventions for municipalities is profound. The aim of this paper is to develop a methodological framework able to reach evidence-based decisions for the sectors where

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actions should be taken and for the prioritization of possible projects, allowing medium-sized, developing municipalities to join the Smart Cities movement.

For this purpose, by analyzing the citizen demands and the city capacity, the authors propose a multi-criteria decision support model, able to assist in the construction of application scenarios for a medium sized municipality. The model was applied in Samos island in Greece, in 2016.

The present paper is structured as follows: Section 2 provides the background for smart cities and the challenges facing medium sized municipalities. After analyzing the urgent need of organizational changes in order to prioritize smart interventions in medium-sized municipalities and present the case of Samos, the authors describe the proposed model in Section 3. The research findings are presented and discussed in Section 4. The following section 5 indicates the appropriate modifications to be made in order for the model to be adaptable to other medium sized municipalities. Finally, the paper ends with conclusions and further research.

ON SMART CITY INTERVENTIONS

A Smart City uses information and communication technologies in order to achieve high quality of life in multiple key areas: economy, mobility-transportation, environment, health care, tourism and culture, waste and water management, safety, democracy and governance. For the first time in 1994, the term “Digital City” was born with the creation of the digital city of Amsterdam, the Netherlands, using the city as a metaphor combined features of a community of people, a site, and a platform for virtual communication and collaboration. In the years that followed, especially after 2000, a large number of studies for this new concept of smart city have been identified (Albino et al, 2015). At the same time, there are a variety of definitions and terms of similar importance, such as: “Virtual City”, “Cybercity”, “Wired City”, “Virtual Community”, etc. Many researchers use more than one of the above terms to describe the same concept, and others use the same term with a totally different meaning. In nowadays, the common place of all these definitions is the use of “smart city” as an allegory for describing a network of people and information moving digitally. A new dimension of a city is presented in the context of the technological revolution in the field of telecommunications and electronics and their integration in the city, the diffusion of information, and the increasing dominance of the digital on the physical space.

The evolutionary journey from “Digital” to “Smart Cities” has shifted interest from cities’ technologies and digital infrastructure (communication networks, sensors, intelligent agents) to the human and institutional dimensions of the city. For example, the use of human creative skills, the cooperation in the field of innovation as well as artificial intelligence applications have gained new interest as key contributors to the design of a smart city. The perception of the “smart city” is not something static, but a process or a number of steps, the development of which is transforming cities into more sustainable, adaptable to the needs of citizens, and therefore more able to respond immediately to the new challenges.

Current research (Chourabi et al., 2012) distinguishes eight areas which affect the implementation and use of smart actions and projects, the first being the organization and management of the project. This field includes the original design, strategy and methods to address the daily difficulties of the action. Furthermore, a project is based on technology: the use of new technologies and IT infrastructure and networks are important features of smart city interventions. The third factor is the institutional framework and various political components. The fourth factor is the model of governance and the fifth factor is the human factor, followed by the economy, infrastructure and the natural environment.

The areas where “smart city” initiatives affect the economic, social, physical, environmental and institutional development of cities are perceived through a wide range of examples of case studies from Europe, Japan, India and North America. Smarter cities all over the world (Copenhagen, Vienna, Barcelona, Stockholm, Tokyo, Boston, New York, Toronto, etc.) have better public communication, greater commitment to cycling and hiking, a greater focus on sustainability and low carbon emission

solutions. Information and communication technologies contribute to the proper functioning of cities, enhancing their effectiveness, improving their competitiveness and providing new ways in which citizens can address issues of everyday life in a better way. The sectors which seem to be priority to implement digital applications are e-government and public administration, energy savings, health care, public transportation, tourism and environment.

The Challenges Facing Medium Sized Municipalities

Big cities always predominated over medium sized ones in quality, variety and size of the available workforce. The lack of financial resources and investments and the reduction in ICT infrastructure are stronger in medium sized municipalities than larger ones. Urbanization spawned the problem of lack of qualified personnel who can carry out technological and administrative issues of urban governance. Furthermore, in medium sized municipalities there is a lack of cooperation among different departments and a lack of support from the national authorities involved.

But when a city can be characterized as a medium sized? The most common term used is the “secondary city”, whose main feature is that it follows in size, population, infrastructure and capabilities the capital/metropolitan city and is usually, if not unknown, surely insignificant outside the borders of the country. During the review of relevant studies about the city ranking in the world, it became clear that what appears medium-sized at the European scale, maybe considered large at the national scale or small in the worldwide scale. Furthermore, although most attention tends to be drawn to the largest metropolitan cities, this is definitely not the category of cities in which most inhabitants live.

In more detail, the 23 percent of the world’s population (around 1.7 billion people) lived in a city with at least 1 million inhabitants, according to a research of the Department of Economic and Social Affairs of the United Nations. (United Nations, 2016).

According to the final results of a research project (financed by the European Community) conducted within the framework of the ESPON 2000-2006 program, in Europe 72 percent of inhabitants live in cities. Around 260 million Europeans live in city regions with more than 100,000 inhabitants, but only 20 percent live in city regions of more than 2.5 million people, while almost half (44 percent) of all urban inhabitants live in city regions of less than 500,000 inhabitants. Although is not easy to determine whenever a city must be considered as a “medium sized” one, we can assume that the category of cities of less than 500,000 inhabitants can be considered to be “medium-sized” ones on a European scale. Definitely, the meaning of “medium-sized” municipalities depends on the scale one looks at.

According to Hellenic Statistical Authority, the urbanization of Greek population has increased and is unevenly distributed on the territory. Indeed, the participation of large and medium sized cities in the total population reached 72.8% (2001) from 52.5% (1951). In Greece, medium sized cities consist of settlements with a population of 2.000 to 9.999 inhabitants.

In conclusion, in medium sized cities live a significant proportion of the inhabitants of a country and is more than clear the urgent need of organizational changes in order to prioritize smart interventions in medium sized municipalities. The challenges of medium sized cities are different from a big one and remain unexplored. All cities are invited to operate in a global environment where natural, political, economic and cultural boundaries gradually lose their power by allowing the free flow of economic and cultural characteristic. Medium sized cities are regional centers and potential main poles of a polycentric urban network and thus acquire a strategic role in a balanced effort growth.

The Case of Samos

Greek cities present marginalization trends due to the limited capacity of the Greek economy and the geographical isolation. The Greek economy is not able to support development activities and knowledge-intensive activities that are expected to form the basis of the urban economy. The development activities initiated by Athens and then the slow and partial decentralization are expected to some important regional cities. In some cases, there are prospects for specific developing

activities exploiting local comparative advantages (industrial tradition, tourist resources). In total, the hypothesis of an increased and potential developmental role for middle sized municipalities not appears to be verified.

Particularly, Greece is at the epicenter of a financial crisis that has affected the lives of citizens and their institutional expressions such as local government. In a time when resources are scarce, cities are forced to find new sources of income inflow exploiting all their competitive characteristics. There is no city that can do it at all, except perhaps a few big worldwide cities. In our time, we do not have a fixed and rigid urban hierarchy but many flexible hierarchies that depend on the performance of cities in different sectors and activities

This paper focuses on Samos, one of medium sized Greek islands in area and population in Aegean Sea. According to the Hellenic Statistical Authority the Municipality of Samos population amounts to 32.977 inhabitants (2011) over 34,000 residents (as recorded in 2001). The insularity makes the North - East of the Aegean unique compared to the regions of the rest of Greece and Europe. Samos is an island with great historical and cultural heritage and with soil constituents, with natural beauty (classified as a green island), the forest of land (despite the repeated fires) alternate with fertile land with vineyards, olive trees and local produce. In recent decades (especially since early 1980), the development orientation is tourism. In order to make Samos fetching tourist destination, it is needed to redefine the physiognomy, to develop alternative forms of tourism, all time and attract investments in high-quality tourist facilities.

The refugee / immigration problem that has emerged in recent years, with particular intensity in the last year (flows 125,000 refugees / immigrants passed through Samos) since Samos is in the way of immigrants / refugees flows through Turkey, from the war zones in the Middle East and North African countries to Europe, it seems that creates additional problems in the main economic activity, tourism.

Samos is a spiral of economic and social impasses, which are compounded by the poor economic situation and the uncertainty in Greece six years, the lack of investment in productive sectors, poor ferry connections to mainland Greece and the continuous fall in the working population due to non utilization of well-educated young population (due to high unemployment).

There is an urgent need to develop realistic goals and strategies that will enable the island to meet and respond to the new era, and where possible, exceed expectations. Samos can be active with regard to sustainable development sufficient to understand its strengths and weaknesses in the light of the opportunities and threats it faces.

THE PROPOSED DECISION SUPPORT MODEL

Problem Definition

There is an urgent need to develop realistic goals and strategies that will enable the medium- sized municipalities to meet and respond to the new era. Medium- sized municipalities can be active with regard to sustainable development sufficient to understand its strengths and weaknesses in the light of the opportunities and threats it faces.

The recognition of the medium- sized municipalities' strengths, addressing the weaknesses and to identify and exploit potential opportunities will be the driving power. Medium- sized municipalities and its citizens should make an effort to modernize highlighting its advantages.

The main objective of the research is to design a model that answers the following questions:

- In which sectors we could take actions, promote projects and develop digital applications in order for medium-sized municipalities to join “Smart Cities”?
- What are the appropriate “smart” applications for a medium-sized municipality?
- How can we prioritize the plethora of “smart” interventions?

In particular, the work aims at drafting alternative scenarios/proposals, which will be the basic idea to implement “smart” applications, which will be tailored to a municipality’s needs, in order to form a key strategy “Smart City document” with proposals for the implementation process.

The authors adopt the idea that the piloting activities will concern 10 key “smart” sectors: Transportation, Energy, Health Care, Water/Waste Management, Citizen Participation, ICT Systems & Applications, Culture & Tourism, Environment, Local Development and Citizens’ Safety. These key sectors are areas of digital interventions that it can be developed “smart” actions and applications. These basic key sectors and a summary of their policy guidelines are given in Table 1.

Phases, Steps and Contents of the Model

The way to ensure a fair and safe development is to analyze the demands and the needs of the city. To date, it must be attempted to include the citizens’ opinion, the organizational, technological and economic status, and “best practices” experience of qualified personnel from other smart cities, so that a “hybrid multi-criteria decision model” will be developed in order to select the best application scenario and through which, specific digital priority applications will be proposed.

The research design follows three phases (Table 2). The first phase consists of the following steps:

- Step 1:** Analysis of citizens’ voice, investigating the factors that shape the attitudes of citizens towards the Smart City Services by Local Authorities.
- Step 2:** Research on Mapping the Current Situation of the Municipality.
- Step 3:** Exploring Best Practices for Smart Urban Planning.

In the first phase, it is attempted to record the citizens’ opinion trends at that time of the survey. Data collection was done by the method of electronic submission of written structured questionnaire with random sampling. The questionnaire consisted of 42 questions, which some were closed and

Table 1. 10 “smart” key sectors as digital city intervention areas

Focus Areas	Summary of Policy Guidelines
1. Energy	<ul style="list-style-type: none"> ● Energy savings
2. Environment	<ul style="list-style-type: none"> ● Environmental Sustainability ● Environmental protection and pollution control
3. Health Care	<ul style="list-style-type: none"> ● Healthcare solutions
4. Transportation	<ul style="list-style-type: none"> ● Optimize mobility throughout the island in real time
5. ICT Systems & Applications	<ul style="list-style-type: none"> ● Develop ultra-high speed multiservice telecom infrastructure
6. Culture & Tourism	<ul style="list-style-type: none"> ● Education strategies and policies ● Culture strategies and policies ● Tourism opportunities
7. Water/Waste Management	<ul style="list-style-type: none"> ● Intelligent solutions in urban water management ● monitoring solutions to urban wastewater management
8. Citizen Participation	<ul style="list-style-type: none"> ● Increase the provision of direct digital services to citizens and businesses ● Improve access to democratic life and bolster the culture of transparency and accountability ● Release and use prioritized open data ● Increase the provision of direct digital services to citizens and businesses
9. Local Development	<ul style="list-style-type: none"> ● Business Economics and Public Policy ● Growth and Employment
10. Citizens’ Safety	<ul style="list-style-type: none"> ● Improve safety of citizens

Table 2. Phases of the model

<i>Phases of the Model</i>						
<i>Phases</i>	<i>Step</i>	<i>Step Details</i>	<i>Methodology</i>	<i>Thematic Sections</i>		<i>Number of questions</i>
A	Step 1: Analysis of citizens' voice	electronic submission of written structured questionnaire with random sampling	sample: 149 citizens of Samos	1.	Demographic Characteristics	8
				2.	General Knowledge on New Technologies	5
	Step 2: Current state of the municipality	→semi-structured interviews with officials of the municipality →electronic submission of eponymous structured questionnaire →interview with the Mayor	sample: 5 officials feasibility sampling	3.	Knowledge on the concept of Smart City	6
				4.	Level of citizen satisfaction	19
5.				Citizens' Suggestions / Ideas	4	
Step 3: Investigation of Best Practices for "Smart Cities" Design form other cities of Greece	electronic submission of eponymous structured questionnaire	sample : 3 Greek municipalities feasibility sampling	1.	General Details of the municipality	3	
			2.	Design and implementation of "smart" Actions	9	
B	Findings	data collection and data analysis	Microsoft Excel	-		-
C	Multi-criteria decision making analysis Table	→Criteria selection →Actions/applications selection →Order ranking →Best Solution	Microsoft Excel	-		-

some open-ended. The questions were divided into five thematic sections, as follows: demographic characteristics, general knowledge on new technologies, knowledge on the concept of smart city, level of citizen satisfaction, citizens' suggestions / ideas.

The first section concerned the demographic features, such as age, place of origin, education level, occupation, etc. The second section contained questions that record the general knowledge on new technologies. The third section consisted of questions on knowledge of the smart city concept. The fourth section was the larger one, which were mostly Likert-type questions related to the level of respondent's satisfaction with respect to the services provided by the municipality. The questions in this section were categorized into 10 key "smart" sectors (table 1). The last section of the survey questionnaire provided to the respondent the opportunity to present his own proposals and ideas. Data collection took place during the period from October 15, 2015 until February 10, 2016.

In the second step of the first phase it is attempted to record the current state of the municipality. When conducting this research the authors:

- Conducted a semi-structured interview with officials of the municipality;
- Asked local officers and directors of the Municipality to record their views through electronic submission of eponymous structured questionnaire;
- Conducted an interview with the Mayor of Samos.

The questionnaire was closed and open-ended and was divided into four thematic sections, as follows: participant's personal information, containing questions relating to general personal information of respondents, such as name and job in the municipality, a brief documentation of the existing situation, aiming at a general survey of the current situation with questions related to the staffing of municipal services, the Internet access of employees, recording the major local social problems, etc.

The third section was related to specific areas of municipal services. The categorization of questions was based in 10 "smart" key sectors, as we mentioned earlier. In particular, the questions of the third section asked the respondent - responsible officer of each municipality service to evaluate the targets set by the department, through the actions (projects or actions) included in the Operational Program of the Municipality. And here the evaluation questions were Likert type.

The last section consisted of open questions, that the participant is free to express his opinion about the advantages and disadvantages of the municipality and to propose actions and solutions, in line with the needs of municipality in order to join Smart cities.

It was given a great importance to the view of the political leadership of Samos municipality, the Mayor. The Mayor's opinion is crucial, not only because it is the "first" citizen of the city, but also because the Mayor -as the head of the majority (60%) of the Municipal Council- is able to decisively influence the decisions of the City Council and direct the views of the executive staff of the Municipality.

The first phase ends with the Investigation of Best Practices for "Smart Cities" Design form other cities of Greece. Specifically, the researchers imprinted the years of experience and valuable knowledge on the design and implementation of actions and applications from other Greek cities. The data collection method was the electronic submission of eponymous structured questionnaire. The questions were closed and open-ended. The selection of municipalities took place according their capability to be considered in light of the progress and contributions to the field of smart cities. Thus, the questionnaire captures the factors that determine the decision on the design of the first "intelligent" actions and applications, and the problems arising from the design, implementation and the maintenance thereof.

The second phase consists of data collection and data analysis of the first phase and a scenario / proposal draft creation for "smart" applications.

The last phase of the model uses the multi-criteria decision-making analysis (MCDM). MCDM is a field of operation research and a math standardized effort. It is a valuable tool used for complex problems. It is usually selected to determine the optimum solution, or to classify alternative solutions, or simply to separate acceptable and unacceptable possibilities. Moreover, we achieve the composition of multiple quality criteria by ensuring the objectives and maintaining the preferences of each decision maker by adjusting an appropriate weight for each criterion. The steps of multi criteria decision process is three: we first define criteria, then we rate the criteria. Finally, we rate our options against the criteria and multiply by the weighting coefficients.

In this research, it is attempted to prioritize the various interventions according to the specific needs of the municipality, through an evaluation matrix with the help of multi-criteria decision-making analysis. In particular, the researchers collect and evaluate/classify a set of solutions/applications for "smart" medium sized municipalities.

For this purpose, it was drafted a list of alternative "smart" applications-solutions that they have been selected after a literature study of other "smart cities" in Greece and abroad and after analyzing the results of this research on citizens' voice, but also on the opinion and experience of municipal

staff. The authors concluded in a list of 37 proposed “smart” applications-solutions categorized in 10 smart key sectors.

Specific criteria were set according to their influence on the decision about the best option. Through performance weighting percentages for each criterion, the authors estimate the total / final weight for each solution-implementation and classify alternative decision scenarios.

For the purposes of this study, the researchers selected certain criteria - metrics that contribute and influence the final decision. Specifically, three criteria can affect the choice of the “best solution” and these are the degree of readiness of the municipality, the citizens’ voice and the degree of application’s maturity. Figure 1 shows the problem structuring method map.

The importance of each criterion and its influence on the final decision, determines the weighting coefficient. The researchers attached more importance (75%) cumulative factors which depended on the Municipality: the degree of the Municipality of readiness and the opinion of citizens, factors related to the political will of the municipal authority, organizational, staffing and informational adequacy and financial the municipality and the first opinion and citizens’ demands and potentials of local target groups. The third factor, with 25% weight, does not depend on the Municipality, but mainly dependent on IT companies.

As far as the sub criteria concern, weighting coefficients are given based on the degree of their influence on the decision (Figure 2).

The key element of this study is the evaluation matrix (table 3) that includes a set of discrete applications-solutions, all the main criteria and sub-criteria of the model and the rate of each solution in each criterion. Then, with a mathematical function, which includes the weight coefficients of each criterion, we evaluate and classify all the options-solutions. Quantification of each quality criterion is a graduation on a discrete scale of 0-3 (0, 1, 2, 3). After the rating scale for each criterion, we calculate the Final Application’s Weightiness Function (AWF), using the function:

$$A.W.F.(x_i) = \sum_{j=1}^m K_{ij} * W_j, \forall i = 1, \dots, n$$

x_i = “smart” application-solution i

n = number of proposed “smart” applications-solutions

m = number of main criteria

K_{ij} = number of rate for the i-application/solution for the main criterion j, $j = 1, \dots, m$

W_j = weight coefficient for the j main criterion

Figure 1. Problem structuring method map

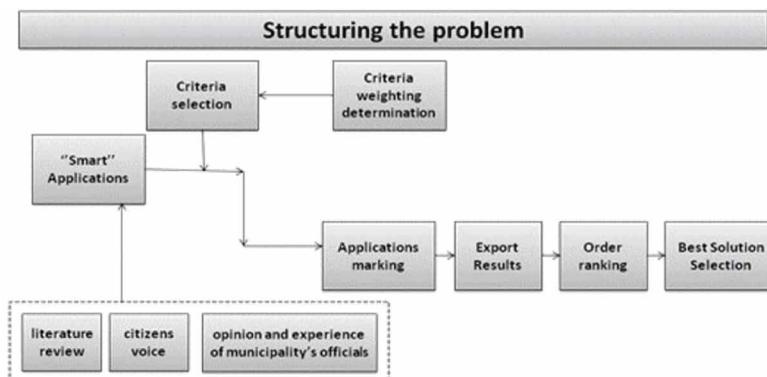


Figure 2. Determination of the weight coefficients for the main criteria and sub-criteria

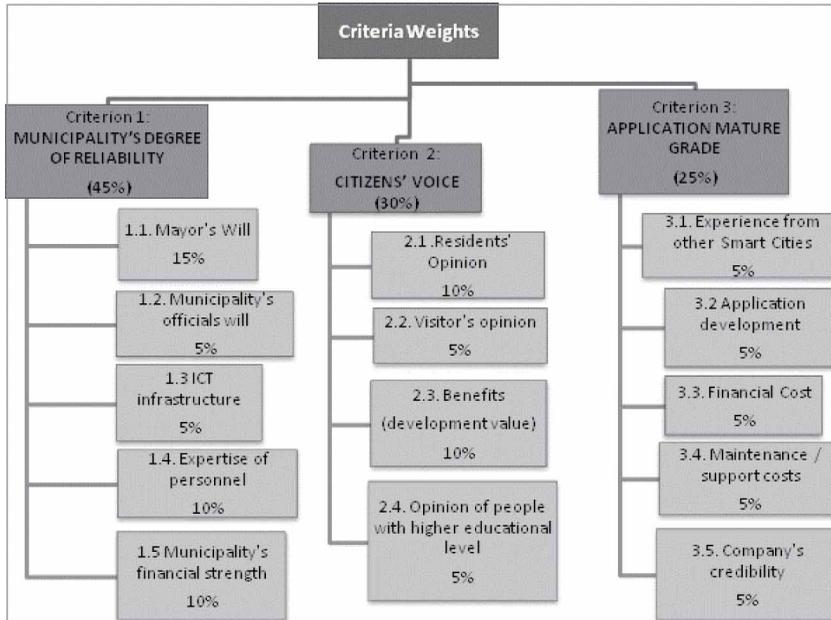


Table 3. Multi Criteria Decision Matrix

Urban Solutions/ Applications	Criterion 1	Criterion 2	Criterion 3	...	Criterion m	Application's Weightiness Function
	Subcriteria	Subcriteria	Subcriteria		Subcriteria	
Criteria Weights	W_1	W_2	W_3	...	W_m	
Application 1	K_{11}	K_{12}	K_{13}	...	K_{1m}	$\sum_{j=1}^m (K_{1j} * W_j)$
Application 2	K_{21}	K_{22}	K_{23}	...	K_{2m}	$\sum_{j=1}^m (K_{2j} * W_j)$
...
Application n	K_{n1}	K_{n2}	K_{n3}	...	K_{nm}	$\sum_{j=1}^m (K_{nj} * W_j)$

According to its definition, the AWF takes values from 0 to 3. According to the value that will be calculated to each “smart” application, we classify each application into three levels. Particularly, if $AWF < 1.5$ then the application is classified to Low Priority Selection (Scenario A), if $1.5 < AWF < 2.5$ the application is classified to Medium Priority Selection (Scenario B) and finally if $AWF > 2.5$ the application is classified to High Priority Selection (Scenario C).

The high priority digital applications/solutions that included in Scenario C are the solutions that a medium sized municipality must plan and implement, achieving directions arising from the desire of the citizens, but also on the willingness of municipal officials.

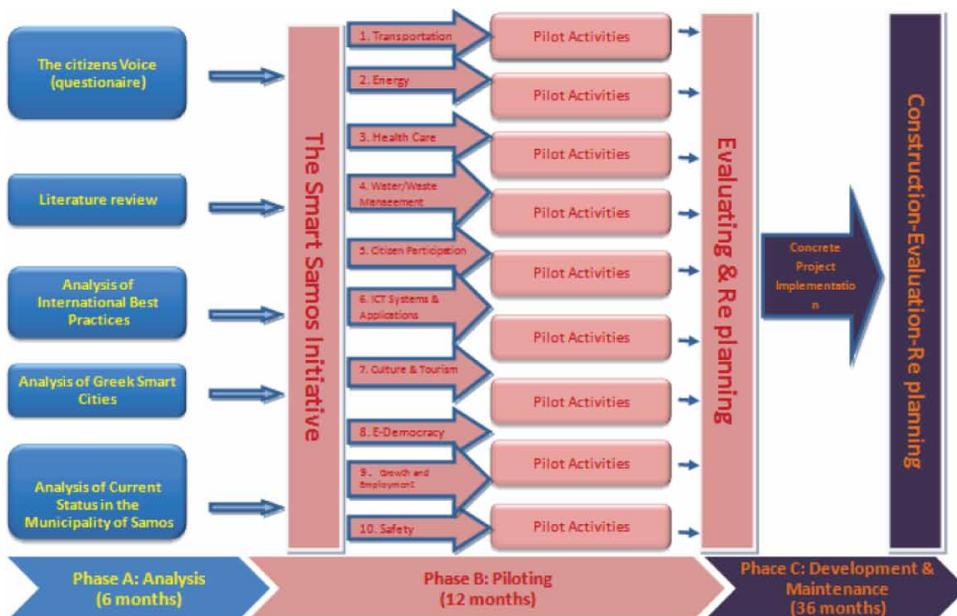
The action plan divided into three phases can be analyzed in Figure 3: Phase A: Analysis phase, Phase B: Pilot phase and Phase C: Phase of Development and Maintenance.

The Analysis Phase includes the presentation of the citizens' voice by analyzing the data that comes from relevant questionnaire. It also studies the literature as far as smart solutions concerns and analyses the international best practices. This first phase ends with the Greek smart cities and the current status of the Municipality of Samos. The synthesis of the various studies of the Analysis Phase will end up to "The Smart Samos Initiative" which is the beginning of the Piloting Phase. The Piloting Activities will concern 10 smart city key areas, as we mentioned above. The Piloting Phase ends up with evaluation and re-planning. The Development and Maintenance Phase concerns concrete Project Implementation and Construction-Evaluation-Re planning.

RESEARCH FINDINGS

The model described above was applied to Samos the period from the end of 2014 until middle of 2016. The data collection took place in 2016. The results reflect the opinion of citizens, the current situation of the municipality of Samos and capture the officers experience of other "smart cities" in Greece as such as Trikala, Heraklion and Veria. For the first time, taking into account parameters such as the citizens voice and the organizational, technological and financial status of the municipality, we attempt to create a hybrid multi-criteria decision-making model in order to select the best "smart" application for Samos.

Figure 3. Smart city action plan



Findings From Phase A

Determining the Voice of Citizens of Samos

Phase A of the model analyzes citizens' opinion investigating the factors shaping the attitudes of citizens towards the services of a Smart City by Local Authorities. The questionnaire captured the common public opinion and "shed light" on the ideas and concepts that dominate to the island of Samos. In the online survey finally answered 149 (80 male and 69 female) residents of Samos. The demographic characteristics of participants, age, educational level and employment are presented in Figure 4.

A great part of the participants (87%) answered that live in a village-town, which is true, since there is no city of over 10,000 residents. The place of residence match with the status of citizenship (62%), which indicates the citizens of Samos showed a great interest in participating in research. Almost 68% of participants said that they know very well up to excellent the English language.

Regarding to new technologies, a great part of respondents indicated that they use computer (PC), mobile phone or tablet (Figure 5b). The internet connection is mostly through computer (PC) and secondarily with mobile phone. The access to the internet is via a permanent connection to a company-provider Internet connection services (> 96%) and secondarily through public or private Wi-Fi.

The survey showed that a large part of the participants uses the internet for information and secondarily for communication (Figure 5a). Only a small part of participants didn't know what a "smart city" is, while 70,5% haven't use a "smart city" application so far (Figure 5c).

Figure 4. Demographic characteristics

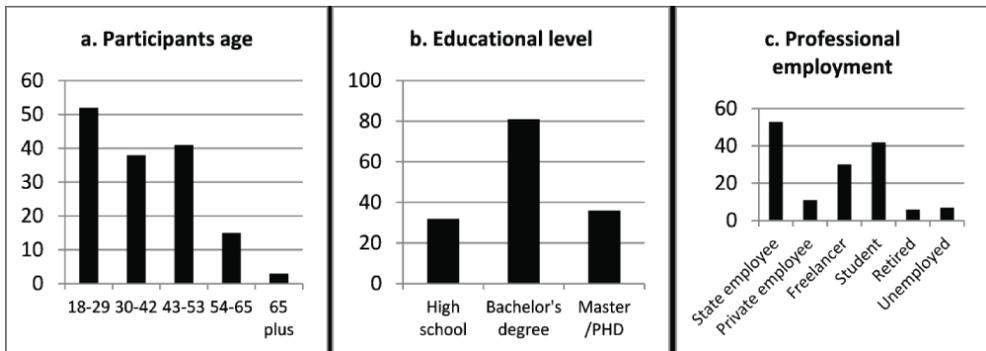
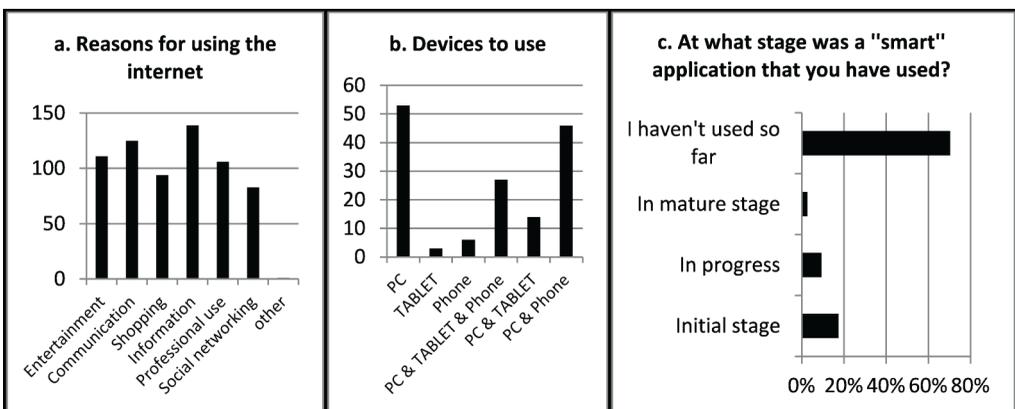


Figure 5. Knowledge on new technologies



Another question concerns the opinion of citizens on issues such as the strengths and weaknesses of Samos (Figure 6 and 7). This was achieved as follows: initially, all responses were recorded, as they were given. Then we categorized and grouped each answer depending on its content and meaning. For this purpose, we created some keywords. Tourism and natural beauty emerged as the two first strengths of the island, through which Samos can achieve local development. On the other hand, citizens point to the lack of interest of local authorities as the main weakness of the island and the “poor” public transportation with the mainland of Greece as well.

Figure 6. Strengths of municipality of Samos

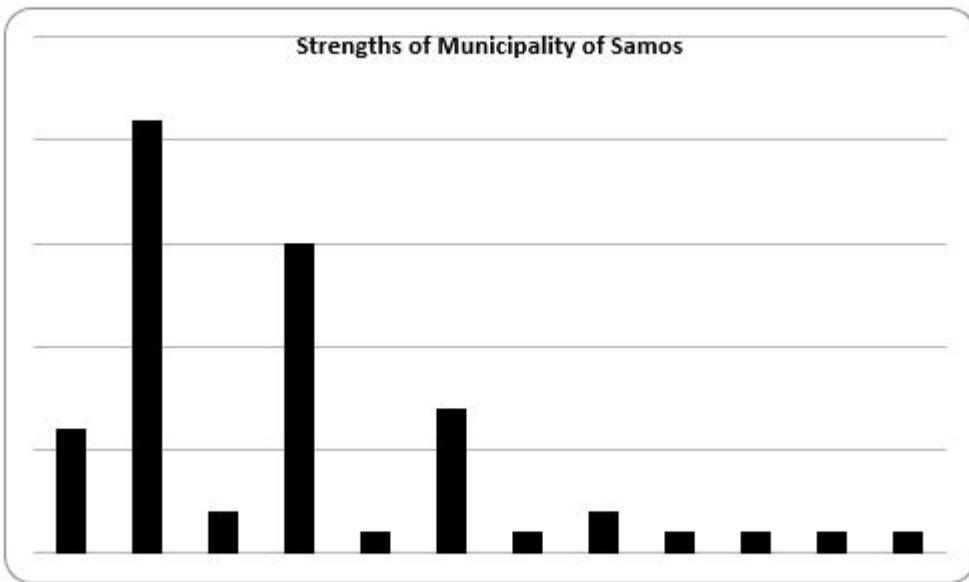
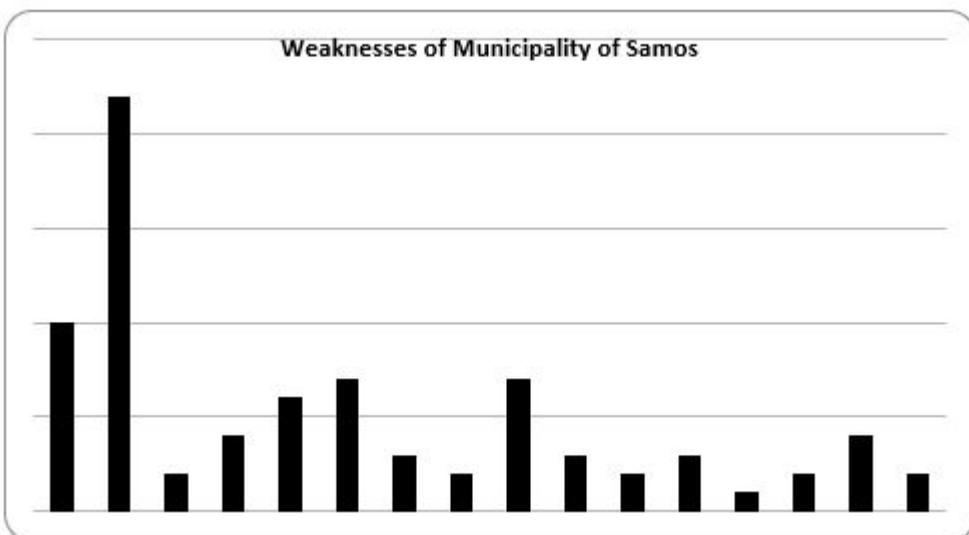


Figure 7. Weakness of municipality of Samos



Figures 8 and 9 capture the most prevalent areas of 10 “smart” key factors discussed earlier, to whom Samos must plan and implement “smart” actions, according to Samos residents’ proposals. E Government and Information and Communication Technology infrastructures are the most preferable areas where the municipality of Samos must focus on. Particularly, for the development of digital applications, the proposals of the inhabitants of Samos highlighted as a first choice the tourist support (e.g. information, events, culture, etc.) as a second option the E government (e.g. e services) and as third option the damage and complaints responding system (e.g. for roads, lighting). Figure 10 shows areas that citizens believe that it must be developed Smart applications.

Mapping the Current Situation of Municipality of Samos

In the second step of phase A the authors performed a formal interview with executives of the municipality, asking them to record their views through electronic submission of eponymous structured questionnaire and finally, they conducted an interview with the Mayor of Samos.

Figure 8. Citizen participation success factors

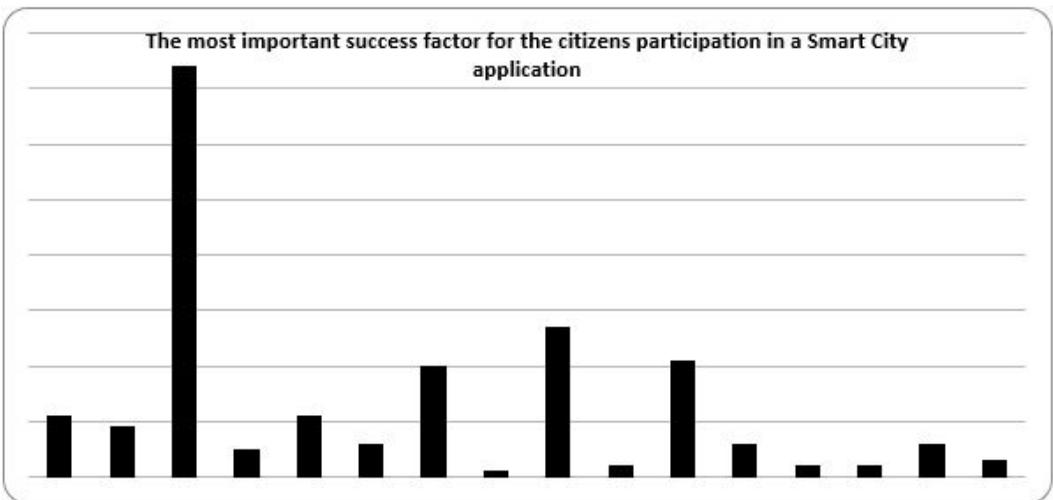


Figure 9. Citizens’ proposals in 10 Key “smart” sectors

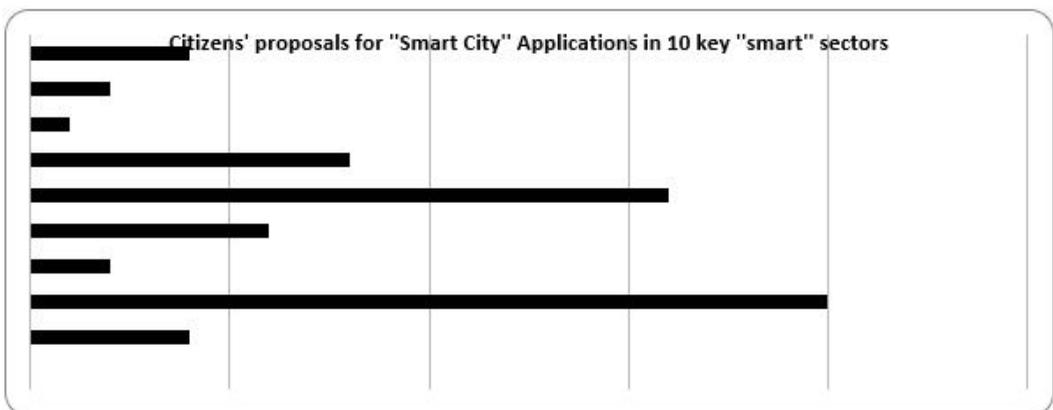
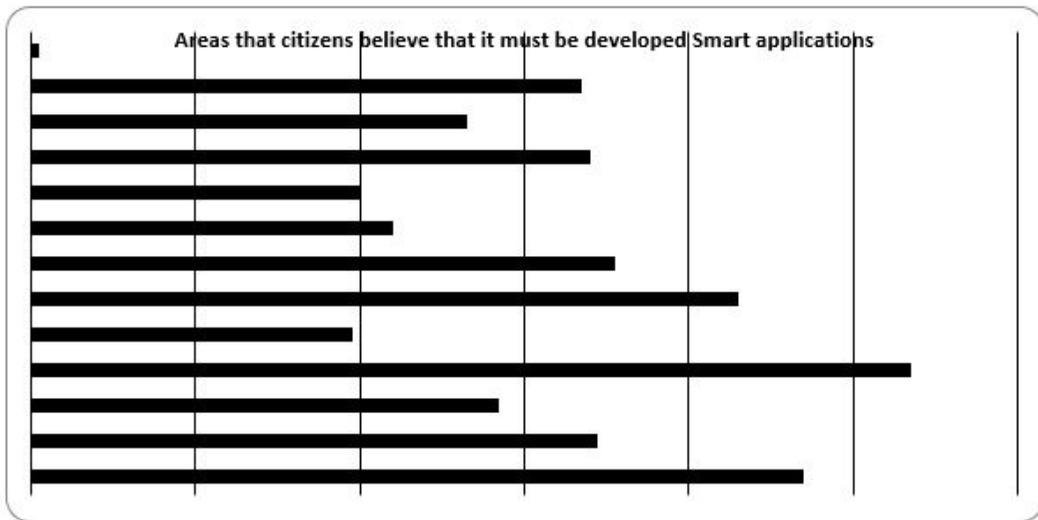


Figure 10. Areas that citizens believe that it must be developed Smart applications



The first contact with the executives of Samos Municipality held early in December of 2015 in the City Hall. The chief executive and other directors of individual departments of the municipality participated. The meeting agenda aimed to gather information of the current situation of the municipality address on:

- Information systems;
- Current projects and development initiatives;
- Programming of the municipality in the view of new operational programs of Competitiveness, Entrepreneurship & Innovation;
- Other needs of municipality.

During the discussion the researchers conducted a briefing of staff about the results of the questionnaire surveying public opinion of the citizens of Samos. From the discussion it became clear that all relevant have shown very remarkable work, which is characterized by cooperativeness and love for the island. However, it became a documentation of weaknesses and problems of the island.

After the meeting, and about a month later, a questionnaire was sent electronically to 18 e-mail addresses of the Municipality's executives, in order to reflect the current situation of the municipality. They finally participated 5 members of the administrative mechanism of the municipality. Some of the results are shown in Figures 11 and 12. The answers of executives eventually categorized and included in the 10 "smart" key sectors.

The researchers estimated as necessary to have the view of the political leadership of the municipality of Samos, the Mayor. The opinion of a Mayor of a city is crucial in Greece, not only because he is the "first" citizen of the municipality, but also because the institutional framework of the local government gives determinative powers to the Mayor (characterized as Mayor-oriented system).

According to the responses of executives the development of "smart" applications in Samos is a mature choice and it is accepted by executives and by the Mayor. The action areas proposed by the executives are the integrated delivery of electronic services to citizens, the development of an information guidebook (with real time information), the recruitment of the municipality with information systems (infrastructure hardware, networking, back office applications) and a number

Figure 11. Samos municipality results

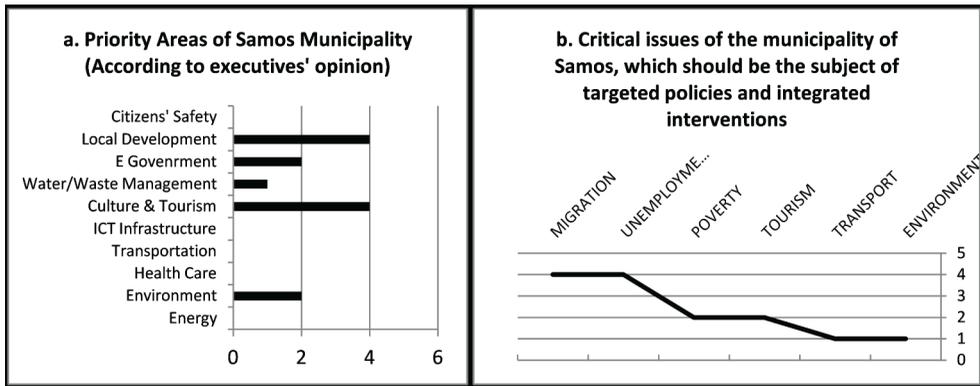
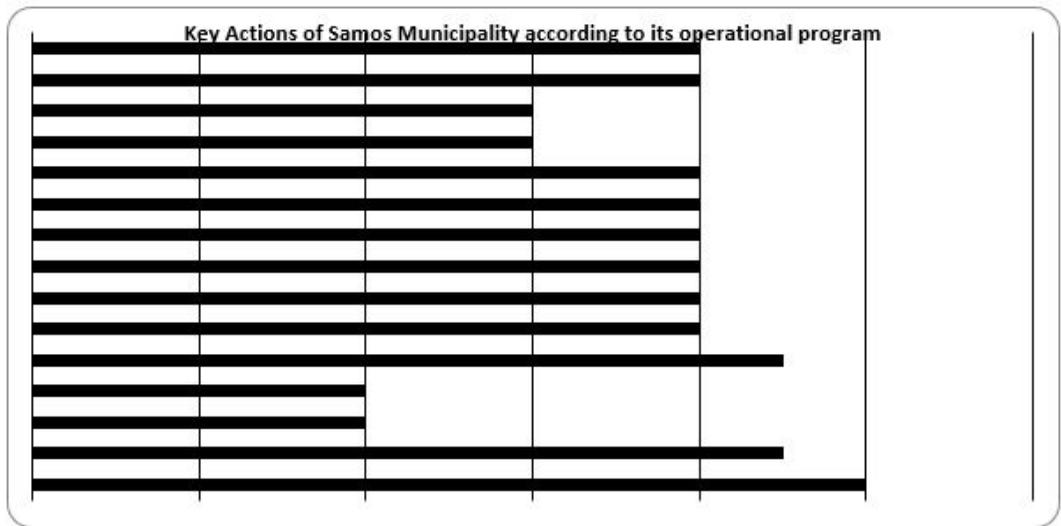


Figure 12. Key actions for Samos municipality



of areas of action (such as kindergarten creation, fault alarm management systems, etc.) and training of personnel in new information and communication technologies.

Serious organizational weaknesses are emerging such as training and educational issues of personal according to information and communication technologies knowledge. Deficit exists according to the required information, network and communication equipment (hardware & software) of the municipality, especially in integrated and interconnected management applications (interoperability) as well as the few municipality points coverage networks with free internet provider hotspot. The views of the Mayor of particular interest were the external openness, transparency, provision of e services, in order to have valid information to citizens, cooperation with University of the Aegean for joint actions, increasing population through investment and development activities, strengthen European acquits with effective participation in the European Union process. Investigation of Best Practices for Smart Cities design.

Recipients of a structured questionnaire were executives of municipalities of other smart cities in Greece such as Trikala, Veria, Larissa, Heraklion, Thermi of Thessaloniki and Ioannina. However, the municipalities that responded were Trikala, Veria and Heraklion.

The Mayor’s political will, vision and experience were the driving “force”. The needs of the local community mainly determined the design of the first intelligent applications, while the problems and obstacles the working group had to deal with, during the analysis, design and implementation phases of the strategic plan were the lack of documentation to other Greek examples, the low culture of cooperation and the immaturity of the participants on digital interventions issues. Figure 13 shows the other “smart” cities best practices.

During the implementation phase problems such as the lack of funding and the political lack of vision were outlined. Finally, in the phase of maintenance and re planning, funding was still the main failure factor, as well as the lack of qualified personnel and political will (let us not forget that the elected Municipal Authority has a finite duration, 4 years old and 5 now, so the vision of an elected mayor may be rebutted by other elected municipal authority).

In conclusion, the actions for application development of “smart cities,” should be considered not only as a technological challenge but as a political process. The central state should complete the information systems under the Interoperability and local government bodies must be coordinators and guarantors of the effort of individual municipalities, unifying their forces.

Suggested Interventions for Smart Samos

After constructing the multi criteria evaluation table of alternative applications in every smart key sector of the 10 areas of digital interventions, we compared the results and its objective is to help decision makers to choose the appropriate applications that best meet the requirements of citizens and visitors of the municipality of Samos, the degree of maturity of Samos Municipality combining company credibility and financial aspects of digital implementation.

Specifically, using the results of the preceding sections, the authors assessed the opinion and will of the citizens of Samos and the maturity of the municipality. This gives the proposed solution multicriteria evaluation matrix, where for reasons of readability the authors omit the transcript of the individual sub-criteria and only quote the rating of the three basic criteria. Table 4 shows the multi criteria evaluation matrix.

Figure 13. Other “smart” cities best practices

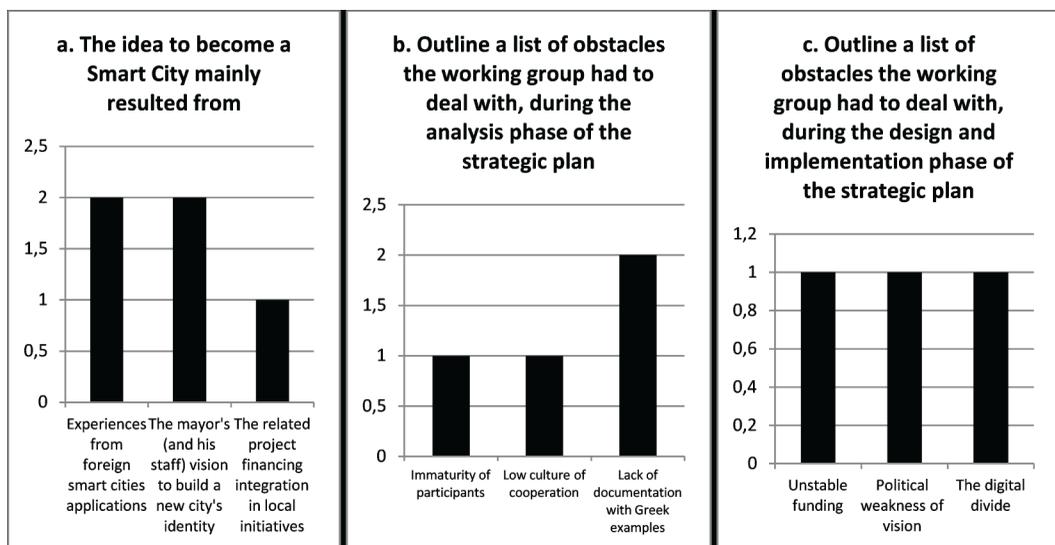


Table 4. Multi criteria evaluation Matrix (an example)

Multi Criteria Decision Making Matrix								
Sector	Urban solution/Urban system	Criterion 1: MUNICIPALITY'S DEGREE OF READINESS	Criterion 2: CITIZEN MATURE GRADE	Criterion 3: APPLICATION MATURE GRADE	Application's Weighting Function	Scenario A Low level of Priority	Scenario B Medium level of Priority	Scenario C High level of Priority
weights		45%	30%	25%	$B1 + B2 + B3$	$A.W.F. = 1 - B$	$1,3 - A.W.F. = < 2,5$	$A.W.F. > 2,5$
Energy	1. Sensors for the city lighting in order to save energy	0,5	0,5	0,4	1,40	*		
	2. Smart stations (charging mobile devices with solar power source)	0,45	0,05	0,1	0,80	*		
	3. Photovoltaic systems (solar panels)	0,45	0,05	0,45	1,35	*		
	4. Smart Foreign Currencies	0,45	0,05	0,25	0,75	*		
Environment	1. Air pollution sensors (CO2, etc.)	0,45	0,5	0,3	1,25	*		
	2. "Smart" bins	0,45	0,5	0,3	1,25	*		
Health Care	1. Telemedicine infrastructure to support vulnerable social groups	0,45	0,75	0,3	1,50	*		
	2. E health Smart Cards	0,2	0	0,3	0,50	*		
	3. Appointments via internet	0,45	0,6	0,45	1,50	*		
Transportation	1. Real time Monitors for arrivals, departures, traffic...	0,45	0,4	0,5	1,35	*		
	2. E-tickets	0,45	0,4	0,35	1,20	*		
	3. E parking	0,45	0,5	0,55	1,50	*		
IT Infrastructure	1. Free Wi-Fi provided in parks in the city	1,05	0,9	0,75	3,00			*
	2. Digital mobile applications (for traffic information, weather, local news)...	1,05	0,9	0,75	3,00			*
	3. Spatial data access	1	0,7	0,45	2,15	*		
	4. Open Data	0,45	0,5	0,25	1,00	*		
Tourism/Culture	1. "Open rank" Application to monitor activities (for informing local citizens/visitors / monuments)	1,05	0,9	0,75	3,00			*
	2. Recording of complaints (visitors)	1,3	0,9	0,75	2,95			*
	3. E-touring	1,33	0,6	0,45	2,40	*		
Water & Waste Management	1. Flow control, pressure distribution and water quality in the city	0,8	0,05	0,3	2,05		*	
	2. Real time water leaks detection	0,8	0,6	0,25	1,75	*		
	3. Smart watering system	0	0	0	0,00	*		
E-Gov	1. e-Forms	1	0,65	0,65	2,30	*		
	2. electronic documents submission	1,35	0,8	0,75	3,00			*
	3. Municipal services electronic payments	1,35	0,65	0,75	2,95			*
	4. Online public consultation (electronic submission (issues and proposals))	1,35	0,9	0,75	3,00			*
	5. Complaints Register	1,35	0,8	0,75	3,00			*
	6. open data	0,45	0,7	0,75	1,90	*		
	7. E voting for city council	0,8	0,8	0,8	2,10	*		
Local Development	4. virtual team	0,8	0,8	0,55	2,35	*		
	1. Available employment opportunities in the local community	0,8	0,8	0,8	2,40	*		
	2. Biospheres & facilities for city residents	1,15	0,60	0,45	2,25	*		
Citizens safety	1. fire alarm system	1,3	0,8	0,3	2,40	*		
	2. Weather alarm sensors	1,05	0,65	0,55	2,25	*		
	3. Monitoring public buildings applications	0,65	0,8	0,3	1,45	*		
	4. online crime reporting system	0,65	0,8	0,8	1,25	*		
	5. electronic emergency incident reporting system	0,8	0,8	0,8	1,50	*		
weights		45%	30%	25%				
Total Urban solution	37				17	12	8	

Multi criteria evaluation matrix classifies 37 smart applications/solutions into three scenarios. Particularly, the final results showed 8 High Priority digital applications, 12 medium priority digital applications and 17 low priority digital applications.

Digital applications included in Scenario C (high priority) are options that the municipality of Samos should plan and implement, thereby achieving directions arising from the citizens' desire, but also on the willingness of municipal officials. Digital applications qualified by priority are electronic services for citizens and applications that support tourism, such as developing informative guidebook.

MODEL MODIFICATIONS FOR USE IN OTHER MEDIUM-SIZED CITIES

This research is based on the belief that medium sized cities can become important as far as production, transport, health, and environmental, etc., concerns. They can meet the demands of the new era and contribute to the development of the country they belong to. However, not all medium-sized cities are the same. Significant economic, physical and cultural differences are identified. There are differences in income, poverty and employment levels.

The model tried to set some principles for the proper development of an effort to prescribe "smart city" actions by a medium sized municipality. This work has been adapted to a medium sized municipality in Greece aiming to become a planning instrument for the design, development and implementation of smart-city interventions. It constitutes a first comprehensive study of residents and visitors needs on issues of digital electronic interventions on the municipality of Samos and identifies the critical issues of the municipality as an organization. By appropriate modifications, the model will provide to another medium sized municipality an analytical toolkit to prioritise interventions in order to map smart city policies and adapt them to the challenges of the new era, to provide integrated digital e-services, improve the lives of residents and visitors and achieve economic and social recovery and sustainable development.

In particular, for the needs of this study, specific criteria-metrics were chosen, which contribute and influence, as the authors believe, the final decision (Figure 2). Specifically, the authors assume that three factors - criteria can influence the choice of the "best smart solution". The importance of each criterion and its influence on the final decision determines its weighting factor. For the purposes of this study, the authors -according to their estimation- matched weighting factors, according to the hierarchy of importance of each criterion. Criteria and especially their weight factors may vary from municipality to municipality. The decision-maker may be differentiated by criteria and/or weight factors. According to the municipality needs, the decision maker must further investigate the factors and criteria that influence the decision-making process.

The authors built a benchmarking table for some specific applications in each sector from the 10 sectors of digital interventions. The aim of the table is to help the decision maker to choose the optimal or optimal applications that best meet the needs of the citizens and visitors of a municipality, combining company reliability and financial elements of digital application.

There is no limitation on the number of available solutions for digital applications, e-services and broadband deployment technologies. The plethora of choices leads the decision maker to choose the right applications to ensure the design and creation of a modern digital city, meeting the needs of the local community and saving resources.

For the purposes of the present study, a proposed list of digital applications and smart actions for Samos was prepared for evaluation. The proposed applications were selected after the bibliographic study of other "smart cities" of Greece and abroad and after the analysis of the results of this research that concern the public opinion as well as the opinion and experience of the executives of the Municipality. Thus, in view of the prevailing applications-actions of various "smart" cities and the proposals of the citizens and the relevant executives of the municipality, a list of 37 proposed solutions for Samos has been compiled, categorized in the 10 areas of digital application development.

The authors believe that this list may vary according to the municipality and continuously add new digital applications, appropriate to the particular municipality.

Figure 14 - in comparison to Figure 1 - indicates the steps that can be modified in the problem structuring method map. The criteria weighting determination and the criteria selection as well may vary according to the municipality. In addition, the list of “smart” applications to be evaluated is not binding, as it may vary according to the desires and needs of the municipality and its citizens.

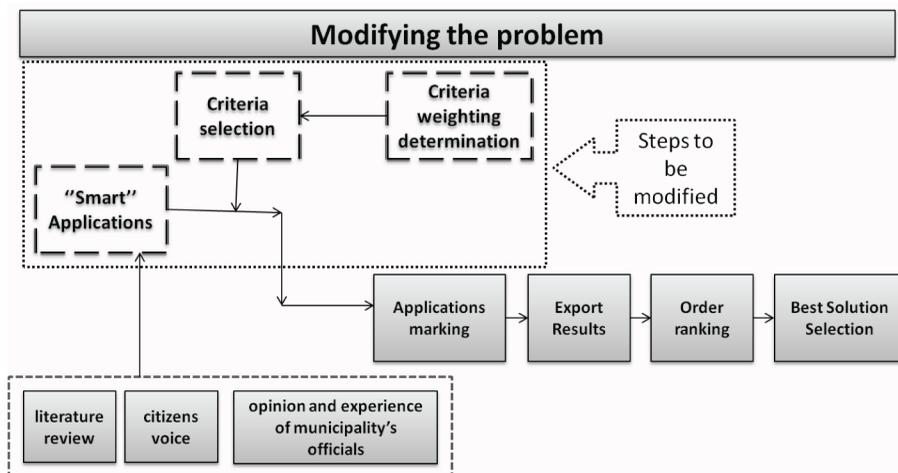
Other cities in Greece where the model of this research could be applied could be some of the many islands of the Aegean Sea as well as cities in northern and central Greece, with a population not exceeding 40,000. At European level, medium-sized cities of European cities could be recipients of the model. As mentioned above, for each country, it is necessary to define and cope with what is meant to be a medium-sized city. However, the model can be applied to any city that has a population of less than half the metropolitan city and lags behind in ICT infrastructure and “smart” applications, but has a vision to become a “leader” in the new digital age. Dumfries in Scotland, Larvik in Norway and Roskilde in Denmark are some examples of medium sized cities in Europe that the authors believe that their model could be a useful toolkit to prioritize “smart” city interventions.

CONCLUSION AND FURTHER RESEARCH

The selection of the best-suited smart interventions for a medium sized municipality is an unexplored but critical issue especially in smaller countries, such as Greece. This paper proposed a model through which a medium-sized municipality can prioritize its needs, taking into account three different parameters: the citizens’ opinion, the organizational, technological and financial status of the municipality and the best practices of other smart cities. Finally, the authors created Multi Criteria Decision Support model for prioritizing interventions. The proposed evaluation matrix tries to set certain principles for evaluating and prioritizing interventions of e smart city.

Through this research, the predominant areas of digital interventions for Samos island were defined. From the application of the multi-criteria decision support model, the integrated provision of digital services to citizens and the development of an information guidebook (with real-time information to the visitor), were the top priorities for the island. Another high priority need was the upgrading of the municipality back-bone information infrastructure (hardware, networking,

Figure 14. Method modifications map



applications). Other areas of proposed interventions were kindergarten management systems, complaints management and personnel training on new information and communication technologies.

A limitation of this study is the poor response of the municipal executives, a result of inadequate training and empowerment, a result also relating to the recent economic crisis in Greece. Moreover, the arrival of numerous immigrants and refugees in the Greek islands over the past two years had an effect upon the local society.

The presented approach can be easily applied, with the proper modifications, in a large variety of cities, offering a very useful tool to decision makers, smart city practitioners and societies. Future research could be conducted to determine the effectiveness of the model and multi-criteria matrix to other Greek and foreign medium sized municipalities.

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