

Defining the Role of the Smart-City Manager: An Analysis of Responsibilities and Skills

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Abstract

The increasing social problems are challenging public administrations to adopt new strategies in order to create smarter cities. With this regard, some cities have created a dedicated organisational unit focused on planning and implementation of Smart City (SC) projects, led by a SC Manager. However, the SC Manager's responsibilities and curricula remain overlooked. The objective of this paper is to theoretically explore the role of the SC Manager in municipalities and to analyse their main responsibilities and skills. Based on an empirical questionnaire administered to public managers and politicians, a Responsibility Index (RI) is defined to identify the domains under the responsibility of the newly role of SC Manager. The questionnaire is also an opportunity for understanding the main required competences and skills through a factor analysis and qualitative investigation of the responses.

Keywords: smart city manager, competences, skills, responsibilities, smart city

1. Introduction

Cities are increasingly exposed to unprecedented challenges that require successful organisational innovations to be solved (Ricciardi and Za, 2014). As a consequence, public administrations have started to implement actions and strategies in order to become smarter, with the aim of improving the quality of life of citizens and stimulating a sustainable and inclusive growth (Dameri and Rosenthal-Sabroux, 2014; Fontana, 2014). However, creating smarter cities is a critical task for several reasons. First, the concept of Smart City (SC) itself is still blurred and at the intersection of different disciplinary areas (Albino et al., 2015; Dewalska–Opitek, 2014). Second, strategies to execute and manage SC projects vary among cities and organisational and managerial research in this field is scarce. Indeed, SC research has been developed primarily in architecture and social sciences arenas as well as in engineering and computer science, while it has been poorly the focus of managerial debates (Ricciardi and Za, 2014).

Some cities have started creating departments dedicated to the development and implementation of the SC plans, led by the SC Manager. However, this phenomenon largely remains disregarded. Conversely, it is relevant for several reasons: firstly, understanding the responsibilities carried out by this new managerial role is necessary to support the organization of SC departments; secondly, the identification of the required competences is relevant for the selection of the curricula; lastly, understanding competences and responsibilities is preliminary to the definition of the educational contents for training the future SC Managers.

This paper examines the emerging role of the SC Manager, by analysing their responsibilities and competences. It is exploratory in nature and is based on a survey administered to city managers and politicians of Italian cities.

The paper is structured as follows. First, authors introduce the debate around the SC

concept and the academic literature related to the competences of city managers (Section 2). After the methodological section (Section 3), authors illustrate the empirical results (Section 4), discuss them (Section 5) and make some final considerations (Section 6).

2. State of the art

There have been several attempts to define the concept of SC and identify its core components. However, a common definition of SC is still missing (Albino et al., 2015). Moreover, authors underline that the integration of infrastructures and technology services is not sufficient for a city to be claimed as smart, but the strengthening of the city management and governance for institutional improvement are also key ingredients (Nam and Pardo, 2011). However, since now researchers have been focused more on the technological aspects of SC rather than on the organisational and managerial ones. Indeed, even if some authors affirm that SC initiatives can require the reorganisation of the city management, its characteristics are still overlooked (Ricciardi and Za, 2014).

Therefore, the pertinent literature is organized in the following two subsections. First, authors present the debate pertaining to the SC arena, with a special attention on the dimensions and domains of SCs. In the second part, authors focus on the use of cross-functional organisations to carry out SC initiatives and on the role of public managers and their characteristics.

2.1 SC: goals and application domains

Cities are being exposed to unprecedented rapid growth. According to the United Nations (2014) (UN), 54 percent of the world's population currently lives in urban areas, while it was only 30 percent in 1960, and it is expected to grow up to 66 percent by 2050. Asia and Africa, today mostly rural, are expected to urbanize during the next coming years, but also Northern America, Latin America and Europe where more than 70 per cent of the population already

live in cities. The revision of this report released in 2015 figures out that world population is growing rapidly, it is currently 7,3 billion and it is expected to reach 9,7 billion in 2050. Given this dramatic growth, cities around the world are facing an increasing number of both environmental problems, such as air and water pollution and ecosystem alteration, economic risks, such as the increasing unemployment rate (Nam and Pardo, 2011; Caragliuet al., 2011; Toppeta 2010) and social challenges such as immigration flows (Huston et al., 2015; Caulier-Grice et al., 2012). In recent years, some cities started developing smarter practices in order to improve the quality of living and overcome the problems of urbanization (Nam and Pardo, 2011) by means of creativity, human capital and bright scientific ideas, also encouraged by European policies (Caragliu et al., 2011). Indeed, in 2011 the European Commission launched the “Smart Cities and Community Initiative”, an investment of more than €80millions with the aim to support sustainability objectives in urban development (Papa et al., 2013). More recently, the European Regions have been invited to define their “Smart Specialization Strategy”, identifying their competitive advantages, technological instruments, and financial resources to support innovation in their cities. Finally, in the perspective of the new framework programme Horizon2020, the European Commission has launched the “Smart Cities and Communities European Innovation Partnership”, with the objective of stimulating a multi-stakeholder approach to the emerging challenges in the sectors of energy, transport and ICT (Papa et al., 2013; European Commission, 2012).

The main objective of SCs has been defined as the improvement of global competitiveness, sustainability, empowerment and quality of life (Komninos et al., 2011). The underlying assumption is that people deserve to live in places where smart policies are able to assure a better quality of work, study, and living (Toppeta, 2010). Thus, a city can be defined “smart” when “investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of

life, with a wise management of natural resources, through participatory government” (Caragliu et al., 2011, p.70). In other words, cities are smart when the city government has the ability to optimize the exploitation of both tangible and intangible assets, enhance the citizens’ quality of life, boost resources’ productivity, and solve emerging problems (Komminos et al., 2013; Shaffers et al., 2011).

Two main research streams can be subsumed from the literature regarding the definition of SC and its domains of application. The first stream of research is technology-centered and focuses on application domains that are heavily based on modern ICT, such as energy, public transport, and waste and water management. Cities that make investments in tangible assets have become fertile environments for Future Internet researches, offering a wide set of application domains (Komminos et al., 2013), such as broadband connectivity, smart devices, sensors and applications, or what is generally defined as Internet of Things (Hernandez-Muñoz et al., 2011; Sanchez et al., 2011; Su et al., 2011) that work together to become the nervous system of a city that senses and acts (Neirotti et al., 2014; Hernandez-Muñoz et al., 2011). The second stream of research is more people-centered because, even if technology and infrastructures are still important as enabling factors to reach soft objectives, it focuses especially on soft domains such as welfare, social inclusion, culture, and human capital (Caragliu et al., 2011; Toppeta, 2010). In these fields smart city plans are characterized by a more bottom-up approach, where through new forms of collaboration and participatory governance (Leydesdorff and Deakin, 2011) the analysis of people’s needs and the definition of social objectives drive the selection of specific enabling technologies. In this case, public administrations use ICT as a tool to group people together and stimulate innovation, knowledge, problem solving and, more in general, economic growth (Caragliu et al., 2011; Hollands, 2008).

Neirotti et al. (2014), moving from Giffinger et al. (2007), propose a classification of the SC application domains based on the degree of importance of ICT as an enabling factor for the development of projects. They identify six main domains of application: natural resources and energy, transport and mobility, buildings, living, government, and economy and people. For each of these domains, they identify additional sub-domains, in order to give a more detailed examination on the different areas that branch from the main fields. This framework is presented in Table 1.

Please, put here Table 1

2.2 Exploring competencies in managing SC efforts

The planning effort to create a smarter urban environment is multi-sectorial, interorganisational and intergovernmental (Alawadhi et al., 2012; Nam and Pardo, 2011). In order to develop an effective SC plan, it is necessary to bring together people from different backgrounds and with different skills and competencies. Many authors think that cross-functional teams answer this necessity (Piercy et al., 2013; Mohamed et al., 2004; Sarin and McDermott, 2003): teams composed by individuals from different departments brought together (Sarin and McDermott, 2003) to complete a project out of organisational rigidity and labour division, which is typical in the public sector (Piercy et al., 2013). Cross-organizational and interdisciplinary teams are the solution in case of integrated plans oriented to a variety of social groups, affected by the problems of shared resources, decreasing budgets and scarce profit prospects, as in the case of SC projects (Piercy et al., 2013; Nam and Padro, 2011). Thus, cities have started creating dedicated SC departments led by a SC Manager. However, several challenges still exist: external pressure for a dual focus both on project delivery and quality, pressure to handle data of different quality and standard smoothly integrated in an information system, pressure from scattered resources and the necessity of a project oriented approach while maintaining functional authority levels, interdepartmental

communication and collaboration (Alawadhi et al., 2012; Kuprenas, 2003). In such contexts a lateral, horizontal authority is considered better than the traditional vertical hierarchy (Alawadhi et al., 2012). Indeed, top management in public organisations is essential in promoting cross-functional integration (Piercy et al., 2013), since their involvement increases motivation, performance, vision, and inspiration in leading innovation initiatives and in championing change actions (Swink, 2003; Harman et al., 2002).

The relationship between public managers and citizens is also an important component to define the role of the management in leading SC initiatives. With this regard, Corrigan and Joyce (1997) discuss the right of the citizens to be included in the decision making process of their municipalities: public managers' interaction with the society is essential for the creation of effective services focused on the community. Also Nalbandian et al. (2013) argue that the link between public managers and the community facilitates the partnership among sectors, groups and individuals. Nalbandian et al. (2013) pinpoint three challenges for public managers in order to identify what is administratively sustainable and political acceptable: to create and enforce a chain of responsibility that needs to avoid political alignment; to synchronize jurisdiction and other forms of external authority with the problem to be solved; the need of citizen's integration in the local government and administrative structures.

Virtanen (2000) focuses more on the competencies of public managers and identifies five areas, namely: *Task competence*, that is the performance and goals given by the task and how and why the task has to be accomplished; *Professional competence in the work area*, the competences of the manager on the subject area; *Professional competence in the administration*, control of the policy program and cooperation; *Political competence*, about values, ideology and power; and *Ethical competence*, which refers to moral values and norms. However, Noordegraaf (2000) has argued that public managers are competent in those situations in which they know how to apply the rules. On the contrary, in more ambiguous

situations, such as the SC arena, characterized by uncertainty and unclear impact, they do not act according to the best option to do, but to the most appropriate. In these situations they have to interpret signals and events, institutionalize issues through labels and meetings and establish political back up.

The available literature about public management is vast, while considerably less extensive is the literature about competences required to public managers who act in a specific environment, characterized by ambiguity and novelty, such as the SC arena.

In order to contribute to fill the lack of research, the aim of this study is to define the domains that should be under the SC Managers' responsibility and to understand their competencies in order to lead SC projects. To this end, this work is grounded on the taxonomy by Neirotti et al. (2014), since it is a thorough and comprehensive classification of SC domains and sub-domains in scientific literature.

3. Methodology

This paper illustrates an empirical analysis of the responses obtained from an online questionnaire administered to 4,620 Italian SC Managers, with a response rate of 5.15 percent. In order to make sure that the survey respondents are a representative panel of public city managers from those cities that are running SC programs and projects, the authors have considered two aspects. Firstly, to control the city dimension, they created a mailing list that only includes the public managers from the two largest cities in every Italian region, as presented in Table 2(ISTAT, 2014).

Please, put here Table 2

Secondly, to control that these cities are managing SC projects and, in turn, that respondents are aware of SC concepts, authors have verified the implementation of SC programs and projects through their official websites and the website of the Italian Smart City Observatory (<http://osservatoriosmartcity.it>).

Also, as a consequence of the unexpected low response rate, authors have verified the absence of bias in the sample and that the obtained responses are still a random significant sample. More than 90 percent of respondents are mainly from cities located in northern and central Italy. In order to verify if it could bias the analysis, authors accessed the report “ICity Rate” (ForumPA, 2014), a national ranking developed by the Observatory ForumPA, that yearly lists the smartest cities in Italy. According to this report, southern Italian cities are notably behind schedule in implementing SC initiatives compared to the other regions. As a consequence, SC programs/projects are sporadic and southern cities lie still in the lower part of the ranking. Thus, our sample reflects the national bias and only the public managers of those cities in which SC initiatives are systematically conducted answered our questionnaire. Finally, the authors had the opportunity to administer the questionnaire in person to 28 politicians who attended the master course in “Management of Smart Cities” delivered at the Politecnico di Torino University. Thus, the total number of analysed respondents is 266.

To increase the interests of informants in answering the questionnaire, an invitation letter was sent, explaining the goal of this research and announcing that a feedback would have been distributed among participants. Moreover, the expected time to fill in the questionnaire and the anonymity of data were declared at the beginning.

Data were collected through a detailed seven-pages survey. Personal details, such as age, gender and professional role were first asked. Then, the taxonomy given in Table 1 was displayed and, for each SC domain, respondents were asked:

- Is your city investing in this domain? (Q1)
- Do you think that this domain should be under the responsibility of a manager in charge of the SC development? (Q2)

Lastly, a third question (Q3), divided into a set of 24 sub-questions, was asked about the competences needed by the SC Manager. This set of questions was drawn empirically by analysing the educational contents of the master courses on SC offered by the Italian

universities. Six postgraduate courses were found to be delivered at various Italian universities over the last three years, with educational contents listed in Table 3.

Please, put here Table 3

The resulting 24 sub-questions about the importance of competences and skills of SC Managers are listed in Appendix 1. The questionnaire ended with an open question where respondents were asked to note down any other suggested competences of the SC Manager that were not considered by the authors. This allows including in the analysis some other competences not listed in the questionnaire and gathering comments.

Before starting the data gathering process, the authors validated the questionnaire with two professors of the Departments of Management of their university, in order to test its comprehensiveness and clarity. The authors received some interesting comments, especially regarding the wording used in the questionnaire. They drew on these suggestions and decided to attach a short glossary to the questionnaire. Indeed, since SC is still a recent issue and similar terms are usually interchangeably (Albino et al., 2015), each SC domain and sub-domain cited in the questionnaire was briefly described in order to explain the meaning of some SC key words and concepts. The authors used an interval scale with five categories, with 1 that stays for negative/minimum and 5 for positive/maximum. Data were entered into a database, coding dummy variables, such as in the case of the gender where male/female was translated into a 0/1 variable. Missing data were replaced with the average value obtained from the answers. Indeed, authors supposed that non-respondents would have answered as the mean respondent.

Computations were performed using the STATA statistic software tool.

Before analysing the results, the exploratory statistics are given in Table 4.

Please, put here Table 4

4. Results

4.1 SC Manager's responsibilities

The responses to Q2 about the responsibilities of SC Managers were first analysed. As anticipated, Q2 relies on the SC domain taxonomy introduced by Neirotti et al. (2014) that identifies *hard* and *soft* domains that should be under the responsibility of the SC Manager. In order to match with the approach used by Neirotti et al. (2014), authors calculated a Responsibility Index (RI). Firstly, the authors calculated the RI on sub-domains RI_{is} : they assigned 1 if the respondent i valued the sub-domain s under the responsibility of the SC Manager with a score greater or equal than 3, otherwise a 0 was given with a score less than 3. After that, they calculated the RI by sub-domains (RIs), as the sum, for respondent i , of the RI_{is} , over the total number of respondents. As shown in Figure 1 the RIs are high for every sub-domain: this means that more than a half of the respondents indicated that the SC Manager is responsible for that sub-domain.

Please, put here Figure 1

In order to identify the domains under the responsibility of the SC Manager, authors aggregated the sub-domains in six domains, according to the conceptual framework drawn by Neirotti et al. (2014), namely: natural resources and energy, transport and mobility, buildings, living, government, economy and people. Thus, they calculated the RI of each domain (RI_{id}): for each respondent, authors assigned 1 to the domain if every RI_{is} of the corresponding subdomain was equal to 1, 0 otherwise. The mean and standard deviation of RI of the six domains are presented in Table 5. In general, they result to be high. It means that the SC Managers do not operate exclusively in any individual domain, but they overcome the boundaries of silos and are responsible for projects in both the hard and soft domains of the SC. Thus, although several SC efforts are still developing into silos, the management of SC initiative spans the vertical boundaries of SC domains.

Please, put here Table 5

This finding is also confirmed by the calculation of a total RI, obtained as the sum of RI_{id} for each respondent. It formally represents the number of domains that are under the responsibility of the SC Manager: 76 percent of respondents considered that the SC Manager is responsible for at least four or more SC domains, while only 24 percent considered that the SC Manager is responsible for projects in just three or less domains.

Authors also investigated the differences between respondents belonging to diverse professional categories, as well as between managers and politicians. They grouped managers into 11 clusters, according to the area of their job position, namely: Administration, Culture and Education, Environment, Finance, ICT, Innovation, Mobility and Infrastructure, Production, SC, Social policies, and Urban planning. No relevant differences emerged between the respondents of these various functional areas. Authors also compared the responses given by manager with those by politicians: while according to the managers more than four are the average domains under the responsibility of a SC manager, politicians listed less than four. Specifically, the Living and Government domains were indicated to be considered under the control of the SC manager by only 33 percent and 50 percent of politicians respectively.

4.2 SC Manager's competences

In order to understand the high-level competencies required by the SC Manager, authors performed an exploratory factor analysis on the results of Q3. Indeed, exploratory factor analysis is used to identify a set of unobserved factors and reconstruct the complexity of observed data in an essential form, when researchers have little ideas about the underlying mechanisms of the observed phenomenon (Matsunaga, 2010). Table 6 shows some statistics on responses to Q3. The rotated solution obtained by the factor analysis identifies five factors, displayed in Table 7.

Please, put here Table 6

Please, put here Table 7

The first factor includes technical skills, management of innovation and territorial planning in urban contexts and includes Q3.3, Q3.10, Q3.11, and Q3.12. The second factor is related to the knowledge of private and public laws about procurement, innovation management, public-private partnership, and open data (Q3.4, Q3.5, Q3.6, Q3.7, and Q3.8). The third factor concerns more soft skills (Q3.16, Q3.17, Q3.18, and Q3.19). The fourth factor is related to financial tools and economic principles (Q3.13, Q3.14 Q3.20), while the last one pertains to general management basic skills that are likely to be required in every curriculum (Q3.22, Q3.23, and Q3.24). Finally, authors calculated the overall Kaiser's Measure of Sampling Adequacy (MSA) to verify partial correlation between variables. It resulted greater than 0.85, and MSA of each single variable that was greater than 0.76 in each case, which means that variables are not problematic in terms of partial correlation and factor analysis is applicable (Rasli, 2006).

During the analysis, authors decided to drop five variables that did not have any high weight on any factor: Q3.1, Q3.2, Q3.9, Q3.15, and Q3.21, and also because it increased the Cronbach's Alpha of constructs. The reliability of the final constructs was verified with Cronbach's Alpha¹. It resulted 0.8335 for the first construct, 0.8226 for the second one, 0.7789 for the third one, 0.7062 for the fourth one, and 0.6444 for the last one.

5. Discussion and limitations of results: the profile of the SC Manager

The results of this analysis help to elaborate some relevant considerations. Firstly, while in some cases SC efforts still appear to be vertically planned, this work shows that the SC Manager encompasses these silos, and operates as a horizontal actor, with responsibilities on

¹ Cronbach's Alpha coefficient is a measure of internal consistency reliability (Osborne, 2008) and is useful to verify if each factor effectively corresponds to a unique construct or not. It is a number between 0 and 1 and usually it is considered sufficient if > 0.6.

projects developed in both hard and soft domains. This result is coherent with the requirement of a multi-sectorial governance of SC initiatives (Alawadhi et al., 2012), through roles that have an intersectional and more general view on the public management process. Thus, cities have started opening SC Manager positions, for managerial roles with a strategic vision, knowledge and responsibilities that cross several SC domains. Interestingly, if these findings are compared with the investments that cities are doing in each sub-domain (Q1), it emerges that cities are still under-investing in SC projects. Thus the SC Manager is a job that has cross-sectoral responsibilities on projects with limited budget. This finding is coherent with the economic crisis in most countries and the consequent policies driving consistent public spending reviews. In most European countries, public budget cuts, together with the Stability Pact and high level of debt of local governments, limit the amount of money that each city can invest, with effect also on SC projects.

The comparative analysis between politicians and managers revealed some further interesting insights with specific regard to the exclusion of the Living and Government domains out of the responsibilities of the SC Manager according to the opinion of most politicians. In particular, the Living domain is considered to be at the cross-road between hard and soft domains, thus some sub-domains such as Entertainment, Hospitality, Welfare, Culture, Public Space Management are usually managed by special public divisions, such as Social Policies or Tourism, and politics consider them outside the SC perimeter. Also, the Government domain encompasses the sub-domains related to transparency and e-democracy, that can be perceived by politicians as their own instruments instead of a prerogative of the managerial board.

The factor analysis gives an interesting insight on the expertise required to a SC Manager. Specifically, the analysis reveals five main categories of required skills. First, *city planning capabilities*: these pertain to urban innovation and, more in general, territorial

planning and management of urban facilities. It takes into consideration those skills linked to the elaboration of a strategic, long term planning for sustainable urban services.

Second, *legal competences* that encompass the legal notions regarding big data/open data management, data security, legal aspects of public procurement, and the contractual issues involved in public-private partnerships.

Third, *soft skills* that refers to personal attitudes such as empathy, flexibility, output oriented and open-mind behaviours, the ability to mediate conflicts and create relationships, strategic vision, project management attitudes and leadership capacity. All these aspects are also highlighted by other authors, such as Virtanen (2000), Müller and Turner (2010), and Nalbandian et al. (2013). The analysis also reveals the importance of *financial resources management*, which consist of instruments of public financing, new financial instruments such as crowd-funding and social impact bonds, and a more general knowledge of economic fundamentals.

Finally, the SC Manager is required to demonstrate some *basic capacities*, that are usually part of every general management curriculum: familiarity with ICT, knowledge of foreign languages, and past professional experiences, that are more and more compulsory not only for managerial positions, but also for an even larger number of professionals.

This multidisciplinary attitude of the SC Manager is also underlined by the open answers given by some respondents, such as “*transversality of competences*”, “*a non-hierarchical vision*” and, in general, by more detailed comments that listed a mix of competences that are in line with the five categories of skills obtained from the empirical analysis.

Furthermore, two other relevant elements emerge from these comments. A first group of respondents wrote that “*dissemination, comprehension and sharing of SC policies with citizens*”, “*capacity of communication toward stakeholders*”, “*a good communicative capability toward both internal and external people*” are other competences that the SC

Manager should have. Thus, communication appears another needful capability that can be considered within the scope of the *soft skills*.

A second group of respondents highlighted the need for the SC Manager to be politically independent, with comments like: “*he has not to be linked to any political party*”, “*he has to have independence of judgement*”, “*managerial autonomy from lobbies and politics*”, “*good autonomy from politics*”, “*he has to be super partes²*”. Thus, the SC Manager results to be a role with horizontal responsibilities and the capacities to pursue SC objectives even with restricted financial resources, with five types of competencies and should be, as some respondents commented, “*politically honest*”. However, the requirement of a political honesty is particularly arduous in a context in which a clear separation between politicians and city managers is difficult to achieve, while reciprocal integration or confusion is prevalent (Liguori et al., 2009). As a consequence, being politically honest appears a difficult task when public managers are as caged leaders, due to political pressure (Sancino et al., 2014).

This analysis has some limitations: firstly, the response rate is considerably low, given the fact that the southern regions of Italy are behind schedule in developing SC initiatives (ForumPA, 2014). However, results give useful insights for further, more extensive research. Secondly, the analysis does not consider the potential impact of the award of European funds as an important external factor that can influence the type of skills and responsibilities of a SC Manager. Indeed, the SC phenomenon has been substantially fostered by European policies and funds (Papa et al., 2013; European Commission, 2012; Caragliu et al., 2011), thus conditioning the selection of the main SC domains where to focus the efforts and develop SC projects and, thus, the competences and responsibilities required to a SC Manager.

² The Latin expression “*super partes*” is typical in the Italian spoken language and means “*neutral*”, “*impartial*”, “*independent third part*”. Given the common use of this term, authors decided not to translate it when they quoted the respondents’ comments.

However, this issue did not emerge from the open questions of the questionnaire. Moreover, from an analysis of the websites of the cities involved in the survey, it seems that a U-turn is underway. Indeed, cities have been started creating their paths toward the creation of SC by setting their strategic objectives as part of elaborated strategic development plans. As a consequence, most cities seek to raise funds through a careful selection of those EU calls and funding opportunities that are in line with their predetermined priorities. The sense of this causal relationship opens potential avenues for further empirical research.

6. Summary and Conclusions

This work is a contribution toward the theorization of the SC Manager role, responsibilities and competencies. Indeed, in recent years, some cities are organizing themselves and establishing specific roles in order to manage SC initiatives and projects. The academic debate has largely discussed the topics of SC and public management, but separately. This paper aims to integrate the twofold areas of research and to help understand and build the cross-functional responsibilities and integrated competences required to the SC Manager. Three main considerations emerge. First, the SC Manager is a horizontal role responsible for leading SC projects in different vertical domains, even if SC Managers have a limited budget for investments. However, by analysing separately the responses of politicians and managers, some differences arise: for politicians, the SC Manager is less responsible for living and e-government initiatives than the opinions of public managers suggest.

Then, five are the main competencies required to a SC Manager: city planning capabilities, legal competencies, soft skills, financial resource management, and basic requirements. Finally, a SC Manager should be politically honest.

These findings have some theoretical and practical implications. First, the role of a public manager whose responsibilities encompass the vertical organization can be a way to integrate and coordinate different SC initiatives under the same strategic vision. Moreover,

these findings are also useful for the construction of the right system of political mandates, necessary to set a horizontal governance of SC domains. Furthermore, the identification of SC Manager's competencies is helpful for the selection of the right curricula for this role. Nevertheless, identifying SC Manger's responsibilities and competences is important to understand the educational needs and set the educational contents of postgraduate and executive courses delivered to public managers of SCs.

From a more theoretical point of view, this paper offers some interesting insights about the SC topic from a managerial perspective, thus contributing to define the concept and the role of a manager dedicated to SC initiatives and opening a stream of research at the crossroads between the SC arena and at the intersection between behavioural and organisation management sciences. Finally, this paper opens paths for further research on the potential impact of external factors on the role of SC manager, such as the availability, nature and domains of European research and development funds.

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Annex 1:

List of questions about SC manager's competences:

- Q3.1) Policies and tools for the management of innovation, research and development
- Q3.2) General concepts about SC, vision and strategic planning
- Q3.3) Urban planning: sharing and participation tools, management and communication of urban planning processes
- Q3.4) Notions about open data, big data and their associated applications for SCs
- Q3.5) Legal and administrative principles of procurement and models for the application of pre-commercial procurement
- Q3.6) Legal aspects for data management, open data, big data, principle of reuse of public IT applications and security of sensitive data
- Q3.7) Legal and contractual tools for the promotion of innovation in public administration, and for the relationship with private technology vendors
- Q3.8) Legal tools for the application of public-private partnerships for the implementation of SC projects
- Q3.9) European funds for innovation, research and development, structural funds, national and regional funds, Horizon2020 framework program
- Q3.10) Notion about strategies, policies, and initiatives for green buildings
- Q3.11) Policies and projects for energy efficiency
- Q3.12) Elements of planning and management of public spaces
- Q3.13) Finance for public-private partnerships and project finance, elements of economic-financial planning, covenant, profitability and bankability indexes, instruments of risks assessment
- Q3.14) New financing schemes for innovative start-ups and SC projects: basics, economic principles, incentives, legal principles of crowdfunding and social impact bonds
- Q3.15) Fundamentals of project management
- Q3.16) General management skills
- Q3.17) Relationship and mediation skills
- Q3.18) Leadership

Q3.19) Personality

Q3.20) Fundamentals in economics, finance and public accounting

Q3.21) Notions of strategy

Q3.22) Familiarity with ICT systems

Q3.23) Knowledge of foreign languages

Q3.24) Professional experience

Domain	Sub-domain	Description
Natural resources and energy	Smart grids	Electricity networks able to take into account the behaviours of all the connected users in order to efficiently deliver sustainable, economic, and secure electricity supplies. Smart grids should be self-healing and resilient to system anomalies
	Public lighting	Illumination of public spaces with street lamps that offer different functions, such as air pollution control and Wi-Fi connectivity. Centralised management systems that directly communicate with the lampposts can allow reducing maintenance and operating costs, analysing real-time information about weather conditions, and consequently regulating the intensity of light by means of LED technology
	Green/renewable energies	Exploiting natural resources that are regenerative or inexhaustible, such as heat, water, and wind power
	Waste management	Collecting, recycling, and disposing waste in ways that prevent the negative effects of an incorrect waste management on both people and the environment
	Water management	Analysing and managing the quantity and quality of water throughout the phases of the hydrological cycle and in particular when water is used for agricultural, municipal, and industrial purposes
	Food and agriculture	Wireless sensor networks to manage crop cultivation and know the conditions in which plants are growing. By combining humidity, temperature, and light sensors the risk of frost can be reduced and possible plant diseases or watering requirements based on soil humidity can be detected
Transport and mobility	City logistics	Improving logistics flows in cities by effectively integrating business needs with traffic conditions, geographical, and environmental issues
	Info-mobility	Distributing and using selected dynamic and multi-modal information, both pre-trip and, more importantly, on-trip, with the aim of improving traffic and transport efficiency as well as assuring a high quality travel experience Innovative and sustainable ways to provide the transport of people in cities, such as the development of public transport modes and vehicles based on environmental-friendly fuels and propulsion systems, supported by advanced technologies and proactive citizens' behaviours
	People mobility	Innovative and sustainable ways to provide the transport of people in cities, such as the development of public transport modes and vehicles based on environmental-friendly fuels and propulsion systems, supported by advanced technologies and proactive citizens' behaviours
Buildings	Facility management Building services	Cleaning, maintenance, property, leasing, technology, and operating modes associated with facilities in urban areas Various systems existing in a building such as electric networks, elevators, fire safety, telecommunication, data processing, and water supply systems. Computer-based systems to control the electrical and mechanical equipment of a building
	Housing quality	Aspects related to the quality of life in a residential building such as comfort, lighting, and Heating, Ventilation and Air Conditioning (HVAC). It includes all that concerns the level of satisfaction of people living in a house
Living	Entertainment	Ways of stimulating tourism and providing information about entertainment events and proposals for free time and night life
	Hospitality	Ability of a city to accommodate foreign students, tourists, and other non-resident people by offering appropriate solutions to their needs
	Pollution control	Controlling emissions and effluents by using different kinds of devices. Stimulating decisions to improve the quality of air, water, and the environment in general
	Public safety	Protecting citizens and their possessions through the active

		involvement of local public organisations, the police force, and the citizens themselves. Collecting and monitoring information for crime prevention
	Healthcare	Prevention, diagnosis, and treatment of disease supported by ICT. Assuring efficient facilities and services in the healthcare system
	Welfare and social inclusion	Improving the quality of life by stimulating social learning and participation, with particular reference to specific categories of citizens such as the elder and disabled
	Culture	Facilitating the diffusion of information about cultural activities and motivating people to be involved in them Care, maintenance, and active management of public spaces to improve the attractiveness of a city. Solutions to provide information about the main places to visit in a city
	Public spaces management	Care, maintenance, and active management of public spaces to improve the attractiveness of a city. Solutions to provide information about the main places to visit in a city
Government	E-government	Digitizing the public administration by managing documents and procedures through ICT tools in order to optimise work and offer fast and new services to citizens
	E-democracy	Using innovative ICT systems to support ballots
	Procurement	Allowing the public sector improving procurement procedures and the associated contract management, with the purpose of assuring best value for money without decreasing quality
	Transparency	Enabling every citizen to access official documents in a simple way and to take part in the decision processes of a municipality. Decreasing the possibility for authorities of abusing the system for their own interests or hiding relevant information
Economy and people	Innovation and entrepreneurship	Measures to foster the innovation systems and entrepreneurship in the urban ecosystem (e.g. presence of local incubators)
	Cultural heritage management	The use of ICT systems (e.g. augmented reality technologies) for delivering new customer experience in enjoying the city's cultural heritage. Use of asset management information systems to handle the maintenance of historical buildings
	Digital Education	Extensive Use of modern ICT tools (e.g. interactive whiteboards, e-learning systems) in public schools
	Human capital management	Policies to improve human capital investments and attract and retain new talents, avoiding human capital flight (brain drain)

Table 1: The taxonomy of the SC, domains and sub-domains. *Source: Neirotti et al., 2014.*

Region	Area	Municipality	Inhabitants
Abruzzo	Centre	Pescara	121448
		L'Aquila	70 314
Basilicata	South	Potenza	67332
		Matera	60 419
Calabria	South	Reggio Calabria	184 603
		Catanzaro	90897
Campania	South	Napoli	989723
		Salerno	133 336
Emilia-Romagna	Centre	Bologna	385715
		Modena	185 239
Friuli-Venezia Giulia	North	Trieste	205523
		Udine	99 458
Lazio	Centre	Roma	2 872361
		Latina	125311
Liguria	North	Genova	593 253
		La Spezia	94215
Lombardia	North	Milano	1 334404
		Brescia	195 272
Marche	Centre	Ancona	101 462
		Pesaro	94 693
Molise	South	Campobasso	49161
		Isernia	22008
Piemonte	Nord	Torino	897513
		Novara	104 500
Puglia	South	Bari	321 223
		Taranto	202 175
Sardegna	South	Cagliari	154 522
		Sassari	127 591
Sicilia	South	Palermo	678 492
		Catania	315 576
Toscana	Centre	Firenze	377 207
		Prato	191 628
Trentino-Alto Adige	North	Trento	117 285
		Bolzano	105 713
Umbria	South	Perugia	166 030
		Terni	112 227
Valle d'Aosta	North	Aosta	34 901
Veneto	North	Venezia	264 534
		Verona	259 966

Table 2: Cities considered for the database. *Source: ISTAT, 2014, online database at http://dati.istat.it/Index.aspx?DataSetCode=DCIS_POPRES1#*

University	Master	Didactical contents	Source
University of Pisa	Second level master in “Smart Cities”	<ul style="list-style-type: none"> - ICT, Programming, cloud computing and internet of things - Smart living 	http://www2.ing.unipi.it/smart-cities/attivita.html
University of Venezia	Second level master “Smart City_LAB”	<ul style="list-style-type: none"> - Smart economy - Smart mobility - Smart environment - Smart people; smart living - Smart governance 	http://www.ricercasit.it/mastersmartcity/Content.aspx?page=2
University of Firenze	Second level master “Designing the Smart City”	<ul style="list-style-type: none"> - Principles and notions of urban planning - Models of urban development - Mobility - Environment - Public spaces - Co-design - Public-private partnership and management - Governance 	http://www.dida.unifi.it/vp-168-smart-city.html
University of Roma Tor Vergata	Master in “Design of people centered Smart City”	<ul style="list-style-type: none"> - New public management - Governance - Empirical cases and experiences - Co-design - Mobility - Smart living and people 	http://www.mifav.uniroma2.it/inevent/events/pcst_master/index.php?s=186&a=322
Scuola Superiore Sant’Anna di Pisa	Second level master “Smart Solutions - Smart Communities (SSSC)”	<ul style="list-style-type: none"> - Vision - Context - Technology - Management - Case studies 	http://www.sssup.it/sssc
Polytechnic of Turin	Master in “Management of Smart Cities”	<ul style="list-style-type: none"> - Strategic vision and planning - Organization and management - Domains and applications - Legal fundamentals - Finance 	https://didattica.polito.it/master/smart-cities/organizzazione_e_docenza_del_corso

Table 3: Didactical contents of SC masters offered by Italian universities

Age distribution						
	18-25	26-35	36-45	46-55	56-65	65+
Number of observation	3	31	48	111	73	0
Percentage	1%	12%	18%	42%	27%	0%
Gender distribution						
	Male			Female		
Number of observation	142			124		
Percentage	53%			47%		
Profession distribution						
	Politician			Public Manager		
Number of observation	28			238		
Percentage	10,5%			89,5%		
Geographical Distribution						
	North		Centre		South	
Percentage	83%		15,12%		1,88%	

Table 4: Demographic distribution of survey respondents

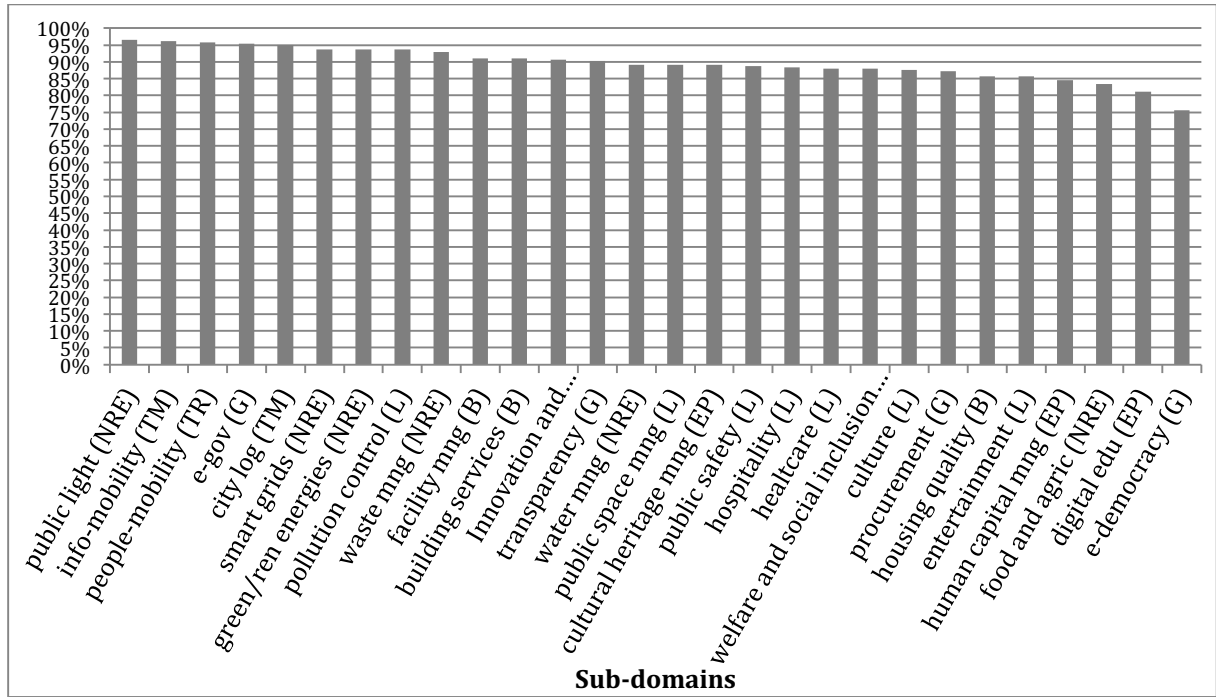


Figure 1: RI_s index by sub-domains

	Mean	Standard Deviation
Natural resources and energy	0,778	0,416
Transport and mobility	0,932	0,252
Buildings	0,805	0,397
Living	0,718	0,451
Government	0,703	0,458
Economy and people	0,729	0,445

Table 5: Descriptive statistics of RI_d index for each domain

Domain	Average	St. dev.
Q3.1	4,117	0,774
Q3.2	4,395	0,745
Q3.3	4,034	0,894
Q3.4	3,921	0,852
Q3.5	3,767	0,883
Q3.6	3,805	0,905
Q3.7	3,940	0,820
Q3.8	4,071	0,822
Q3.9	4,474	0,661
Q3.10	4,034	0,927
Q3.11	3,970	0,901
Q3.12	3,917	0,926
Q3.13	3,831	0,874
Q3.14	4,037	0,862
Q3.15	4,105	0,861
Q3.16	4,470	0,776
Q3.17	4,556	0,665
Q3.18	4,395	0,831
Q3.19	4,289	0,767
Q3.20	4,007	0,756
Q3.21	4,116	0,812
Q3.22	4,109	0,745
Q3.23	4,177	0,820
Q3.24	4,131	0,786

Table 6: Descriptive statistics of question Q3

	Variable	Factor1	Factor2	Factor3	Factor4	Factor5
Q3.3	Urban Planning	0.6723	0.3152	0.0813	-0.0697	0.1099
Q3.4	Open and Big Data	0.0283	0.6048	0.0791	0.2871	0.1599
Q3.5	Principles of procurement and pre-commercial procurement	0.2531	0.6378	0.0756	0.3541	0.0827
Q3.6	Regulation about open and big data	0.1781	0.7840	0.0372	0.2220	0.1003
Q3.7	Regulation about procurement of innovation	0.2064	0.7584	0.1597	-0.0790	0.0706
Q3.8	Regulation about public-private partnership	0.1673	0.7401	0.1834	0.0841	0.1313
Q3.10	Sustainable building	0.7520	0.1508	0.0040	0.2343	0.1033
Q3.11	Energy efficiency	0.8166	0.0640	0.1702	0.1129	0.1015
Q3.12	Management of public spaces	0.8280	0.1912	0.0910	0.1134	0.0456
Q3.13	Finance: PPP/PF	0.5151	0.1661	0.0906	0.5578	-0.0345
Q3.14	New financial instruments	0.3115	0.2641	0.2409	0.5458	0.0677
Q3.16	Project Management	0.1533	0.1673	0.6060	-0.0273	0.3331
Q3.17	Relationship capabilities	0.1441	0.1922	0.7821	0.0368	0.1517
Q3.18	Leadership	-0.0001	0.0790	0.8203	0.1100	0.0051
Q3.19	Personality	0.1500	0.0183	0.7369	0.2158	0.1466
Q3.20	Economic know-how	0.2015	0.1721	0.1799	0.7210	0.1876
Q3.22	ICT	-0.0455	0.2624	0.0951	0.4730	0.5953
Q3.23	Foreign language	0.0515	0.0362	0.1863	0.1797	0.7636
Q3.24	Professional experience	0.2707	0.1839	0.1411	-0.0900	0.7261

Table 7: Results of factorial analysis on question Q3