Smart Cities and Associated Risks: Technical v/s Non-technical Perspective

Priyanka Singh[1][a] and Markus Helfert[2][b]
[1]School of Computing, Dublin City University Glasnevin, Dublin 9, Ireland
[2]School of Business, Lero - The Irish Software Research Centre, Maynooth University, Maynooth, Co. Kildare, Ireland

Keywords: Smart City, Risks, Sociotechnical Perception.

Abstract: The new era of smart city is accompanied by Information and Communication Technology (ICT) and many other technologies to improve the quality of life for the citizen of the modern city, that in turn, has brought immense opportunities as well as challenges for government and organizations. These challenges often introduce risks with smart city services on which citizens are heavily reliant. The connotation of smart city services introduces risks not only with the technology but also with non-technical aspects like process and management where a human element is involved. However, there are only limited attempts to investigate risk in the context of process and management while the literature of technology-oriented risks is relatively comprehensive. This paper aims to reveal the significance of technical versus non-technical elements in smart city services, and how to integrate both views with the help of Enterprise Architecture (EA) for addressing the impact of risks. On the basis of this review, this paper argues that for an effective risk assessment process, it is vital to consider both technical and non-technical components together which would lead to improved governance strategies for risk mitigation approach.

1 INTRODUCTION

The term smart city is not something that has acquired attention in the area of research for the first time. It has been evolved for over many years and now when it's an era of Internet of Things (IoT), sensors, power grids, machine learning, cloud and fog computing, and many other technologies, we aim to create much smarter cities. Smart cities are different from the normal cities in the context of services that are being delivered in the cities. These services include not only technical components such as sensors, devices, actuators but also some other important elements as data, applications, and stakeholders across those technologies. Innovative technologies increase uncertainty and complexity, and there is a need to look beyond technology for effective managerial and policies to deal with the risk (Jennings, 2010). As highlighted by Nam and Pardo (2011), the implication of smartness in the urban or metropolitan context not only specifies employing cutting-edge information and communication technologies (ICTs), but also policy and management related concerns. It has also been pointed out that more than 50 percent of IT projects fail due to the non-technical aspects such as policy, organization, and management- associated risks. Hence, addressing risk only at technical level does not solve the issues at other levels like process and management where behavioural element is also involved. Therefore, it becomes important to address these factors, which can further lead to some form of risks in today's smart cities.

This paper contains a discussion and review of existing risk emergent areas in the smart cities. The purpose is to provide an overview of research in the field, identify possible factors that existing literature is not addressing adequately from the risk assessment point of view for smart cities. Later on, in the discussion section we highlight the need for sociotechnical perception for the risk assessment process, and tried to examine this perception from the lens of enterprise architecture. The structure of this paper is as follows: Firstly, we describe the review methodology and results of the search (Section 2). Secondly, we classify the risks in smart cities, and influencing factors for them (Section 3). Thirdly we

[a] https://orcid.org/0000-0001-6182-6111
[b] https://orcid.org/0000-0001-6546-6408

Singh, P. and Helfert, M.
Smart Cities and Associated Risks: Technical v/s Non-technical Perspective.
DOI: 10.5220/0008494402210228
In *Proceedings of the 3rd International Conference on Computer-Human Interaction Research and Applications (CHIRA 2019)*, pages 221-228
ISBN: 978-989-758-376-6

discuss the missing factors from risks assessment point of view and how can we include them to minimise the impact of risks (Section 4) and Finally, we conclude our findings for the future research (Section 5).

2 METHODLOGY

In this paper we follow a systematic approach presented in Webster and Watson (2011), for reviewing the existing literature on smart cities and associated risks with them. We selected relevant journals and conferences on the basis of electronic database Scopus and our search strategy revolved around the terms "Smart City", "risks", "Management", "Process" and "Governance" and by using advanced search criteria, we restricted the academic discipline to computer science, social sciences, engineering and business management and accounting. We reviewed 182 papers after applying the mentioned filters, and then selected those papers which discuss risks emerging domains and triggering factors for them in existing smart cities. Total 248 articles were generated, and after screening of title and abstracts, 66 articles were discarded. Only 182 papers remained to be examined in depth. This process has been summarised in Fig. 1.

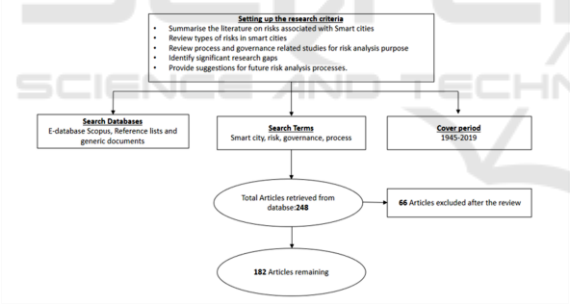

Figure 1: Summary of the Literature Review Process.

3 SMART CITIES AND ASSOCIATED RISKS

Before discovering the risks associated with smart cities, we need to recognize its core conceptual elements defined as "a smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operations and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects" (ITU-T Focus Group, 2014, cited in Mohanty, Choppali & Kougianos, 2016, p.41).

Despite the facts that the concept of smart city is not only about technological aspects but also about social and environmental perspectives, existing studies mainly focus on risks from a technological perception and abandoning the existence of social element. The most important element in smart cities is the way services are being delivered and that is not only about the technology but about service transformation and improvement (Nam & Pardo, 2011). When it is about service transformation and improvement, it's noteworthy to understand the importance of several stakeholders who are part of governing authorities in the city. Also they do not only take important decisions with regards to the city but also are involved in management of key processes contributing towards the effective delivery of smart city services**.** Therefore, it becomes important to consider them while addressing risks for city services.

When it comes to risk then, there are many defnitions for it in the literature and it differes with respect to the context, but as we are talking about smart cities thus, we tried to look into its definitions from the city council perspective as they are the main governing authorities to deal with any kind of risks in the city. We selected one of the defnitiotns of risk, documented by Waterford city council risk management group in Ireland. And it is defined as "Risk can be defined as the probability or threat of damage, injury, liability, loss, or any other negative occurrence that is caused by external or internal vulnerabilities, and that may be avoided through pre-emptive actions" ("Waterford City and County Council Risk Management Policy June", 2017, p.2). Another definiton of risk has been given as: "Risk is often expressed in terms of a combination of the consequences of an event (including changes in circumstances) and the associated likelihood of occurrence" (Standardization, 2009, p.2). We are trying to examine different factors causing risk in today's smart cities and how can we include them while carring out risks assessment process. Risk assessment process is defined as "Overall process of risk identification, risk analysis and risk evaluation" (Standardization, 2009, p.5). We are not focusing on any specific type of risk rather trying to examine all factors along with the technology which can icrease the probabilty of risk in different domains, and should be considered during risks assessment process.

3.1 Technology Oriented Risks and Effecting Factors

The objective of Johnsen (2018) is to provide a review of systemic risks in smart cities reliant on intelligent autonomous transport systems. Smart city has been addressed as "software ecosystem (SEC)" which defines the complex environment of a smart city. Safety, security and resilience have been considered as a main concerning areas from the risk assessment point of view. This paper identifies that the smart cities not only deal with information but at the same time with actual critical complex processes, and it require methods which can include technology, human elements and organisational issues. It has been pointed out that there is a very less focus on emerging risk, safety, security and societal consequences associated with modern smart city services. Similarly process and technology have been found as major elements causing information security related risk (Wu et al., 2018). According to authors, there could be disastrous consequences due to all kinds of information security problems, specifically it constitutes great challenges to traditional information security systems. Authors presented the case of Taiwan's city where it faces many security issues and it has been emphasised that the construction of smart cities should consider macro-level perspective along with technology, data, public infrastructure, security protection, services, and human resources. As per Taiwan's iThome 2018 Enterprise Information Security Survey , employees' lack of knowledge of advanced security processes and technology ranked highest with 63.1% towards security related risks (Wu et al., 2018).

Today's information and communications technologies (ICT) permit interconnection, collaboration, and communications between devices and machines without need for direct human intervention (Hosu et al., 2015). The new array of security/privacy issues requires inventive solutions in an era where data collections are far away from expectations (Yorgos et al., 2019). The citizens/users must be ensured that their data and private life are secure, although most of the issues arise when data are shared with third parties, who do not follow the strict security/privacy requirements of the original provider (Yorgos et al., 2019). It has been pointed out that periodic and emergency procedures should be part of a coherent security policy, irrespective of its original secured design. Authors also mentioned that with the participation of key public and private actors, there is a need for complex risk analysis process and subsequent policy and engineering design to reduce risk. Also, human factor has been considered as one of the important elements to analyse safety associated risk.

Autonomous vehicles industry has recently acquired a lot of attention, and most of the cities are planning to introduce it soon, but before introducing such services, it is also important to consider its impact on society and how governing authorities are going to take actions during any kind of disastrous situations which may pose some type of risk. "Since the introduction of autonomous vehicles (AVs) in 2010, their development and appeal has increased significantly. However, the successful operation of AVs and their impact on society depend significantly on their management and on addressing risks associated with them" (Lim & Taeihagh, 2018, p.2). In this paper, authors focus on privacy and cybersecurity related risks which are crucial to the development of smart and sustainable cities, and examine actions taken by the government for addressing these risks worldwide. These actions are taken in the form of legislations, guidelines and further research is in progress to come up with a more specific laws and regulations. It has been pointed out that the autonomous system will have a control of AV, not the human, so the responsibility for car accidents will move from the occupants to manufacturers. Along with that, manufacturers and software providers face greater risk of lawsuits resulting from accident compensation, which may discourage innovation if systematically allocation of responsibility is not addressed by liability laws. Boeglin (2015) explained that there would be dynamic wireless exchange of data among immediate vehicles with the help of Vehicle-to-vehicle (V2V) technology which would permit self-driving cars to recognise threats and hazards, and calculate risks or to take required actions to avoid and mitigate crashes. However, there is a risks that information shared about users can be compromised or improperly used by attackers. It has also been highlighted that there is an impact on social values, such as freedom and privacy, or the questions for legal liability because of the usage of self-driving cars. This is another instance where social impact has not been considered and technology is ready to be used in the future planning of the smart cities.

Another type of risk has been highlighted with respect to the data usage and surveillance in autonomous vehicles by (Rannenberg, 2016, cited in Lim & Taeihagh, 2018) as: (a) there are "no explicit rules to consider certain data special and have special hindrances for their usage", the data collected in AVs may be misused in several ways that hindrance AV passengers. (b) Author argues there are many ways by which personal data can be exploited using

geographical locations and destination of AV users, for an instance if people are participating in any interest group or travelling for a political meeting, then it could decrease their participation due to the fear that such kind of recordings can "expose them to risks". Similarly, there could be less impartial society, greater social turbulence due to enabling AVs of extensive surveillance which potentially hinder the development of smart government and influencing policy making (Lim & Taeihagh, 2018). Furthermore, it has been pointed out there is a need of proper governance frameworks for managing privacy associated risks required for endorsing the continuous usage of connected infrastructure and information and communication technology (ICT) towards socio-economic expansion.

Some of the issues found in Lim and Taeihagh (2018) relate to Marie et al., (2018) where authors explained risks and challenges associated with the automation of urban green infrastructure (UGI). These risks have been identified by examining six case studies of vertical farming, virtual fencing, health monitoring, youth-driven citizen science, automated tree stewardship and robotic tree-care. It has been emphasised that these types of risks are addressed by providing technological fixes to all societal problems without considering the social and economic cause of the problem. Various health associated risks have also been identified such as technostress caused by over usage of smart phones, obesity, asthma and stress along with the ethical concerns regarding data sharing and privacy of health app users, and due to the increased surveillance. Consequently, there is a critical necessity to question what specifically is being made sustainable, for whom, and by which criteria it needs to be made (Marie et al., 2018). These are the questions that government and local authorities need to answer before deploying such projects where human intervention is almost negligible and consequence of these services has been neglected. Hence it becomes important to analyse how citizens would react to this new era of technology where fully automated services are going to replace the existence of human element.

There are some other types of risks classified in the literature due to the disastrous situations as natural disasters or any other kinds of emergency situations. "Emergency Management (EM) deals with the risk and consequences of an emergency event and aims at reducing or avoiding negative effects and implementing an effective recovery action" (De Nicola, Melchiori & Villani, 2019, p.2). Authors considered smart cities case study for EM analysis as it is a challenging domain due to the fact that smart cities are characterized by interconnected physical and virtual services establishing complex ecosystems. It has been pointed out that during the planning of cities, aspects like social implications, the impact on the environment, and respect for diversity does not hamper innovation but enhance it. Falco (2015) suggested the similar factors required to be taken into consideration for the effective risk management process and better resilience plan. It has been stated that technology-centric resilience plans might lead to a lack of significance on societal consequences and historical context for capturing the cause and effects of disastrous events.

All these studies emphasise the fact that there are more factors to consider other than solely the technology while addressing risk in smart cities. Cities can only be recognised as smart when there is an investment in the growth of human along with the social and environmental capitals (Yigitcanlar et al., 2019). We argue that this perception should be considered for the risk assessment process as well. Another important component in smart cities is "governance", local government and council play a vital role in addressing any kinds of risks. Therefore, we tried to examine disparate aspects from the governance point of view to understand the risk from their end as well.

3.2 Governance Oriented Risks and Effecting Factors

There are numerous research and solutions to address risks in different domains of smart city services from the technology viewpoint, but there are very limited attempts to discuss the processes and management which take place in the backend of those services and how they can influence the different types of risks. There are several stakeholders involved starting from planning to delivery of services such as council, local government, private companies etc. and eventually they are the ones who are responsible for taking any kind of crucial decision either during any disastrous situation or during any kinds of security/privacy/health/safety related issues resulting from smart city services. Therefore, it is worth understanding risks coming from the governance perspective and how these risks can influence the other form of risks in the city.

Techatassanasoontorn and Suo (2010) found five types of risks in the smart city infrastructure projects from the governance viewpoint directed by local government summarised as:

(a) Socio-political Risks: These risks are associated with regulations, policy as well as with social and political forces. Also city council's vote and political

support is required to start any kind of project. There are various solutions in the form of policy and regulations to address risks associated with security and privacy (Lim & Taeihagh, 2018). However, if necessary policies are not passed due to the internal conflicts of interest among stakeholders then it can result in some other form of risk as security or privacy.

(b) Approval Risks: Approval risks are those which intercept from receiving any kind of a formal permission or approval to start the project or to further make any progress. A good business plan and an appropriate feasibility analyses are required to avoid risk for successful completion of project.

(c) Financial Risks: Funding related problems for instance lack of preliminary funding, failure to produce enough revenue, lack of money to substitute or upgrade equipment, with unpredictable implementation costs that may threaten project existence and success.

(d) Technical Risks: Technical risks are risks associated with technology selection and implementation. There are three types of risks identified in terms of technology as geographical difficulties of network coverage, discontinued technology, and a questionable technology choice.

(e) Partnership and Resource Management Risks: Partnership and resource management risks deal with various stakeholders who may have conflicting goals and interests, partnerships issues, asset rights, human resources, marketing, and poor performance of networks.

Heaton and Parlikad (2019) identified another type of risk from the digitalisation of the built environment and found that there is a risk as information flowing between various platforms and rapidly becomes unmanageable, and the value of that information also becomes lost. Moreover, authors argued that people element is often neglected at the cost of technology and strategic development which is critical component for developing a successful smart city. Governance is noteworthy challenge for the development of a smart city and some of those challenges are less transparency, standalone city services, absence of human resources and liability (Sujata et al., 2016, cited in Heaton & Parlikad, 2019). It is important to note that these types of challenges further lead to some form of risks already discussed by (Techatassanasoontorn & Suo, 2010). Hence it is significant to consider such viewpoints while addressing risks in the smart city context. The most important factor is examining social factors along with the technology while conducting a risk assessment process to gain better understanding of the impact on society as well as on governance.

There are some other challenges from the governance side when it comes to emergency situation, and one of them is information sharing during such scenarios, which has been considered as a significant factor by (Cohen et al., 2017). In this paper authors addressed the importance of effective communication between governance and public to handle crisis situations in an effective manner for achieving better resiliency. This information becomes very important when decision makers and local leadership have to design policy for planning communication with the citizens and resilience building processes. Hence it is worth communicating such information with a proper communication channel and the value of such information should not be lost, so that such disastrous situations do not cause any kind of safety or health-related risks. It can be observed that people involved in such processes are key players to handle such crises and are also responsible for taking important decisions during any kinds of emergency situations. This is what we have been pointing out throughout our discussion. The "Social Factor", which is not only important from the citizen's viewpoint but also from the different stakeholders' point of view who are directly or indirectly engaged with people and the services. Gonzalez et al., (2017) emphasised that there is a requirement of risk assessment and mitigation tools which can take account of multi-stakeholder's perception involved in city resilience, and how mitigation policies best support the resilience planning. Bolton and Foxon (2015) discuss the similar issue in infrastructure transition projects from a socio-technical system viewpoint, based on electricity and heat distribution networks in the UK. This paper addresses different challenges such as lack of local level leadership and coordination, lack of risk averse business culture etc. from the governance side. It has also been pointed out that project couldn't make much progression due to the disintegrated sector structures and a deficiency of clear and persistent framework for low carbon infrastructure governance.

Similar findings were highlighted with respect to the complexity of multi-stakeholders and actors involved in risk-related decision making process which creates highly complicated and fragmented structure of society (Hermans, Fox & Van Asselt, 2005). This research found that risk assessment process deals with three major challenges described as 'complexity', 'uncertainty' and 'ambiguity'. Multi-stakeholder related issues have been highlighted by many researchers within the governance. Another instance of this issue has been revealed by Simonofski and Snoeck (2019), and it has been emphasised that due to the various stakeholders, planning of development process becomes complex and difficult in e-government

projects. Consequently, the work of integrating feedback from stakeholders or the essential signatures of the superiors causing risk to the software as it becomes antiquated by the time all stakeholders are associated. On the similar note, Pierce and Andersson (2017) identified that there are many challenges faced by municipal decision makers which are related with non-technical issues such as collaboration, governance and many others whereas security is not considered as a major challenge. It has been further pointed out that the risks of cities are too much dependent on technology and there is a technological lock-in effects caused by solution providers. Comparison of these findings with those of other studies confirms that to minimise risk and challenges associated with smart city services there is a requirement to include both technical and non-technical viewpoints instead of just focusing on technology and neglecting the other factors around it. These risks have been categorised along with the influencing factors for them in Table 1 and Table 2.

Table 1: Categories of Risks.

References	Security	Privacy	Safety	Emergency/ Disaster	Liability	Health	Governance
(Johnsen, 2018)	x		x				
(Wu et al., 2018)	x						
(Yorgos et al., 2019)	x	x					
(De Nicola et al., 2019)				x			
(Lim & Taeihagh, 2018)	x	x			x		
(Marie et al., 2018)						x	
(Simonofski & Snoeck, 2019)							x
(Cook et al., 2018	x		x			x	
(Techatassanasoontorn & Suo, 2010)							x
(Heaton & Parlikad, 2019)							x
(Cohen et al., 2017)							x
(Bolton & Foxon, 2015)							x
(Hermans et al., 2005)							x
(Boeglin, 2015)	x	x					
(Gonzalez et al., 2017)							x
(Falco, 2015)				x			x
(Pierce & Andersson, 2017)							x

Table 2: Risks influencing Factors from Literature.

References	Risks Influencing Factors
(Johnsen, 2018)	Organisational Issues.
(Wu et al., 2018)	Security processes, Technology.
(Yorgos et al., 2019)	Lack of periodic and emergency procedures in policy.
(De Nicola et al., 2019)	Absence of automated models.
(Lim & Taeihagh, 2018)	Absence of proper governance framework, Lack of effective Policy.
(Marie et al., 2018)	Lack of social and economic consideration.
(Simonofski & Snoeck, 2019)	Requirement of Multi-stakeholder's approval.
(Cook et al., 2018)	Absence of prescribed software standard, Less secured systems.
(Techatassanasoontorn & Suo, 2010)	Conflicting goals, Discontinued technology, Absence of effective policy.
(Heaton & Parlikad, 2019)	Negligence of social factor, Absence of human resources.
(Cohen et al., 2017)	Lack of effective Communication.
(Bolton & Foxon, 2015)	Lack of local level leadership & coordination.
(Hermans et al., 2005)	Complex, uncertain and ambiguous risk assessment process.
(Boeglin, 2015)	Liability related issues, Negligence of societal consequences.
(Gonzalez et al., 2017)	Unclear accountability, Lack of perspective from various stakeholders.
(Falco, 2015)	Negligence of social and historical context.
(Pierce & Andersson, 2017)	Weak collaboration, Outdate regulations, Financial challenges, Technology awareness issue.

4 RISKS FROM THE LENS OF ENTERPRISE ARCHITECTURE AND DISCUSSION

As it can be seen from the Table 2, that there are various non-technical parameters influencing risks in different domain of the city and there is a common factor among all those parameters. That is "social factor", this term includes a wide range of issues and we classify it from two sides, one is from the governing authorities and another from the citizen's perspective. When we consider governance standpoint, then there are internal as well as external stakeholders who influence the execution of processes and policies. Therefore, the issues related with proper decision making, collaboration, liability and accountability, finance, etc. increasing the chance of risks in different

domains of smart city services. Another viewpoint is from the citizen's side, while introducing new services with advanced technology oriented solutions, we often neglect its consequences as highlighted by Marie et al., (2018), which increases the probability of risks in disparate areas and effecting citizens of the city. Hence it becomes essential to consider these factors before deploying any new services during the planning phase itself, so that risks emerging from such services can be avoided in the future, and even if it occurs then we have a better plan to mitigate them. Enterprise Architecture(EA) has been extensively used in organisations and "It is a holistic approach to systems architecture with the purpose of modelling the role of information systems and technology in the organization, aligning enterprise-wide concepts and information systems with business processes and information" (Barateiro, Antunes & Borbinha, 2012, p.3301). EA framework has also been suggested as a way to manage complexity, multi-stakeholders and the service- oriented nature of smart cities in smart cities (Pourzolfaghar et al., 2018). Also an architected approach radically reduces the risks, timeline, and potential mid- project failures in e-Governance model as compared to other approaches ("The Open Group Guide Starting an Enterprise Architecture Capability in the Government Sector," 2018). Therefore, enterprise architecture could be a good approach to analyse risk associated with smart city services while considering all those non-technical factors which cause risks. However, it is an underrepresented area so far, and need more exploration. We aim to investigate those factors with the help of enterprise architecture in our future work.

5 CONCLUSION

There is a plethora of research to investigate risks in different domains of the smart cities, and most of them are focusing on technological part. This paper argues that there are various factors other than the technology which influence risks, and these factors can be analysed with the help of EA. However, EA and risk is not well explored, and there are various factors that can be responsible for effective risk analysis process. Therefore, we need to understand the impact of these factors and their influence on overall risk assessment process. In particular, as environments and systems in smart cities become more complex and dynamic, the understanding of risk resulted from architecture is important. That is, traditionally risk results from malfunctioning of software elements or physical system. With increasing complexity, risk results not only from this, but also associated with complexity of these systems.

ACKNOWLEDGEMENTS

This work was supported with the financial support of the Science Foundation Ireland grant 13/RC/2094 and co-funded under the European Regional Development Fund through the Southern & Eastern Regional Operational Programme to Lero - the Irish Software Research Centre (www.lero.ie).

REFERENCES

Barateiro, J., Antunes, G., & Borbinha, J. (2012). Manage risks through the Enterprise Architecture. *Proceedings of the Annual Hawaii International Conference on System Sciences*, 3297–3306. https://doi.org/10.1109/HICSS.2012.419

Boeglin, J. (2015). The Costs of Self-Driving Cars: Reconciling Freedom and Privacy with Tort Liability in Autonomous Vehicle Regulation. *THE YALE JOURNAL OF LAW & TECHNOLOGY*, *17*.

Bolton, R., & Foxon, T. J. (2015). Infrastructure transformation as a socio-technical process - Implications for the governance of energy distribution networks in the UK. *Technological Forecasting and Social Change*, *90*(PB), 538–550. https://doi.org/10.1016/j.techfore.2014.02.017

Cohen, O., Goldberg, A., Lahad, M., & Aharonson-Daniel, L. (2017). Building resilience: The relationship between information provided by municipal authorities during emergency situations and community resilience. *Technological Forecasting and Social Change*, *121*, 119–125. https://doi.org/10.1016/j.techfore.2016.11.008

Cook, D. J., Duncan, G., Sprint, G., & Fritz, R. L. (2018). Using Smart City Technology to Make Healthcare Smarter. *Proceedings of the IEEE*, *106*(4), 708–722. https://doi.org/10.1109/JPROC.2017.2787688

De Nicola, A., Melchiori, M., & Villani, M. L. (2019). Creative design of emergency management scenarios driven by semantics: An application to smart cities. *Information Systems*, *81*, 21–48. https://doi.org/10.1016/j.is.2018.10.005

Falco, G. J. (2015). City Resilience through Data Analytics: A Human-centric Approach. *Procedia Engineering*, *118*, 1008–1014. https://doi.org/10.1016/j.proeng.2015.08.542

Gonzalez, J. J., Magnus, B., Eden, C., Gimenez, R., Hernantes, J., Howick, S., … Sarriegi, J. M. (2017). Stalking Resilience: Cities as Vertebrae in Society's Resilience Backbone Jose. *Information Technology in Disaster Risk Reduction*, *501*, 31–45. https://doi.org/10.1007/978-3-319-68486-4

Heaton, J., & Parlikad, A. K. (2019). A conceptual framework for the alignment of infrastructure assets to citizen requirements within a Smart Cities framework. *Cities*, *90*(January), 32–41. https://doi.org/10.1016/j.cities.2019.01.041

Hermans, M. A., Fox, T., & Van Asselt, M. B. A. (2005). Risk Governance Towards an Integrative Approach. *Handbook of Risk Theory: Epistemology, Decision Theory, Ethics, and Social Implications of Risk*. https://doi.org/10.1007/978-94-007-1433-5_44

Hosu, A. C., Varga, M., Kiss, Z. I., Polgar, Z. A., & Ivanciu, I. A. (2015). Integrated ubiquitous connectivity and centralised information platform for intelligent public transportation systems. *IET Intelligent Transport Systems*, *9*(6), 573–581. https://doi.org/10.1049/iet-its.2014.0206

Jennings, P. (2010). Managing the risks of Smarter Planet solutions. *IBM Journal of Research and Development*, *54*(4), 1–9. https://doi.org/10.1147/jrd.2010.2050540

Johnsen, S. O. (2018). Risks, Safety and Security in the Ecosystem of Smart Cities. *Intech Open*, *2*, 64. https://doi.org/10.5772/32009

Lim, H. S. M., & Taeihagh, A. (2018). Autonomous vehicles for smart and sustainable cities: An in-depth exploration of privacy and cybersecurity implications. *Energies*, *11*(5). https://doi.org/10.3390/en11051062

Marie, N., Raymond, C. M., Rutt, R. L., Stahl, A., Plieninger, T., Sandberg, M., … Jönsson, K. I. (2018). Landscape and Urban Planning ' Rage against the machine ' ? The opportunities and risks concerning the automation of urban green infrastructure. *Landscape and Urban Planning*, *180*(September 2017), 85–92. https://doi.org/10.1016/j.landurbplan.2018.08.012

Mohanty, S. P., Choppali, U., & Kougianos, E. (2016). Everything You Wanted to Know About Smart Cities, (August 2016). https://doi.org/10.1109/MCE.2016.2556879

Nam, T., & Pardo, T. A. (2011). Smart city as urban innovation. In *Proceedings of the 5th International Conference on Theory and Practice of Electronic Governance - ICEGOV '11* (p. 185). https://doi.org/10.1145/2072069.2072100

Pierce, P., & Andersson, B. (2017). Challenges with smart cities initiatives – A municipal decision makers' perspective. *Proceedings of the 50th Hawaii International Conference on System Science (HICSS-50)*, 2804–2813. https://doi.org/http://hdl.handle.net/10125/41495

Pourzolfaghar, Z., Bastidas, V., Mamkaitis, A., & Helfert, M. (2018). Standardisation of Enterprise Architecture Development for Smart Cities, (c), 28–34.

Rannenberg, K. (2016). Opportunities and risks associated with collecting and making usable additional data. In *Autonomous Driving*.

Simonofski, A., & Snoeck, M. (2019). Co-Creating e-Government Services : An Empirical Analysis of Participation Methods in Belgium, (February). https://doi.org/10.1007/978-3-319-98953-2

Standardization, I. O. for. (2009). GUIDE 73 Risk management-Vocabulary, 1–5.

Techatassanasoontorn, A. A., & Suo, S. (2010). Exploring risks in smart city infrastructure projects: Municipal broadband initiatives. In *14th Pacific Asia Conference on Information Systems, PACIS 2010* (pp. 13–24). Retrieved from https://www.scopus.com/inward/record.uri?eid=2-s2.0-84856021996&partnerID=40&md5=d04771bb672569da9f3da1ce9d759c01

The Open Group Guide Starting an Enterprise Architecture Capability in the Government Sector. (2018).

Waterford City and County Council Risk Management Policy June. (2017), (June).

Webster, J., & Watson, R. T. (2011). Analyzing the Past To Prepare for the Future : Writing a Review. *MIS Quartely*, *26*(2), 12. Retrieved from www.jstor.org/stable/4132319

Wu, S., Guo, D., Wu, Y., & Wu, Y. (2018). Future Development of Taiwan's Smart Cities from an Information Security Perspective. *Sustainability*, *10*(12), 4520. https://doi.org/10.3390/su10124520

Yigitcanlar, T., Foth, M., Sabatini-marques, J., & Ioppolo, G. (2019). Can cities become smart without being sustainable ? A systematic review of the literature. *Sustainable Cities and Society*, *45*(June 2018), 348–365. https://doi.org/10.1016/j.scs.2018.11.033

Yorgos, Y. J. S., Golias, M., Dedes, G., Douligeris, C., & Mishra, S. (2019). Challenges, Risks and Opportunities for Connected Vehicle Services in Smart Cities and Communities. *IFAC-PapersOnLine*, *51*(34), 139–144. https://doi.org/10.1016/j.ifacol.2019.01.056