Contemporary Smart Cities: Key Issues and Best Practices

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Abstract—**The goal of the paper is to summarise the most common key issues and best practices of contemporary smart cities based on a globally selected and analysed research corpus with governmental and business documents from the last three years. The paper also provides a comparative analysis of the corpus with recently published academic sources. The ultimate goal is to create a framework study of the contemporary smart city landscape to support the connected research projects from different disciplines, and also, to give ammunition for policy makers of future cities to their strategies.**

Keywords-Smart city; data-driven society; life quality; mobilisation; smart citizen; artificial intelligence

I. INTRODUCTION

Smart services, products and systems promise that the latest technology is going to force emerging developments and digital ecosystem constantly. The question is where are we on this timeline.

The latest digital technology presents so-called smart devices and smart services. However, our expectation is based on more and more advanced level smart solutions in an intensive competition of digital markets. Our research questions concern a contemporary view. Is "smartness" available in fact, or, do we recognise the early stage of smart technology? Is, eventually, a sudden leap required for a more complex smart systems based on artificial intelligence? Which ideas, issues and initiatives describe contemporary smart environments, from a global view?

Studying the academic sources or professional trend reports of emerging digital technologies led to the identification of two major approaches. A significant amount of scholarly papers have a wide perspective on social-cultural-economic changes reflecting smart technologies and the first developments based on the upcoming artificial intelligence [1][2]. The other massive majority of academic research has presented a zoom into the state of art technologies regarding the highest level of developments and initiatives [3][4]. In conclusion, these approaches point out a non-comprehensive field of the so-called smart environments.

Building a basis of a more comprehensive summary, a short literature review is going to summarise the academic point of view of the contemporary smart city developments. These theoretical pillars are going to prepare the presentation of the corpus-based research. The subject of the research project is going to propose a comparative, two-dimensional analysis of emerging digital technologies with their effects on smart cities based on the most popular business and governmental documents. The first dimension is going to highlight the key issues of the smart environments and the second one is going to present the most cited best practices. Both of them are created by a carefully selected corpus containing the most popular strategic documents or trend reports of smart cities from the last three years.

The ultimate purpose of the paper is to map the contemporary smart city landscape providing a comprehensive summary of governmental and business decision making on this field with an academic analytical view.

The paper consists of five sections. First and foremost, the Consideration of Terminology outlines the suggested approach of smart ecosystem. This section introduces the next one, called Short Literature Review presenting the academic sources. The section provides a summary of a research corpus and its interpretation. The Methodological Concerns follows it to describe the criteria of content filtering, software-supported and manual methods of the analysis. Findings are presented in the next section which specifies the key issues and best practices of smart cities based on the corpus. The Conclusion closes and summarises the theoretical and the research-based results, particularly in context of upcoming artificial intelligence and expectation of engagement by smart citizens.

II. CONSIDERATION OF TERMINOLOGY

Smart ecosystem has been recently defined by building new business, society and culture by digital devices and services in networks. This approach is particularly valid for smart cities facilitated by local governments and business. Following the academic and market-based discourses on this field, our digital environment has become smart, and artificial intelligence (AI) seems to be on the doorstep.

Per definitionem, a smart ecosystem is associated with a place or system highly related to information and communication technologies [5], ubiquitous sensing, data-driven decisions and cognitive computing [6], and optimisation of operations [7][8]. These ingredients determine the design of smart environments with an expected final goal of an artificial intelligence driven ecosystem. The term "smart" describes an intermediate milestone between an initial state of digitalisation and the upcoming artificial intelligence. The former

milestone belonged to the coding and the first digital networks. The latter assumes a created non-human intelligence, what is capable to be rational or is able to act rationally [9] and which holds a potential for a good-AI-society with human dignity, governmental responsibility and ethical-normative innovations [10].

Considering these simplified definitions, smart technology supported environments are available. However, certain smart environments still are supported by limited digital services, while others present advanced automated and self-managed developments. The overall picture is therefore not uniformed, moreover, different milestones are represented in the same environments. In other words, digital, smart and artificial intelligence based ecosystems are not available in themselves, only mixtures of their elements are relevant to different goals and different circumstances from the cultural background to the financial investments.

Investigating this complex landscape, numerous news, agendas, top lists, reports and visions are available but a simplified global summary of these is missing. However, a contemporary brief has become indispensable for policy makers and researchers to support constructive co-operations with stakeholders, shareholders and connected research projects. After the considered terminology, this paper targets to fill the mentioned gap by an outline of current academic literature in the next section, and also, by results of corpus-driven qualitative research for an overall and comprehensive picture.

III. SHORT LITERATURE REVIEW

Starting with the academic sources, the most remarkable summary of smart city approaches is the work of Albino and his co-authors from 2015 [11]. Their research project was focusing on the meaning of 'smart' in the 'smart city' context first. Their in-depth literature review revealed a wide range of smart city characteristics including among others built and natural environments, quality of life, mobility, info-communication technology, innovation, and also, economic or socio-political issues.

Besides, concerning the wide range of academic publications and exploring the highly cited sources related to the topic, the most emphasised issues are the "big data" and "algorithms" in the smart city context [12][13]. Regarding the city-based datasets, the emerging trend is to study the city-operation and citizen-driven open data, and in particular the smart city engagement by locals to share their activities, ideas and opinions [14][15]. In parallel, the number of papers in governmental issues [16] and in local entrepreneurship vs. global companies are growing rapidly with critical aspects [17].

Meanwhile, the technological conditions are changing drastically. According to the Complimentary White Paper: IoT Platforms – Enabling the Internet of Things [18], there were 15.4 billion devices available in 2015. The number is growing to 30.7 billion until 2020 and to 75.4 billion until 2025 with emerging Industrial Internet of Things (IIoT) ratio in it.

These developments are closely related to further rapid changes via cloud, mobile internet, advanced robotics, 3D printing, autonomous vehicles and further upcoming technological trends [19]. In parallel, half of the full population is using the internet and more sensors

and machines are getting connected. The advantages of the Machine to Machine communication (M2M), the automatised operations, the networks of dynamic software [20] are measured in dollar billions year by year with direct impact to economy, society, and also, to city maintenance [21]. These trends and numbers represent how the smart technology wires more and more fields of operations and how fast is the speed of emerging info-communication technology via data traffic and digital services.

A smart ecosystem was created recently [22] for efficient operations and for discovering new options for human beings. Regarding the business research trends, Gartner offers a digital hype cycle trend report to with expected technologies in every year [23]. Additionally, Huawei has a Digital Activity Heat Map developing an index of transformation and connectivity [24]. Last but not least, top lists of smart cities by Forbes [25] and further trendsetter summaries represent the strong interest in emerging technologies and their predictable effects in the society and business. Although, these reports summarise developments and innovations by branded contents, an independent approach is also needed.

The next question is how can we improve a comprehensive summary of mainstream contemporary trends in smart technology, which is also useful for academic research and for governmental or business strategies? What kind of key issues and factors force the present developments and forecasts? Which patterns are visible and transparent for a framework study on the field of smart cities? The next section is going to present a research methodology and results to the contemporary smart cities.

IV. METHODOLOGICAL CONCERNS

Based on the studied academic sources, our research project focused on the latest governmental and business documents building a corpus via multiple filters. The analysed corpus was created by strategic documents, trend reports, white papers, future visions and implementation reports of smart cities from all over the world. Only completed and published files were selected, which were official communication of business and governmental partnerships. The selection criteria belonged to the time dimension and the global representation. The last three years presented the timeframe for a contemporary summary. For global overview, all inhabited continents were filtered and the focus was only on the cities, not on regions or further kind of localities to present a comparative approach. It was a decision to pre-select the most searched documents from the same regions and about the cities avoiding overlapped descriptions.

Based on these criteria, the most popular and most downloaded, publicly available documents were assorted by the globally used search engine called Google. The content criteria required summaries with governmental and business research co-operations. The language criteria assumed only the texts in English for the widest filtering option and for the comparative research study in global context.

Due to the above mentioned criteria, one hundred and fifty documents created the research corpus. Most of them were white papers, trend reports, city reports and

strategic visions. Besides them, industrial agendas, local government plans, analysis of governmental-business collaborations, blueprint documents, implementation reports, market analysis, partnership reports and strategic submit documents were also appeared in a smaller proportion.

After eliminating the non-informative stop-words from the documents (such as "a", "the", "or") and the short texts from the visual illustrations (e.g., repeated and highlighted sentences or keywords from the texts), the frequency of key issues have become available from the text analysis. For the common occurrence in a variety of text units the research applied WORDij and Quadratic Assignment Procedure (QAP). Based on Pearson Correlation [26], word connection frequencies and strong ties among the key elements were found to interpret the word pairs and content networks. Gephi 0.9.1 supported the visualisation of the results regarding the key issues. The most cited best practices were collected by the word frequency of the city names and based on it, a manual content analysis produced the short comparative summary of the city reports. The key issues and best practices of the contemporary smart cities in the last three years have become available in this way. The next section outlines the obtained results.

V. FINDINGS

This section will present the general frequency and its interpretation based on the whole corpus first. Concerning the word connection frequencies and strong ties among the key issues, word pairs and content networks are going to be analysed. Last but not least, best practices are going to be highlighted as the content analysis.

A. Key Issues

The corpus of the one hundred and fifty documents presents thousands of pages with hundreds of key elements in a text network. Most of these elements have average strong connections. The goal was to find the most central issues with the strongest ties.

According to our findings, the first strongest word pair is evidently the "city" and "smart" together in this order. On the third place, there is "data" all above of the further frequent keywords with similar strong connection to the "smart city" word pair, which result is closely related to the already mentioned academic approaches. Consequently, all further key issues are connected to the strongly tied central content elements, namely "smart-city-data".

Concerning the corpus results, big data, open data, data sets, data analysis and data-driven decision are providing primarily the innovation, optimisation and creative ideas in the presented projects and future plans. In other words, smart city does not exist without digital data, which is the alfa and the origo of future city developments. The concepts of data-driven society has become a city management approach. The term "information" is also in the top keywords as an extra interpretative layer on "data". Information-communication technology, information management, information security, information governance and information economy are built on the data-driven society to utilise the advantages of the digitalisation.

Listing the further key findings, project-based thinking, service-oriented logic, public issues, developments with strong correlation to research, governmental decisions and financial sources, energy sector and technological concerns are representing the key issues with the highest frequency. These focal points summarise a complex city operation with multiple key functions.

Compared to the academic sources, the role of artificial intelligence in a smart ecosystem is underrepresented and not available in the list of key issues. Neither the technological developments nor the human vs. machine aspects are mentioned in the smart city context.

TABLE 1. MOST FREQUENT WORD PAIRS DEFINED BY PROPORTION, ENTROPY AND MUTUAL INFORMATION

Word pairs		Frequency	Proportion	Entropy Term	Mutual information
life	quality	561.000000	0.000601	0.004460	5.535064
city	design	575.000000	0.000616	0.004556	4.085312
private	public	577.000000	0.000619	0.004570	4.033457
city	development	607.000000	0.000651	0.004775	3.099892
public	sector	620.000000	0.000665	0.004863	4.017711
smart	solutions	670.000000	0.000718	0.005199	2.502526
private	sector	693.000000	0.000743	0.005353	5.297493
smart	development	813.000000	0.000872	0.006140	2.067863
data	city	922.000000	0.000988	0.006839	1.333144
smart	project	951.000000	0.001020	0.007023	2.602895

Referring to the academic literature review in another aspect, the human factors and the engagement of local citizens are more represented in the corpus than it was expected. However, these human factors are also underrepresented compared to the frequency of the key issues. Primarily the citizen-driven open data is highlighted in this context along various sectors and decision points. The focus is on the contribution to the common interests via automatisation and comfortable smart city services supporting the local business and higher standard of living. Engagement by locals or their involvement into the decision making are at least seldom mentioned as a result of the activities of the NGOs, volunteering or being ambassadors of innovative technologies.

The text analysis has also revealed the word pairs to understand the closest connections of the key issues. Beyond the frequency, the proportion, the entropy term and the mutual information have specified and defined the core correlations of a contemporary smart city (see Table 1). According to the results, the "life quality" presents the fundamental category and the goal of the smart city strategies and trends. The "liveable city", even more accurately, a "welfare city" or the the improvement of the city lifestyle are in the focus in most of the analysed city concepts.

The "city design" category on the second place reflects on the ongoing changing status from planning to testing and to the implementations. Besides, several digital services have become built-in technologies or invisible but elementary part of the life quality. The fundamental motivation is the potential for the cost reductions of the city operation. The reason behind the intensive investment to the smart technology by governments and business is consistent to the statistics of M2M in the literature review. Additionally, the documents emphasise the importance of "building three layers together" regarding a human-made physical layer from buildings to roads, a digital layer from maintenance to optimisation, and also, a layer of nature with sensorised parks with monitoring systems and breathing buildings with natural building ventilation technology in

a post-carbon city. These three dimensions provide the main constructions of the targeted life quality.

On the third place in the word pair list, "private" and "public" issues are represented together. In most of the cases, the interest of general public and moral or legal questions of privacy matters are not in line. The already mentioned "open data" and its platforms or the optimised operations via these platforms belong to the public interest in a society or business. However, users of digital systems strive to keep their sensitive or private data, and also, control them. In conclusion, the documents in the corpus draw different boundaries between private and public issues as different cultures, technological developments or political systems. In the top ten word pairs, "public" and "private" appear as sectors and their interpretation highlights the "city as an operation" approach. The final goal is to engage the general public to share their data collections and ideas about their cities as local citizens. The above mentioned life quality is the most relevant common incentive in this mutual goal.

After the analysis of the podium finish, the following elements are presented in word pairs, "project", "development" and "solution", what is in line with the key issues based on frequency analysis above. In parallel, the "data city" also appears. It confirms the key central elements, such as "smart-city-data", mentioned at the beginning of this section.

Investigating the content networks, the highlights are different in the case of governmental and business approaches (see Figure 1 and Figure 2). Although the first and foremost component is the "data", it is more crucial for business than for the governmental strategies. According to the corpus, national and local governments are also focusing on the information, which depends on the informative data sets or values. This interpretative approach results in a project-based view in governmental context. Otherwise, the business considerations are more technology-oriented and the energy sector plays a key role in its fundamental issues.

The overlapped fields are the "developments", "services" and the "public sector" presenting the main
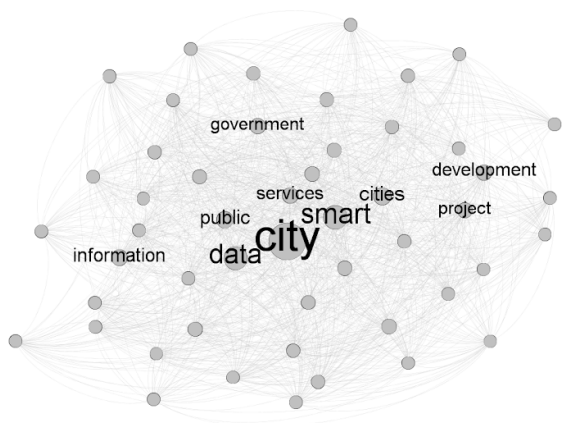

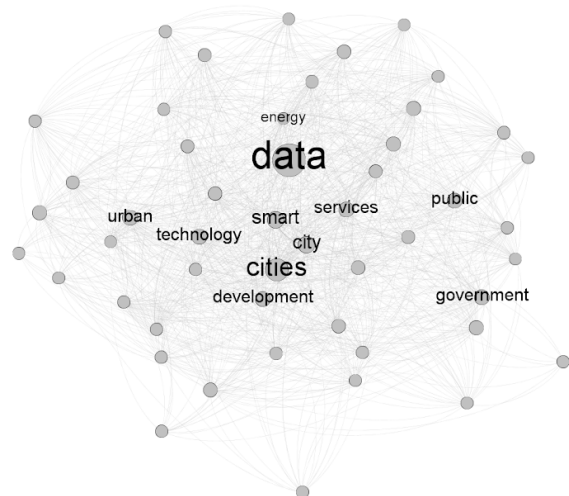Figure 1. Key issues of the governments in a smart city

Figure 2. Key issues of business in a smart city

columns of the co-operations between business and governments. Analysing only the top issues, it is remarkable, how determinant is the governmental strategy for the business and not vice versa. This is related to that the framework conditions and fundings of smart cities derived from the national or local governments.

Consequently, the key issues of the contemporary smart cities are the open data, the life quality, the governmental framework and strategy, the capable business to the city design by projects, services and developments. The most sensitive matters belong to the boundaries between the public and private sector. The next section is going to deal with their details.

B. Best Practices

Studying the best practices, the most referred cities are London, Austin, Prague and Hong Kong in the corpus, which is partially unexpected result compared to the latest smart city top lists of business and academic reviews. However, the most searched hits globally presented the following scope, presumably due to the cumulative results of the three years timeframe. All these referred cities have a strong "data" focus with special interest in open data platforms. The optimisation by projects, developments and services are also highlighted in their best practice citations.

Including the highlighted key issues, the profiles of these smart cities present different strategies. The "big data" and "open data" items of London reflect a data-driven decision making in the city strategy, which is correlate to the results of academic sources, and also, the findings of text analysis. Austin joins this data-gathering strategy by Data Rodeo building mostly as an innovative mobilisation. Prague works as a learning organisation using smart e-government with data-collections and also developing a modern public transport. Hong Kong implements also a data-technology hub which supports the sustainable mobilisation and in addition, the ICT-technologies.

Regarding the life quality, the role of the public transport and the optimised mobilisation are highlighted mostly in the best practice cases. In this context, the improvement of air quality is also a fundamental part of these examples, especially in case of Hong Kong. Austin emphasises also the mobilisation issue, additionally with available and affordable city-based services. Prague highlights the importance of sustainability and mitigation of the effects of climate change. Last but not least, London also joins these strategic elements and the city management supports the living labs to test of life quality via new implementations.

Concerning the governmental vs. business supported solutions, the competitiveness of the cities and the data-based governmental-business collaborations are cited mostly in the case studies. Illustrating with examples, the Smart London Board co-operates with the representatives of academic and leading technology sectors, while Prague, Austin and Hong Kong facilitate the local business and the hubs of global companies via accelerated and simplified public administration.

Finally, the dilemmas of the public vs. private sector are less represented in the best practice cases. The reason is probably a simplified approach, namely the mentioned cities presuppose the possible balance between public interest and the individual or community interests. In details, London is open for feedbacks by communities and neighbourhoods, Austin applies knowledge sharing and public hearings, Prague uses digital education or open evaluation system and Hong Kong invites the citizens to smart and creative development services.

To sum it up, the highlighted best practices also confirm the open or big data as key issues. The supplementary common element is the mobilisation in this part of the analysis. An unexpected result is that the smart citizenship with public and private matters is low-represented by the best practices compared to its significance.

VI. CONCLUSION

The goal of this paper was to map the key factors and best practices of contemporary smart city. Comparing the literature review to the results of the corpus analysis, smart city implementations have diverse patterns in approaches and applications. However, the data-driven logics and the goal of higher life quality are all above. Overlapped fields are the business facilitation in the framework of local government strategy, the mobilisation and public transport for liveability with less polluted air quality. Dilemmas of the public and private sectors can be resolved by improving engagement of citizens, communities and neighbourhoods in open data systems or services.

There are expectations on engagement of smart citizens by the academic reviews. However, this expectation is low-represented and less elaborated in the research corpus. The practice depends on the political decisions, fundings and the calculated cost reductions. The upcoming artificial intelligence should be more represented with clarified distinctions compared to the milestones of digital and smart services.

In conclusion, the studied documents in context of academic literature review essentially draw attention to universal key issues of contemporary smart cities, and also, emphasise on a few fundamental fields, which requires profound investigation before the area of artificial intelligence. Considering the original dilemma, namely where we were on the timeline of digital-smart-AI-based operation, "digital" and "smart" services were highlighted. The AI-based systems are partly available, which starts to support more complex landscape of contemporary smart cities.

According to key issues and best practices, one of the most undigested field is the citizen-based open data and the expected active participation of citizens in the smart cities. The future plan of the research project is to investigate the role of human factors in urban environments from citizen engagement to public or privacy matters.

REFERENCES

1. N. T. Buck, and A. While, "Competitive urbanism and the limits to smart city innovation: The UK Future Cities initiative" Urban Studies, vol. 54, issue 2, pp. 501-519, 2015, doi: 10.1177/0042098015597162

2. V. Albino, U. Berardi, and R. M. Dangelico, "Smart Cities: Definitions, Dimensions, Performance, and Initiatives." Journal of Urban Technology, vol. 22, issue 1, pp. 3-21, 2015, doi: 10.1080/10630732.2014.942092

3. Y. Mehmood, N. Haider, and I. Muhammad, "M2M Communications in 5G: State-of-the-Art Architecture, Recent Advances, and Research Challenges." IEEE Communications Magazine, vol. 55, issue: 9, pp. 194-201, 2017. doi: 10.1109/MCOM.2017.1600559

4. C. Rametta, G. Baldoni, A. Lombardo, S. Micalizzi, and A. Vassallo, "S6: a Smart, Social and SDN-based Surveillance System for Smart-cities" Procedia Computer Science, vol. 110, pp. 361-368, 2017, doi: 10.1016/j.procs.2017.06.078

5. O. Melaha, "Citizen-driven dashboards in smart ecosystems: a framework." Interaction Design and Architecture(s) Journal - IxD&A, N. 31, pp. 32-42, 2016.

6. D. T. Larose, and C. D. Larose, "Discovering knowledge in data. An introduction to data mining" 2nd Ed. New Jersey: John Wiley & Sons, 2011.

7. Ericsson Networked Society, "The three ages of megacities" [Online]. Available from: https://www.ericsson.com/assets/local/news/2012/8/ns_megacities_report_4.pdf 2012. Retrieved: 3 June 2018.

8. N. Verhoeff, "A logic flayers: Indexicality of iPhone navigation in augmented reality" In Hjorth, L., Burgess, J. and Richardson, I. (eds.) Studying mobile media cultural technologies, mobile communication, and the iPhone. NY, London: Routledge. 2012.

9. S. J. Russell, and P. Norvig, "Artificial Intelligence. A Modern Approach" 3rd Ed. Harlow: Pearson, 2015.

10. C. Cath, S. Wachter, B. Mittelstadt, M. Taddeo, and L. Floridi, "Artificial Intelligence and the 'Good Society': The US, EU, and UK Approach" Science and Engineering Ethics April 2018, Vol. 24, Issue 2, pp. 505–528, 2017, doi: 10.1007/s11948-017-9901-7

11. V. Albino, U. Berardi, and R. M. Dangelico, "Smart Cities: Definitions, Dimensions, Performance, and Initiatives." Journal of Urban Technology, vol. 22, issue 1, pp. 3-21, 2015, doi: 10.1080/10630732.2014.942092

12. D. Beer, "The social power of algorithms" Journal Information, Communication & Society, vol. 20, no. 1, 1-13, 2017, doi: 10.1080/1369118X.2016.1216147

13. I. A. T. Hashem, V. Chang, N. B. Anuar, K. Adewole, I. Yaqoob, A. Gani, E. Ahmed, and H. Chiroma, "The role of big data in smart city" International Journal of Information Management, vol. 36, issue 5, pp. 748-758, 2016, doi: 10.1016/j.ijinfomgt.2016.05.002

14. A. Degbelo, C. Granell, S. Trilles, D. Bhattacharya, S. Casteleyn, and C. Kray, "Opening up Smart Cities: Citizen-Centric Challenges and Opportunities from GIScience" International Journal of Geo-Information, vol. 5, issue 2, 16, 2016, doi: 10.3390/ijgi5020016

15. F. Salim, F. "Urban computing in the wild: A survey on large scale participation and citizen engagement with ubiquitous computing, cyber physical systems, and Internet of Things" International Journal of Human-Computer Studies, 81. pp. 31-48, 2015, doi: 10.1016/j.ijhcs.2015.03.003

16. A. Meijer, and M. P. R. Bolívar, "Governing the smart city: A review of the literature on smart urban governance" International Review of Administrative Sciences, vol. 82, issue 2, pp. 392–408, 2015, doi: 10.1177/0020852314564308

17. R. G. Hollands, "Critical interventions into the corporate smart city" Cambridge Journal of Regions, Economy and Society, vol. 8, issue, 1, pp. 61-77, 2015, doi: 10.1093/cjres/rsu011

18. IHS Markit, "Complimentary White Paper: IoT Platforms - Enabling the Internet of Things" [Online]. Available from: https://www.ihs.com/Info/0416/internet-of-things.html 2016. Retrieved: 3 June 2018.

19. McKinsey and Company, "Internet of Things" [Online]. Available from: http://www.mckinsey.com/global-themes/internet-of-things. 2016. Retrieved: 3 June 2018.

20. B. Edson by Microsoft, "Creating the internet of your things." [Online]. Available from: www.InternetOfYourThings.com by Microsoft, 2015. Retrieved: 3 June 2018.

21. McKinsey and Company, "The internet of things: Mapping the value beyond the hype" [Online]. Available from: http://www.mckinsey.com/insights/business_technology 2015. Retrieved: 3 June 2018.

22. S. B. Letaifa, "How to strategize smart cities: Revealing the SMART model", Journal of Business Research, vol. 68, issue 7, pp. 1414-1419, 2015, doi: 10.1016/j.jbusres.2015.01.024

23. Gartner Hype Cycle, [Online]. Available from: https://www.gartner.com/technology/research/methodologies/hype-cycle.jsp Retrieved: 3 June 2018.

24. Huawei Digital Economy Heat Map, [Online]. Available from: http://www.huawei.com/minisite/gci/en/index.html Retrieved: 3 June 2018.

25. Top Smart City Rankings, [Online]. Available also from: https://www.forbes.com/sites/iese/2017/05/31/the-smartest-cities-in-the-world-for-2017/ OR https://www.forbes.com/sites/chynes/2017/11/10/singapore-ranks-as-one-of-the-top-smart-cities-in-the-world/#4e260802717d (the latest ones). Retrieved: 3 June 2018.

26. M. L. Patten and M. Newhart (2018) Understanding Research Methods. 10th Ed. New York. London: Routledge.