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Smart and valued? ICT urban (transport) solutions in the city official communication

Sabina Kauf[1]✉, Iwona Pisz[2]

[1] https://orcid.org/0000-0002-5978-4490
[2] https://orcid.org/0000-0001-6079-3178

University of Opole, Faculty of Economics, Institute of Management and Quality Sciences
46a Ozimska St., 45-058 Opole, Poland
e-mail: [1]skauf@uni.opole.pl, [2]ipisz@uni.opole.pl
✉ corresponding author

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Abstract

To optimize the everyday functioning of a city, urban authorities can implement smart city tools and solutions. Mobility is a typical field associated with the concept of a smart city. It is interesting to take a closer look at the solutions applied through the information accessible on the official websites, while exploring, at the same time, the possibilities offered by new research tools. The main objective of this work is to establish the significance of the information and communication technologies (ICT) in the process of creating smart mobility in a smart city, based on the texts posted on official websites. Using the natural language processing (NLP) methods and tools offered by the CLARIN.EU infrastructure, we verified dominant connotations with the mobility in the cities recognized as smart. The cities sample is the extract from the existing smart city rankings. To fulfil our goal, we searched for an answer to the question: What information about ICT solutions is posted on the websites of the studied cities and in what thematic contexts are they used? We looked for the results of the smart city rankings, referring to the official websites of the selected cities (a random selection from a total of 174 cities). The results show that mobility forms a distinct topic in smart cities communication, covering various kinds of transport solutions and systems, with a strong focus on the project side of this activity. The results are the part of the research "The smart city 4.0 maturity model," conducted at the Department of Marketing and Logistics UO.

Introduction

The concept of a smart city was created as a response to the challenges of modern cities. Among others, this relates to the constantly growing number that populate cities, the urbanization processes, and the congestion. These phenomena cause enormous management problems and pose challenges for the transformation of urban life. The modernization of the cities' functioning methods entails the necessity to implement innovative solutions, based on digital technologies, and a cooperation between all stakeholder groups. Thanks to new solutions supported by the information and communication technologies (ICT) tools, city planners and authorities strive to improve the functioning of the city in various areas, such as mobility, resources management, crime prevention, energy, health, and education.

The combination of the real and virtual worlds (Kagermann, 2014; Hermann, Pentek & Otto, 2016) results in the emergence of a new model of urbanization and smart city development. The technologies, such as big data, the internet of things, cloud computing, and cyber-physical system, clear the way not only for the technological transformation of the city, but also for changing the lives of its inhabitants (Kupriyanovsky et al., 2016). Additionally, intelligent sensors and big data analysis enable real-time control. Thus, they support the smart city vision, which uses the most advanced ICT to provide value-added services for the city administration and its citizens (Zanella et al., 2014).

ICT transforms the smart city into an open innovation platform (Hernández-Muñoz et al., 2011), based on a ubiquitous network of sensors that meet the requirements of open, affiliated, and trusted platforms. In a smart city, economic growth is supported by information and communication technologies, which not only improve the city management, but also (and perhaps above all) stimulate social participation and the idea of sharing (Kitchin, 2015). In a smart city of this form, technologies serve people, providing them with comfort and safety, and improving the quality of life. However, it should be made clear that although technological solutions undoubtedly make life easier, when considered in isolation from the social context, they do not fulfil their role. With the above issues in mind, the aim of this article is to analyze the ways in which the cities can communicate, through their official websites, and the scope and areas of ICT application to their residents, which support not only the development of a smart city, but most of all the development of smart mobility.

Literature review – smart city in the context of the ICT solution

The concept of a 'smart city' is becoming increasingly more popular, which leads to different ways of defining it. An analysis of the literature enables a distinction between two main definitional trends: (1) a city functioning on the basis of the ICT technologies (Hollands 2008; Komninos, 2008) and (2) a new paradigm in the city development, in which the human and social capital, education, and the natural environment play a key role (Giffinger et al., 2007; Caragliu, Del Bo & Nijkamp, 2011; Lombardi et al. 2012; Neirotti et al., 2014). The technological trend of a smart city is reflected, *inter alia*, in the definition of Bakici, Almirall, and Wareham (2013), who perceive a "smart city as a high-tech intensive and advanced city that connects people, information and city elements using new technologies in order to create a sustainable, greener city, competitive and innovative commerce, and an increased life quality". IBM defines a smart city in a similar way, i.e. "A city is an interconnected system of systems. A dynamic work in progress, with progress as its watchword. A tripod [infrastructure, operations, people] that relies on strong support for and among each of its pillars, to become a smarter city for all" (Muller-Seit, Seiter & Wenz, 2016, p. 4). This definition indicates three key features of a smart city: (1) instrumentation, i.e. the presence of ICT solutions in the city (sensors and mobile devices); (2) connectivity, i.e. the availability of connections between the real and the virtual world by means of instrumentation; and (3) intelligence, meaning the ability to use new technologies in the process of the city development (Harrison et al., 2010).

The proponents of this approach claim that cities stand on the brink of a revolutionary breakthrough and will become dream cities. Every sphere of life will be digitized; applications, algorithms, and artificial intelligence will reduce congestion, prevent crime, and create free public services (Giffinger et al., 2007). However, will it really be so, or is the reconfiguration of the city to technological problems enough to make people feel good in the city? Probably not. Reconstructing the foundations of urban life, and managing the city from the technological perspective only, will lead to the cities being superficially intelligent and deeply full of injustice and inequality. Therefore, in the local government practice and in research discourse, the second trend of understanding the smart city is increasingly more often dominant, which transverse far beyond its technocratic perception. From this perspective, technological solutions only support the smart city, but thanks to them, it is easier to assemble information and a political vision into a coherent program for the improvement of the city and its services.

New technologies are an instrument for creating cities that are able to connect physical and social capital, provide improved services, and create infrastructure at a very high level of quality. This approach is reflected in the definitions of Caragliu, Del Bo, and Nijkamp (2011), who wrote the following: "We believe a city to be 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 governance" This trend is also followed by Komninos (2008), who assumes smart cities to be the "territories with high capacity for learning and innovation, which is built-in the creativity of their population, their institutions of knowledge creation, and their digital infrastructure for communication and knowledge management". A broader overview of the definition of a smart city has been described by Albino, Berardi, and Dangelico (Albino, Berardi & Dangelico, 2015).

A modern smart city is a concept that listens to the needs of its residents and naturally adapts to them. Technologies functioning in the city serve people by providing them with comfort and safety and increasing their quality of life. Nevertheless, as mentioned above, we know that technological solutions undoubtedly make life easier; however, when considered in isolation from the social context, they do not fulfil their role. That is why R. Robinson refers to the need for the mutual implementation of the vision of cities in the future, i.e. top-down, implemented by the authorities, and bottom-up, controlled by citizens (Robinson, 2015). If a city wants to be really smart, it must be a common space of stakeholders involved in developing ideas and creating innovations (Fritz et al., 2018).

In the context of modern information technologies, we can define a smart city as an "information technology combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems" (Townsend, 2013, p. 15). A smart city is defined as a city in which ICT is merged with classic infrastructures, coordinated, and integrated using new digital technologies (Batty et al., 2012). Mitchell defines a smart city as an "intelligence based on the increasingly effective combination of digital telecommunication networks (the nerves), ubiquitously embedded intelligence (the brains), sensors and tags (the sensory organs), and software (the knowledge and cognitive competence)" (Mitchell, 2007). It does not exist in isolation from other urban systems or is linked to them only through human intermediaries. There is a growing network of overlapping connections ranging from mechanical and electrical systems installed in buildings to the systems embedded in household appliances, transport systems, electrical networks, plumbing, and urban security. Various definitions of a smart city indicate that the concept of a smart city is constantly evolving, which is a consequence of urbanization and digitization.

ICT technology, smart city, and mobility – relationships and dependencies

Creating a smart city based on ICT will solve various problems that cities experience. The largest influence of ICT on the execution of the smart city concept is in the area of smart mobility, which means an enormous web of connections, transport, and communication, with a large speed that connects all the resources of the city (Stawasz, Sikora-Fernandez & Turała, 2012, p. 100). Smart mobility is narrowly connected with the implementation of ICT technologies and intelligent systems of transport (ITS). ICT technologies can be divided according to the level of its costs. In the first group, there are low-cost solutions related to the managing of applications that control the traffic lights of crossings and messages shown on boards with changeable data (VMS). In this group, there are also systems of automatic identification of vehicles (AVI). To solutions with higher costs, we place, for example, telematics that are a connection of countable technology (IT) with telecommunication. Its implementation in a macroscale allows, for instance (Kauf, 2019), the (1) increase in the safety of traffic and a lowering of the costs of external transport, (2) a reduction of pollution in the natural environment, and (3) a development of the intermodal transport. They also facilitate easier management of public transport – thanks to monitoring and controlling the fleet, improved access to information from users in real time, and the ability to plan a journey and create intelligent systems of transport (ITS). The main goal of which is to support, control, and manage the processes in transport as well as to connect these systems.

In a smart city, data platforms become the basis for a comprehensive digital transformation, which enables the identification and adaptation of solutions to specific problems of the city. They will facilitate partnership with the private sector as well as allow the residents to observe and value changes and, most importantly, be their co-creators. ICT enables the citizens, via their smartphones, to become mobile recipients of urban life and to take an active role in the life and creation of the city. The cloud technologies, and the development of wireless Internet, have become the basis for studying the flow of residents in specific transfer nodes, adapting traffic, and the intensity of public transport to the needs of residents, as well as automatic change of traffic lights. The residents of today's cities can use many services through their phones, such as public transport tickets, as well as submit comments on the functioning of the metropolis to its authorities. One of the examples is the Warsaw mobile application, through which citizens can inform municipal services about faults, neglected vegetation, or acts of vandalism. Intelligent transport systems improve the city traffic by providing drivers and authorities with information about the current situation on communication routes. The city of Bucheon in Korea may serve as an example, where IBM has installed a camera system linked to the software that counts vehicles on the road. Thanks to them, the residents and city authorities were able to react faster and better to traffic jams. Equipping public transport stops, for instance, with an interactive information board and a Wi-Fi transmitter enables the collection of information about the number of people and the times with the highest traffic (Guanochanga et al., 2018). Equipping buses with beacons (small devices that send a radio signal and communicate with smartphones via Bluetooth connectors) and the combination of both 'digital traces', makes it possible to analyze the entire journey of travelers and to optimize the adjustment of the number of public transport vehicles to the actual needs. Equipping buses with ICT, measurably helps the travelers themselves, for example, through the Google Maps application, which checks train and bus timetables on an ongoing basis and informs about real-time changes (Lange, 2018). Therefore, when opening Maps, the exact time when the means of public transport appear at the stop can be seen.

The use of ICT in the mobility area connects the road users with the road infrastructure and information systems. Real-time information allows improved planning of the journey and facilitates the choice of the means of transport (especially in multimodal journeys), including more effective management of traffic. The basis for the development of intelligent transport systems are technological solutions, such as telematics. In a smart city, thoughtful and effective traffic management meets the needs of various groups of stakeholders who are the users of city infrastructure. Thus, the pursuit of intelligent mobility is not tantamount to the expansion of the transport infrastructure and building new lanes, but it means efficient use of space and creating real alternatives to individual transport. Such activities create an opportunity for a qualitative change, i.e. the improvement of the natural environment and living conditions in the city. Achieving satisfactory results in this area, and implementing the smart mobility idea, is a real challenge for the city as the authorities have to face the following problems:

- development and implementation of effective, sustainable, and safe public transport systems, including Mobility-as-a-Service solutions and other travel planning platforms;
- adapting to innovations in the field of mobility and acceptance of vehicles (i.e. electric, autonomous, shared, and communicating with each other);
- development of guidelines and strategies for meeting air quality standards, and maintaining them at the level specified by EU and national legislation;
- development of public-private partnership and cooperation with academic and research centers to solve the problems of environmental pollution, congestion, and sustainable development;
- construction of sustainable infrastructure (physical and digital) that support innovative mobility solutions offered by the public and private sectors.

Currently, there is probably no city in the world where the reality of urban mobility meets the needs and preferences of its residents while guaranteeing, at the same time, safe, clean, reliable, and cost-effective ways of traveling to your destination. Therefore, the key challenge of a smart city is to create such conditions for mobility that allows the reduction of congestion, road accidents and collisions, and, above all, reduce the negative impact on the natural environment.

In conclusion, the use of ICT allows improved management of mobility in the city and stimulates the inhabitants to cooperate. Smart city, based on ICT technology, i.e. integrating new technologies and innovative ideas, concepts, and solutions, requires cooperation and strategic partnerships. Only then will it be effective and efficient. It will guarantee improved quality-of-life for residents and enables the cities to cope with new challenges.

Research methodology

Optimizing the functioning of a smart city requires the use of appropriate ICT tools and solutions, whose task is to facilitate the movement within the city and reduce congestion. Therefore, an attempt has been made to analyze the applied and implemented ICT solutions on the basis of the available information on the official websites of the smart cities. The pilot study used thematic modeling tools to identify the main themes of the ICT-related communications offered by the cities. The research was carried out with the use of natural language processing methods and tools, which enabled a differentiation of the thematic groups concerning ICT in urban transport. To achieve our goal, we searched for an answer to the question: What information about ICT solutions is posted on the websites of the surveyed cities? We assumed that the thematic models (the topics) revealed in the study reflect the main uses of the ICT. The research procedure consisted of five stages, which are shown on Figure 1.

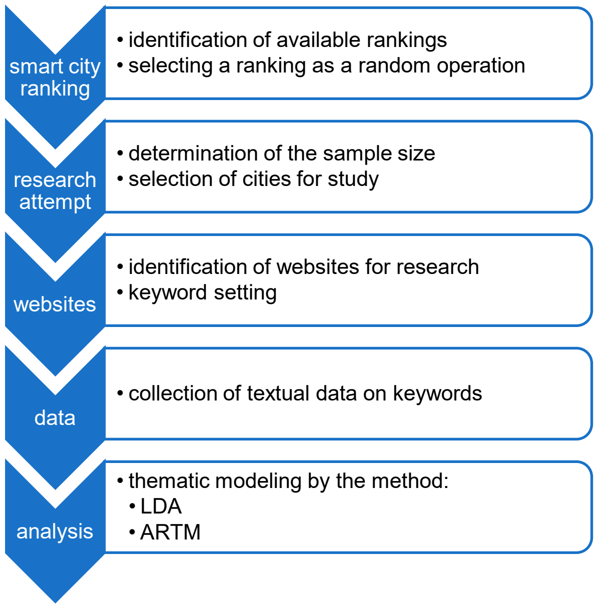

Figure 1. Schematic of the research procedure

Stage 1 consisted of the selection of city rankings, i.e. the smart city rankings were searched on the websites. There were 16 cities selected, in which the complete lists of the cities included in the ranking were available. The number of ranked smart cities ranged from 20 to 174, and the analyses were carried out at different time periods.

Stage 2 focused on the selection of the research sample. It was assumed that the most appropriate method would be to use representative methods. Thus, the size of the sample included the following: (1) internal differentiation of the general population features (variability of phenomena); (2) the applied sampling scheme, which largely determines the effectiveness of the study; (3) the adopted level of reliability of the results, i.e. the confidence level; (4) the method used to estimate the parameters characterizing the community; and (5) the available financial resources. It should be added that an increase in the sample size increases the precision of the estimator. However, the overall size of the sample does not depend on the size of the population, but on internal differentiation. Considering the above, the acceptable margin of statistical error was established at the level of 5% (for the confidence level $\alpha = 0.95$), while the population fraction equals 0.5 and the population size comprises 174 smart cities. The randomized survey was a list of 174 cities in the world, which were included in the IESE Cities in Motion Index prepared in 2019 (Berrone & Ricart, 2019). This ranking included the largest number of cities and was the newest available, in which a complete list of the analyzed cities was published. If the sampling procedure was used, the necessary sample size was set at 120 cities. Nevertheless, due to the preliminary nature of the research, it was decided to study only a small number of cities, without keeping the minimum sample size. Out of 174 cities selected for this analysis, number 10 was adopted as the sampling interval using systematic selection, which enabled the selection of 17 cities, i.e. Tokyo, Los Angeles, Wellington, Gothenburg, Edinburgh, Lyon, Santiago, Seville, Moscow, Nottingham, Athens, Naples, Doha, Cordoba, Salvador, Novosibirsk, and New Delhi.

Stage 3 was dedicated to the selection of websites, i.e. the websites of the cities selected for the study were identified and the keywords were specified (*inter alia*, smart city, technology, and sustainable development). Stage 4 was the collection of text data. For the selected links, all of them returned by a Google search were collected, i.e. site X, "Y", where X is the website address and Y is the search term (quotation marks mean a direct hit to the content page). Such identified links, with matching text, were processed using Newspaper3k to download the content of the page. Using this method, a set of texts was obtained, which were analyzed through thematic modeling (Walkowiak & Gniewkowski, 2020), using the Multilingual Topic tool provided by the CLARIN.PL research infrastructure, via the web service portal (http://ws.clarin-pl.eu/). First, the clusters of non-randomly occurring words were distinguished by: (1) creating a model of the coexistence of words (giving information on how often certain words accompany each other throughout the body and in individual texts) and (2) calculating the probability of the occurrence of individual words in a random text extracted from the corpus. Then the words were linked in the so-called topics, i.e. the sets of words that coexist with each other. By means of statistical operations, such sets of words were distinguished, which probably do not coexist with each other by chance (the sum of the probabilities of occurrence must be 1).

Stage 5 concentrated on the text processing using the CLARIN infrastructure. The LDA and ARTM algorithms were used to extract topics. This enabled a definition of the thematic coherence, i.e. the content connections of the meanings of words that make up a single topic. The results are presented graphically. The size of the words in the graphic representation of the topic depends on the relative frequency of occurrence, i.e. the probability of the word occurrence in each document of the corpus.

Research result

The results were obtained for both methods, using LDA and ARTM algorithms to confront the reliability of the topics identified for predetermined keywords. As combinations, we used such keywords as "smart city", "ICT", sustainability, and technology. The final documents are accessible in various formats; for ease of interpretation, we chose distance mapping with clouds of words. Among 20 topics provided by both basic algorithms (LDA and ARTM), we selected those which contained the words referring to the mobility subject. For each analysis, the algorithms made 50 iterations on the blocks measuring 20 000 bytes (but respecting words length in each block). Each topic represents a distinct set of words from the texts that are included into the analyzed corpus. These topics – with statistical significance – denote different aspects of the subject described in analyzed texts. Part of the identified topics grouped words in other languages (i.e. Russian, Spanish, Italian, and Swedish) since the topic modeling tool operates in one language at a time. We chose English for the analysis as the most commonly used and accessible language, even on the websites of non-English speaking countries.

The initial data contained 4023 files in the txt format for almost all cities (except for Athens, for which any information with "smart city" notion existed in the moment of website scanning). Many of these files contained disclaimers, comments, lists of tabs, or links, so the necessary selection was reduced to 1498. Afterwards, they were grouped into thematic sets, containing 205 text files for the ICT theme, 196 for sustainability, 390 for smart, and 698 for technology. Not every city had a balanced set of texts; some keywords were lacking in the corpus, but the analysis produced a few interesting features (see Figure 2). The observations are ordered in two columns, respectively, for the algorithms used, i.e. on the left, the LDA modeling is shown, on the right – the ARTM. Words from the mobility field, such as "transport", "vehicle", "car", or "traffic", are weakly synchronized with ICT (images (a) and (b)), but the identified topic sets it together with the "city" and "project" notions.

It can be indicated that, in the analyzed corpus, the ICT used in the mobility field coupled with various projects executed or planned for the cities. The mobility vocabulary was more often present in the topics related to such notions as "smart", "sustainability", and "technology". In the case of the "smart" topic, the mobility vocabulary coexists with the system and city notions, which can be seen as confirmation of the perspective adopted in official communication offered by the authorities governing the analyzed cities. In the "technology" context, mobility is exposed as relating to the service (in LDA-led processing) or to the city project (in ARTM transformation results). In case of the "sustainability" topic, the mobility couples with residents (LDA version) or other stakeholders, such as students, experts, people, users, institutions, or conferences. Considering only the consistency of the word cloud that represent each topic, we can see that the LDA analysis provides a more coherent view of the aspects presented by the topic, while ARTM gives a less homogenous view of the themes present in the studied corpus.

Other interesting features of the identified topics are linked to the mobility vocabulary, e.g. more infrastructure-connected in the "smart" context or user-oriented in the "sustainability" milieu. Although the thematic sets were disjointed, as they regarded such keyword as "ICT", "sustainability", "technology", and "smartness", some lexical relationships endured in the majority of topics; for example, the terms "city – transport" arose when searching with keywords such as "ICT" and "sustainable development". The words "city – project – system – transport", however, were present in the topics for which the following keywords were used: "ICT" and "technology". For each 30-word set, apart from the mobility vocabulary, we can identify some notions that are used to describe the same reality as the keywords searched in the texts, extracted from official websites.

Discussion

The results of the topic modeling used to extract the most relevant vocabulary from official information published on the websites of the smart cities seem to be promising in many ways. Thanks to the CLARIN-PL support, the search time and extraction of texts from various kinds of documents (printed materials, websites, audio materials, etc.) was shortened significantly. The methods used by CLARIN-PL allow for an exploration of the groups of co-occurring words, which describe the activities depicted in such texts by the frequency of their use in the analyzed documents. With a larger initial set, some hypotheses in the inductive research process can be sustained or denied. Our pilot research confirms that the used method is appropriate for the processing of large collections of texts and provides important results in the form of meaningful

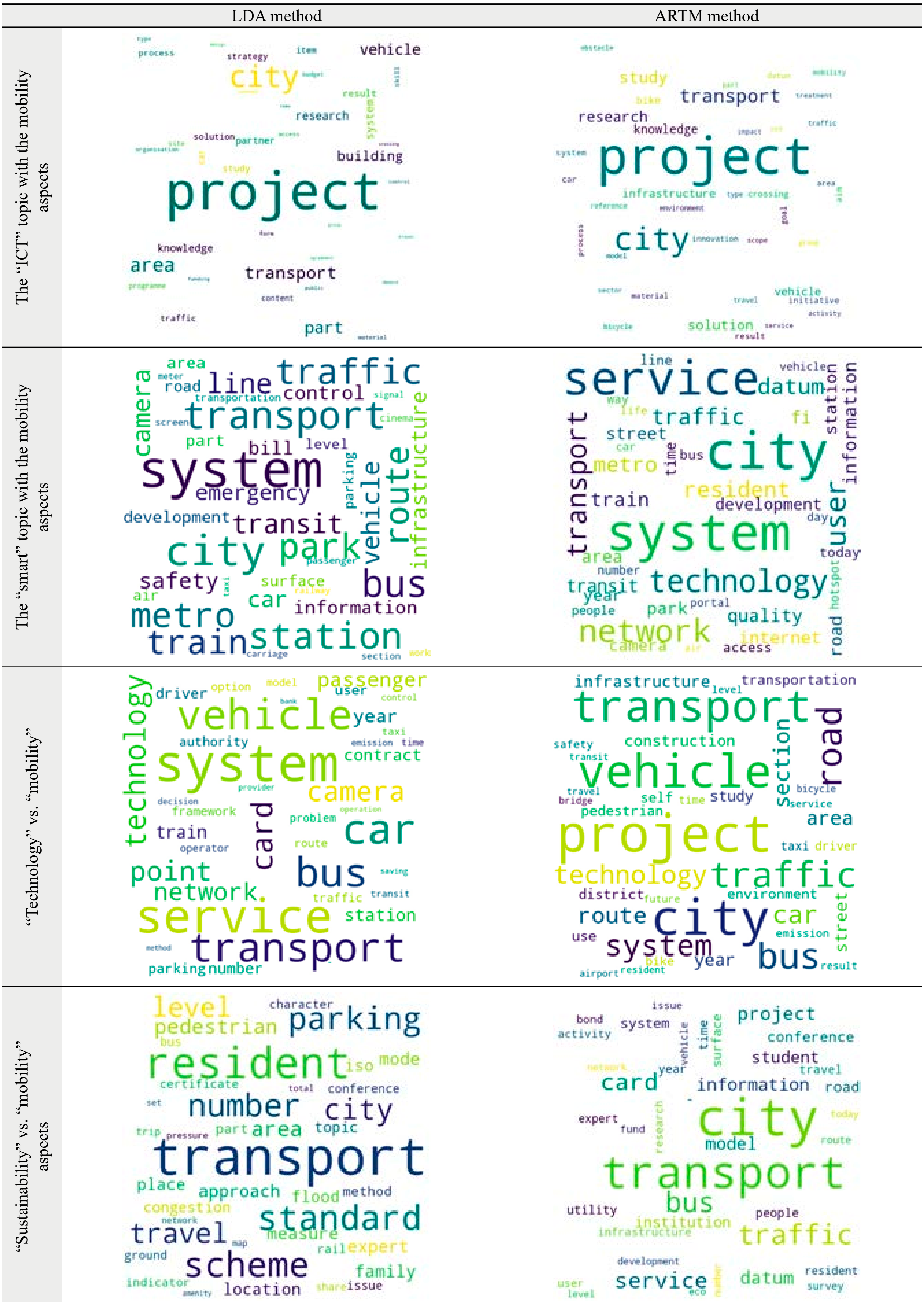

Figure 2. Results obtained from selected smart cities websites that communicate the topic modeling method

topics that describe a given issue from different perspectives.

Even if the method used is statistically accurate, the problem of interpreting the results obtained is still a challenge. It requires an examination into the base body of the texts and carrying out a deeper analysis of their functions, their sender, and the recipients. An interesting case in this aspect is Moscow, whose official communication on the website largely focuses on the representatives of the city authorities and their activities. In contrast, the Gothenburg communication refers mainly to the events, without exposing the roles of the authorities. Even in such a limited form, our study signals the possibility to identify differences in the way information is formulated among the considered cities. In the collected texts, the thread of the initiating activities is strongly exposed, which is manifested by the word "project" present in most topics. The implemented solutions are accompanied by research ("study", "survey", and "respondents") and they are systemic in nature.

It should be noted that environmental expressions are very poorly represented in the topics referring to mobility in smart cities. In the context of "technology" we can find "environment" and "emissions" (ARTM method), while in the case of "sustainability" we have "congestion" (LDA method) and "air" is denoted by both methods for the "smart" topic. Such a situation may result from a small sample size or by mainly associating the concept of a smart city with technological advancement, omitting the environmental effects. In addition, it should be emphasized that the cities used for this study represent the entire cross-section of rankings, i.e. from those that occupy the highest places to those placed in the last positions. This surely has an impact on the outcome of the study, as the cities included in it represent a diverse level of awareness and needs, resources and capabilities of action, and the sophistication of the implemented solutions. The results of our study indicate that the ICT solutions are poorly linked to mobility in the selected cities. By contrast, in the technology-related topics, the mobility concepts are clearly represented. The absence of solutions from the known literature, mentioned in item 3, may be puzzling. It seems that, on the one hand, this is influenced by the specificity of websites with information addressed to residents and, therefore, given without or with simplified specialized vocabulary. On the other hand, the variety of available solutions results in a lower frequency of occurrence of their names and, consequently, less visibility for the search algorithm.

In this context, it is noteworthy that the dominant technological solution used in the studied smart cities are cameras, clearly present in the "technology" and "smart" topics. Then again, in the "smart" topics, the concepts related to the transmission of information ("hotspot", "portal", "signal", and "screen") and means of transport ("train", "bus", "car", and "metro") with its basic infrastructure are mentioned. It is interesting that most expressions relating to the smart city stakeholders appear in the context of sustainability ("expert", "student", "user", "pedestrian", "resident", "family", and "institution"). This situation may result from an account of the social aspect in the dimension of sustainability to a greater extent than in other contexts (technology, either ICT or smart). However, the absence of concepts related to ecology is puzzling. Is this dimension of sustainability so obvious that it is not mentioned on the websites of smart cities? In order to interpret the obtained results to a high standard, it is necessary to examine the websites of the studied cities and verify the other research questions that were formulated in the process of our analysis. This will be the next step in our research, which is beyond the scope of this study. The pilot studies conducted so far shows that the applied thematic modeling procedure is a useful tool at the initial stage of research, which contribute significantly to the construction of a set of research questions that make a multifaceted analysis of the studied phenomenon possible.

Conclusions

The relatively limited number of cities covered by this study, during the pilot study, enabled the formulation of careful conclusions only. We note the usefulness of the method employed to explore large sets of text data and to extract statistically significant topics from them. However, their preparation is time-consuming and their interpretation cannot be undertook without a reference to the original texts. In light of the conducted research, we can conclude that in the analyzed sample of cities and texts, the connection between the concept of a smart city, broadly understood mobility, and ICT technologies was confirmed. Still, the aspect of environmental friendliness is poorly represented. Even if the selected cities have sustainable development strategies, this thread in the acquired texts is hardly visible.

The obtained results confirmed that smart cities are based on new information technologies, which they communicate to residents on their official websites. However, these technologies are not always associated with mobility and transport. This may be due to the fact that the information was obtained from the official websites of cities, and not from public transport entities for which the use of ICT seems obvious. Nevertheless, the obtained research results should send a signal to the city authorities that the information provided through official channels (i.e. websites) on the scope of the ICT implementation for mobility is insufficient. Therefore, the city residents may not have adequate knowledge about the smart mobility development. This conclusion creates further directions for future research exploration, which may allow the identification of the scope of the ICT usage in smart mobility. One of them may be an analysis on the residents' opinions expressed in social media or in comments posted on official websites. The information obtained by this method could, for example, be the basis for the evaluation of smart mobility implementations, and possible corrections that enable an improved response to the needs of residents that encourages them to use public communication more often.

References

1. Albino, V., Berardi, U. & Dangelico, R.M. (2015) Smart cities: definitions, dimensions, performance, and initiatives. *Journal of Urban Technology* 22(1), pp. 3–21.
2. Bakici, T., Almirall, E. & Wareham, J. (2013) A smart city initiative: the case of Barcelona. *Journal of Knowledge Economy* 4, 2, pp. 135–148.
3. Batty, M., Axhausen, K., Giannotti, F., Pozdnoukhov, A., Bazzani, A., Wachowicz, M., Ouzounis, G. & Portugali, Y. (2012) Smart cities of the future. *The European Physical Journal Special Topics* 214, pp. 481–518.
4. Berrone, P. & Ricart, J.E. (2019) *IESE Cities in Motion Index*. [Online] Available from: https://media.iese.edu/research/pdfs/ST-0509-E.pdf [Accessed: February 06, 2022].
5. Caragliu, A., Del Bo, Ch. & Nijkamp, P. (2011) Smart cities in Europe. *Journal of Urban Technology* 18, 2, pp. 65–82.
6. Fritz, M., Rauter, R., Baumgartner, R. & Dentchev, N. (2018) A supply chain perspective of stakeholder identification as a tool for responsible policy and decision-making. *Environmental Science & Policy* 81, pp. 63–76, doi:10.1016/j.envsci.2017.12.011.
7. Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanović, N. & Meijers, E. (2007) *Smart Cities: Ranking of European Medium-Sized Cities*. Viena: Centre of Regional Science (SRF), Vienna University of Technology.
8. Guanochanga, B., Cachipuendo, R., Fuertes, W., Benitez, D.S., Toulkeridis, T., Torres, J. & Meneses, F. (2018) *Towards a RealTime Air Pollution Monitoring Systems Implemented using Wireless Sensor Networks: Preliminary Results*. IEEE Colombian Conference on Communications and Computing (COLCOM), doi:10.1109/colcomcon.2018.8466721.
9. Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J. & Williams, P. (2010) Foundations for smarter cities. *IBM Journal of Research and Development* 54, 4, pp. 1–16, doi: 10.1147/JRD.2010.2048257.
10. Hermann, M., Pentek, T. & Otto, B. (2016) *Design Principles for Industrie 4.0 Scenarios*. Proceedings of 49th Hawaii International Conference on System Sciences (HICSS), 3928–3937, doi: 10.1109/HICSS.2016.488.
11. Hernández-Muñoz, J.M., Vercher, J.B., Muñoz, L., Galache, J.A., Presser, M., Hernández Gómez, L.A. & Pettersson, J. (2011) Smart Cities at the Forefront of the Future Internet. In: J. Domingue et al. (Eds.): *Future Internet Assembly*, LNCS 6656, pp. 447–462.
12. Hollands, R. (2008) Will the smart city please stand up? Intelligent, progressive or entrepreneurial? *City* 12, 3, pp. 303–320.
13. Muller-Seit, G., Seiter, M. & Wenz, P. (2016) *Was ist einer Smart City? Betriebswirtschaftlichem Zugange aus Wissenschaft und Praxis.* Wiesbaden: Springer Gabler.
14. Kagermann, H. (2014) Chancen von Industrie 4.0 nutzen. In: Bauernhansl T. & Hompel M. (eds). *Industrie 4.0 in Produktion, Automatisierung und Logistik. Anwendung, Technologien und Migration*. Vogel-Heuser, pp. 603–614.
15. Kauf, S. (2019) Smart logistics as a basis for the development of the smart city. *Transportation Research Procedia* 39, pp. 143–149.
16. Kitchin, R. (2015) Making sense of smart cities: Addressing present shortcomings. *Cambridge Journal of Regions. Economy and Society* 8, pp. 131–136.
17. Komninos, N. (2008) *Intelligent Cities and Globalisation of Innovation Networks*. London–New York: Routledge.
18. Kupriyanovsky, V., Bulancha, S., Kononov, V., Chernykh, K., Namiot, D. & Dobrynin, A. (2016) Integration of Industry 4.0 technologies for "smart cities" development. *International Journal of Open Information Technologies* 4 (2), pp. 41–52.
19. Lange, M. (2018) From real-time city to asynchronicity: exploring the real-time smart city dashboard. In: *Time for mapping*, pp. 238–255. Chapter doi: 10.7765/9781526122520.00021.
20. Lombardi, P., Giordano, S., Farouh, H. & Yousef, W. (2012) Modelling the smart city performance. *The European Journal of Social Science Research* 25(2), pp. 137–149, doi: 10.1080/13511610.2012.660325.
21. Mitchell, W.J. (2007) Intelligent cities. [Online article]. *UOC Papers* 5. Available from: http://www.uoc.edu/uocpapers/5/dt/eng/mitchell.pdf [Accessed: February 06, 2022].
22. Neirotti, P., De Marco, A., Cagliano, A.C., Mangano, G. & Scorrano, F. (2014) Current trends in smart city initiatives: Some stylised fact. *Cities* 38, pp. 25–36.
23. Robinson, R. (2015) Reclaiming the "Smart" agenda for fair human outcomes enabled by technology. [Online] March 20. Available from: https://theurbantechnologist.com/2015/03/20/reclaiming-the-smart-agenda-for-fair-human-outcomes-enabled-by-technology/ [Accessed: February 05, 2022].
24. Stawasz, D., Sikora-Fernandez, D. & Turała, M. (2012) Koncepcja smart city jako wyznacznik podejmowania decyzji związanych z funkcjonowaniem i rozwojem miasta. *Zeszyty Naukowe Uniwersytetu Szczecińskiego* 721, Studia Informatica Nr 29, pp. 97–109 (in Polish).

25. Townsend, A.M. (2013) *Smart cities: Big data, civic hackers, and the quest for a new utopia*. London: WW Norton & Company.
26. Walkowiak, T. & Gniewkowski, M. (2020) Distance Measures for Clustering of Documents in a Topic Space. In: Zamojski, W., Mazurkiewicz, J., Sugier, J., Walkowiak, T. & Kacprzyk, J. (eds) *Engineering in Dependability of Computer Systems and Networks. DepCoS-RELCOMEX 2019. Advances in Intelligent Systems and Computing* 987, pp. 544–552. Springer, Cham, doi: 10.1007/987-3-030-19501-4_54.
27. Zanella, A., Bui, N., Castellani, A., Vangelista, L. & Zorzi, M. (2014) Internet of things for smart cities. *IEEE Internet of Things Journal* 1, 1, pp. 22–32, doi: 10.1109/JIOT.2014.2306328.

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