**Smart Structures and Systems**, *Vol. 27, No. 3 (2021) 435-445*
DOI: https://doi.org/10.12989/sss.2021.27.3.435


# Expectation of smart mentality and citizen participation in technology-driven cities

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(*Received October 10, 2019, Revised December 22, 2020, Accepted January 16, 2021*)

**Abstract.** The purpose of the paper is to investigate the expectations of smart mentality and citizen participation in technology-driven cities. 150 mainstream trend reports, white papers, and research summaries are analyzed in one corpus as business, governmental, and university research cooperations. The changing trends of the related academic literature frame the study. Keyword statistics, word pairs, content networks, and correlation matrix reveal the expected citizen participation. The most referenced top ten cities and their strategies support the understanding of the smart mentality behind the participation. According to the findings, open data, communities, collective participation, socio-technical engagement, and empowerment are the most expected human factors. Anonymity, neighborhood-based implementations, and temporary human roles are underrepresented in the corpus, as well as the privacy concerns and ethical issues. However, the emerging AI technology and the interpretative metaphors with rainforest, team player, and public agora urge a focus also on these indicators with a contribution of citizen engagement. The paper provides governmental policymaking and the academic research of technology-driven cities with a citizen-centric and complex summary.

**Keywords:** smart citizen; smart city; technology-driven cities; intelligent environments; civic participation; community; smartmentality; open data; empowerment; privacy; ethics; interpretative metaphors

## 1. Introduction

The smart or technology-driven city is trending now in governmental, business strategies and in academic research not only with adjective "smart" but also, with further definitive prefixes "cognitive" and "intelligent" (among others Ishida 2017, D'Onofrio and Portmann 2017). The "smart" category has already referred to certain human sensing and control regarding digital operation. Alternatively, categories of "cognitive" and "intelligent" presuppose a more complex operation that probably becomes comparable to the human substances as constant reference points in terms of philosophy.

In parallel to the extensions of artificial creations, the attention has been increasingly on human participation and mentality in the context of smart or intelligent environments. The reason behind this growing interest is that human existence has been less and less available to investigate independently of the current technology which feeds on data sets of the general public and its surrounding services. This trend is also reinforced by the so-called black-box model with machine learning holding specific risks (Rudin and Radin 2019) from biased decisions to a low level of transparency in society. Thus, trustworthy and societal-aware smart and AI technology started to be in the spotlight (Pedreschi and Miliou 2020) as a countertrend of the focus in technology. Consequently, the human factor has become less insightful in itself and the technological environment has become the main driver of human participation. It is therefore suggested to identify the expected contemporary human participation and the adaptive mentality while it is available. The results may improve the non-human substances, although that is not the subject of this study.

One of the most pervasive digital environments, namely smart cities, allows a complex investigation of human factors in the previously mentioned field. Technology-driven cities assume not only a digitalized infrastructure with an intelligent service network and data-driven decisions (Feher 2018), but also, an ongoing reflection flow of citizens, communities, or any other kind of human participation. Moreover, reflections and adaptations of users are also shaping digital developments. This interactive connection between technology and the general public results in a field to be explored for interpretation of smart city landscapes.

Additionally, a significant approach, smartmentality (Vanolo 2014) proposes a conscious and reflexive usage of digital technology. Although Vanolo discussed this term concerning the responsibility of policymaking and political-financial decisions, this term might also be extended to smart citizens and their networks. Their mindset, attitude, and adaptive behavior play a pervasive role in responsible activities, engagements, or experiments. This concept is also considered for liveability, quality of life, predictability, comfortable lifestyle, and human values (Gudowsky *et al.* 2017, Hernafi *et al.* 2016). Consequently, the efforts of

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ISSN: 1738-1584 (Print), 1738-1991 (Online)

citizens reflect well-being when they apply smart technology deeply into technology-driven cities.

In line with this, the goal of this paper is to investigate the expected participation or mentality of individuals and collective users in technology-driven cities. To study the contemporary strategies of co-operative business-government-university research projects, a research corpus has been created via mainstream executive summaries, trend reports, white papers, and future visions. Investigating this corpus, the paper summarizes the most cited human aspects of digitally defined urban environments presenting topic networks and their case studies. The ultimate goal is to understand, how the current and future city landscapes are shaped by human-centric strategies, and also, to support the business and political decision making with a global synopsis.

## 2. Changing trends in the literature. A short review

According to the scholarly databases, the number of academic papers about smart cities has grown rapidly in the last decade (Lim *et al*. 2018). Investigating only a few major public and restricted databases (from Google Scholar to Science Direct, EBSCO, or JSTOR), the intensive interest started to grow around 2011 and multiplied in the last decade.

Smart services and their converging developments have become only one of the reasons behind this trend (Soto *et al*. 2015).

First, the base of these services is the civil infrastructure, in the context of smart citizenship. The civil infrastructure is needed to maintain and manage to support human activities (Fujino *et al*. 2009) in a sustainable way (Myung *et al*. 2014) with sensing systems, wireless communication (Boller *et al*. 2015, Yu *et al*. 2010), mobile devices (Jeong *et al*. 2016), various robotics and automation technologies to build environments (Mondal and Jahanshahi 2020, Myung *et al*. 2014). The large-scale systems with a large number of sensors and actuators for remote monitoring have a great potential to help infrastructure owners obtain more and up-to-date knowledge of their structures to also influence societal factors and decisions (Shrive *et al*. 2009). The connected environmental services support urbanization and efficient urban governance (Daramola and Olowoporoku 2017) in particular if citizens' smartphone data also accurately assists the human-induced measurements (Chen *et al*. 2016).

Second, the promise of artificial intelligence (AI) technologies (Burgess 2018) with cognitive or intelligent services has been anticipating a structural change with higher complexity integrating IoT, cloud computing, machine learning, deep learning, neural networks, and robotics. Smart cities are becoming even more technology-driven cities, serving as a framework for either smart or AI technology. However, research studies focus mainly on technology with these approaches.

In parallel, the summarized digital transformation facilitates a changing view of governmental and business strategy in the cities, especially regarding institutional change and the attitudes to adaptation of their citizens (among others Meijer and Bolívar 2016). Therefore, the massive non-human focus from AI to robotics also promotes the human factors to be investigated more deeply. Concurring with the idea of Gudowsky and his co-authors (Gudowsky *et al*. 2017), societal needs, demand-side thinking, inhabitant participation in policy economy provide a contemporary perspective in smart city strategies. In close association with this, it is also probably necessary to rethink the social infrastructure (Han and Hawken 2018) beyond the, above mentioned, predominance of technological view or civil infrastructure. Thus, highlighting the human factors in a smart city context has become essential before the next steps towards the black-box model (Rudin and Radin 2019).

The goal of this paper to contribute to this discourse with a three-dimensional investigation as governmental, business, and university research summaries. Considering the forthcoming technological impact, the specific part of the city strategies should include the citizens with their data sets and digital footprints (Feher 2017) via online or sensorized systems, and also, their activities and engagement to smart environments. Although this view has still been less pronounced compared to the technological view, its significance has been increasing (see the analyzed corpus below), as well as in the case of academic research (among others Benoit and Hiroko 2016, Thomas *et al*. 2016) if the latter shows less intensity.

Beyond the criticism of publication numbers, conceptual considerations are suggested. Two specific academic sources are significant in arguing the fundamental problems with smart city definitions which results in non-proper interpretations of smart citizenship. First, Vanolo (2016) emphasizes how smart urbanism is a poor concept because of ambivalent concepts. According to his critics, freedom, privacy, or activities of citizens are less significant in smart city strategies as it seems necessary (Vanolo referring to Isin and Ruppert 2015). According to his consideration, a "public agora" would be expected with the responsibility of citizens. Additionally, Neirotti and his co-authors (Neirotti *et al*. 2014) emphasized that without a universal definition of the smart city there is no available cornerstone for smart citizens and only the local context or financial resources shape the characteristics of a technology-driven city. Considering this approach, the cultural-social-economic framework determines the smart citizens in different cities in various ways. These citizen-focused concepts are triggering to put citizens in the spotlight beyond the non-comprehensive smart city definitions.

Concluding the literature review, the growing infrastructural or technological academic sources (among others Barns *et al*. 2017, Phdungsilp 2011) facilitate growing attention to human factors (among others Gudowsky *et al*. 2017) and citizen-based strategies. In the context of the upcoming human and non-human structural changes, simplified smart city definitions, or just technology-focused concepts are now insufficient. Nevertheless, a citizen-based or systematic cultural-social-economic approach improves future city strategies.

Therefore, it is necessary to map globally and systematically the landscape of the smart city and smart

citizen approaches together to understand the previously mentioned issues. Following this goal, transdisciplinarity (Gudowsky *et al*. 2017, Brown 2015) and deep analysis of related documents will be supported to summarize recommendations for strategies of future cities. The following analysis of a globally filtered corpus has been developed, inter alia, for this purpose.

## 3. Research questions and methodological considerations

Following the research goal and the emerging trends, an investigation of expected participation and mentality in technology-driven cities is in the spotlight. A global corpus was built to analyze the related current trends and to understand the expected human functions. Considering the literature review, the connected term "smartmentality" (Vanolo 2014) was also in the focus as the role of the citizens and communities.

Along with the terms of citizen participation and smartmentality, two research questions were formulated as follows:

RQ1 What is the expected participation of smart citizens in technology-driven cities?

RQ2 What kind of smartmentality is supposed to be shaped for this participation?

This two-dimensional approach supports the definition of technology-driven citizen-roles and mentality with the criteria of responsibility, adaptive behavior, and citizen-engagement. To answer the research questions, corpus-based content networks of city strategies were analyzed as follows. The ultimate goal was a meta-analysis or statistical analysis of the research corpus.

First and foremost, the corpus was selected and built based on the most downloaded and linked documents of smart cities, based on the cumulative data of Google hits from three years (2014 Q2 – 2017 Q2). First, the keywords were "smart city," "smart citizen," "government*," "business," "university" and "research" applying together. The criteria were to find the first 150 hits of mainstream executive summaries, trend reports, project analysis, white papers, and future visions of governmental-business-university research co-operations from the millions of hits (G2B2UR as a 3D approach). The goal was to find the most viewed and popular hits to build a corpus and answer the research questions. In this selection, 50-50-50 files were related to the sub-corpus criteria, identifying the main owners of the projects as governments, companies, and universities.

Second, English documents were filtered only for the subservient decision about the methodology of text analysis. English sources also represented the language that reached most readers all over the world. The completed, showcase-styled, non-academic, and visualized PDF files were selected aiming at a wide audience with easily understood summaries. Thus, dynamically changing web content, such as websites, changing top lists, or blogposts were intentionally excluded from the analysis.

It was crucial to specify that the examined university research projects only appeared as a part of government and business documents and as collaborations. In other words, university research in this sub-corpus was not equivalent to a literature review. The reason behind this decision was to separate the university research projects in co-operation with governments and business from the academic discussion above. The selected documents in the corpus are produced for marketing goals or public communication, not for scholarly debates.

The corpus, summarising the three years, reflects rapidly changing technological issues and the emerging internet in human roles. The disadvantage of the short term is that long-standing discourses are not available. This disadvantage was compensated by the literature review while a studied short term allows the investigation of the coming technologies with more flexibility.

The corpus was made up of one hundred and fifty documents for RQ-driven meta-analysis choosing documents with the same quality criteria, allowing a systematic review. Executive summaries, trend reports, collaborative projects for wider international publicity, summarized contemporary strategies, and concepts with a strong focus on expected participation. The research limits of this selection are coming from the rapidly changing technology trends and social trends. However, the research findings give a summary for a given period.

After the corpus was formed, the diverse methodology of conventional text statistics and text network analysis with data visualization was applied. The networked data visualizations were built by the co-occurrence matrix of the text. To interpret the structural attributes and topics of the text, network metrics were created. The network visualization supported the qualitative interpretation of the data. Quadratic Assignment (QAP) Pearson correlation supplied the well-known correlation coefficient as a metric of comprehension for two matrices. For the word pairs, two words were connected if they co-occurred in the same sentence and were not more than three words from each other. Based on these terms, WORDij (Danowski 2013) software was applied for the analysis. In the process of data visualization and network calculation, the software Gephi 0.9.2 (Bastian *et al*. 2009) was utilized. To filter non-informative and conjunctive words from the corpus, a stop list was generated. Connections were only counted if the two words co-occurred at least two times. Connections based on word co-occurrences in the text had no directions, therefore, the results of the network analysis were interpreted undirected ones.

Network nodes were presented as their size was equal to the amount of their importance. The importance of words was equal to their betweenness centrality (Brandes 2001, Paranyushkin 2011). Therefore, the sizes of the nodes represented the number of occasions one had to touch the node to connect two randomly chosen nodes with the shortest path in the network. Louvain modularity was applied to detect topic clusters in the corpus. A modularity algorithm (Newman 2010, Fortunato 2010) identified the communities within the network. Nodes ordered in the same community had more connections than were expected based

on chance in a random network with the same number of nodes and density. The coefficient of modularity equaled the number of edges within a group of nodes minus the number of edges of the group of nodes in the random network. Gephi software used Louvain modularity with the standard 1.00 resolution (Blondel *et al*. 2008). The resolution was applied to encounter the fragmentation of poorly connected large networks. Transparency and qualitative interpretation were essential in data visualization, therefore, an animation called Force Atlas (Jacomy 2009) was chosen to render the networks with the most central nodes in the center surrounded by connected nodes with smaller centrality from the same community. In summary, this complex process supported the analysis of the corpus with a network of keywords, word pairs, text networks, and most cited city cases.

## 4. Findings

The completed corpus was broken down into three subcorpora as the owners of the co-operations in 3D research. The three subcorpora were "business," "governance" and "university research".

Following the research questions, the purpose was to find the key citizen-based expectations and smartmentality in the corpus. The analytical units of the corpus were selected as human factors. These parts have been found manually as the protocol of text analysis (Krippendorf 2018). Defining the core elements, keyword statistics, and word pair analysis was applied. The first part of the findings presents the connected top keywords and word pairs in the whole corpus. This part points out the correlation among the subcorpora via text networks.

### *4.1 Findings I. with keywords and word pair frequencies. Expected citizen is community*

Starting with the first subcorpus, the so-called business-focused part of the corpus, the top ten keywords in frequency are connected to the human aspects from "people" or "citizen" to "communities". The framework is represented by open data and social-private issues. Activities or engagement factors belong to the living-collaboration-participation pivot. With the next subcorpus, the government-driven top words of the corpus highlight the "public" interest of activities by citizens and communities. The role of open data, participation, collaboration, public and private sectors, authorities, stakeholders, and safety also have a strong focus in this context. The third subcorpus, university research holds the topics of living issues, social perspective, and collective activities of the business and governmental projects.

Accumulating these results as the whole corpus, active participation forms are assumed by both individual and collective users. Primarily, their *data sets*, *collaborations*, *and living issues* are highlighted as extracted topics. Comparing the findings, the business subcorpus focuses on the *collaboration* aspects, the governmental subcorpus emphasizes *participation*, and university research underlines *collective outputs*. Private matters are more focused on by governments and businesses (see Tables 1-3. below). These results point out the key roles of business, governments, and university research, namely, the purpose-oriented work and sharing belong to the business, acting and taking are crustal for the governmental approach and university research connects these.

Obviously, the occurrence of the keywords reflects further cultural, economic, or social contexts resulting in words that do not have exactly the same meaning. Although the goal of this paper does not support this direction, the section about the top ten cities below will present details about these contexts.

The further keywords of the top twenty are repeated the plural or singular versions of the above mentioned key terms, also with synonyms and similar categories. However, the term "empowerment" is also highlighted in the top twenty which is noticeable as a reconfirmed category. This means a special participation type with additional authority, power, and responsibility of citizens in decision making. This factor will be more detailed in the next section.

To compare the content networks, the similarity of every

Table 1 Network statistics of Business subcorpus - TOP 10 keywords

| Label | Degree centrality | Betweeness centrality | Modularity class |
|---|---|---|---|
| People | 16 | 3.927453 | 0 |
| Living | 14 | 0.652778 | 0 |
| Citizen | 16 | 1.742532 | 0 |
| Collaboration | 15 | 1.323088 | 1 |
| Open | 17 | 4.925866 | 0 |
| Community | 16 | 8.387374 | 0 |
| Participation | 12 | 0 | 0 |
| Data | 16 | 3.570707 | 0 |
| Private | 16 | 3.570707 | 1 |
| Social | 16 | 1.742532 | 1 |

Table 2 Network statistics of Government subcorpus - TOP 10 keywords modularity_class

| Label | Degree centrality | Betweeness centrality | Modularity class |
|---|---|---|---|
| People | 18 | 9.135365 | 0 |
| Public | 15 | 1.053114 | 0 |
| Citizens | 17 | 3.968698 | 0 |
| Data | 17 | 3.968698 | 1 |
| Private | 14 | 0.160256 | 0 |
| Collaboration | 15 | 0.532984 | 0 |
| Living | 15 | 0.532984 | 0 |
| Comumunity | 17 | 0.160256 | 0 |
| Participation | 17 | 3.968698 | 1 |
| Open | 15 | 0.532298 | 1 |

Table 3 Network statistics of University-research subcorpus - TOP 10 keywords

| Label | Degree centrality | Betweeness centrality | Modularity class |
|---|---|---|---|
| Social | 17 | 3.963167 | 0 |
| Living | 15 | 1.654401 | 0 |
| Data | 17 | 3.963167 | 0 |
| Public | 15 | 1.259199 | 1 |
| People | 17 | 3.963167 | 0 |
| Open | 15 | 1.042929 | 0 |
| Community | 17 | 3.963167 | 0 |
| Participation | 18 | 11.296501 | 0 |
| Collective | 13 | 3.333333 | 0 |
| Communities | 15 | 4.681818 | 0 |

Table 4 Correlation matrix of Business, Governance and University subcorpora

| | Business | University-research | Government | Number of random permutations |
|---|---|---|---|---|
| Business | 0.000 | 0.887 | 0.955 | 100 |
| University-research | 0.887 | 0.000 | 0.876 | 100 |
| Government | 0.955 | 0.876 | 0.000 | 100 |

two datasets was measured with the QAP Pearson correlation coefficient. The QAP Pearson correlation compares two datasets with a standard number of 100 permutations expressing the similarity with the well-known correlation coefficient. Table 4 shows the result of the analysis with a correlation matrix. Studying this matrix, linear dependence is the strongest in the case of government-business co-operations.

Otherwise, university research presents a relevant and integrated role in business strategies, and also, in governmental policies. Obviously, this result partly derives from the corpus selection. By comparison, strong linear dependence also substantially confirms the importance of citizens in all three kinds of strategies and reports.

Interpreting the top word pairs in the whole corpus, the previously mentioned word lists are combined. The keyword "*public*" appears in different pairs of the whole corpus with the highest frequency, and with the word pair **"**private" or "open data" primarily. The result underlines a significant correlation between the private and public sectors based on open vs. non-open data distinction. The case study section will also reflect this result.

### *4.2 Finding II. with text networks. Smartmentality as engagement and empowerment*

These filtered terms and their strongly connected extracted topics provide a deeper analysis via the text networks. Keeping the 3D corpus, subcorpora reveal the

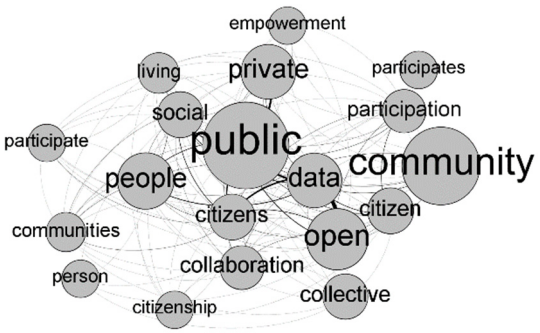


Fig. 1 Text network of business subcorpus

connections and average path of the keywords.

In the business-focused part of the corpus, there are 127 edges between the keywords. On average a node has 13.368 connections. This number is relatively close to the maximum number of connections a node has (18), therefore specific combinations of the keywords are frequently co-occurring in the corpus. On average 1.26 steps need to be taken to connect two keywords in the network. The longest distance between two nodes is three steps which present a multiple strong connected content network. Nevertheless, the average path length indicates that certain keywords are presented as hubs, therefore, on average the components of the network could have short connections. The density of the network measures 0.743. 74.3% of the possible connections between all of the nodes are presented in the network. According to modularity, there are 2 communities detected in the groups of keywords and these groups are more connected than would be expected based on chance (see Fig. 1).

The results of network analysis confirm the relevance of human factors in smart city projects. In the business subcorpus, the category of "*community*" is a hub instead of individuals such as "people" or "citizens". This result possibly derives from the parallel spotlight on the "public" sector which is also a hub in this network. While people as individuals and citizens are supposed to have privacy issues or privacy matters substantially, the public factors with communities assume *collective participation*, open data, and collaborative willingness. The expected output is a contribution to open data and to a voluntary active operation.

The question is how the category of "empowerment" fits into this logic from the periphery of the text network with private issues. Checking the text details behind, the meaning of "empowerment" in this subcorpus roots in citizens' engaged decisions or participation in the local business. Illustrated with examples, empowerment facilitates micro-business, peer-to-peer platforms, transparent open data, collaborative models, or investments of infrastructure. Consequently, communities and collaborations are expected in the context of empowerment. Moreover, empowerment also reflects on the smartmentality with bottom-up developments or complex types of engagements. This result, of the role of empowerment, is a noticeable indicator of how citizens support infrastructure and smart services.

Moving forward, the governmental subcorpus has a few


Fig. 2 Text network of governmental subcorpus

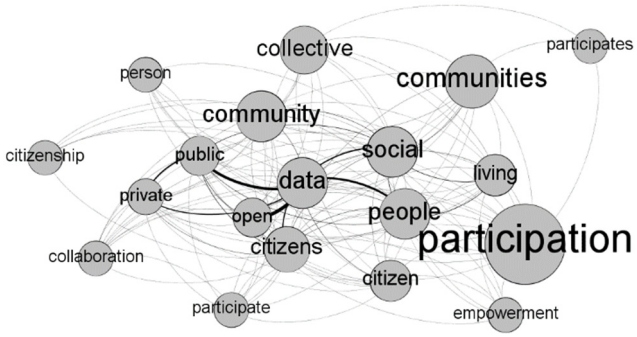


Fig. 3 Text network of university research subcorpus

more (130) edges. This corpus has almost the same maximum number of 18 and quite a similar average degree which is 13.684. The average number of steps that have to be taken to connect two random nodes in the networks is 1.24. Therefore, the same attributes are presented as before. The number of two longest paths in the network indicates that this one has a shorter longest distance. The same conclusion is presented in density which measures 76% of the possible connections. A low positive coefficient of modularity indicates that groups of nodes are more likely connected than would be expected based on chance in a random network (see Fig. 2).

According to the network analysis, the category of "*people*" forms a hub in the center with intensively connected further central nodes, such as the correlated "citizens" and their public or open data, and also, the partly collective and partly personal "participation". Compared to the top ten keyword statistics, the "social" factor is more connected and highlighted than would be expected. The reason behind this result could be the context of the society regarding the governmental view. "Collaboration" is on the edge assuming the role of "communities" behind, just like the "living" factors. The "empowerment" is also on the margin of the network compared to the business subcorpus. However, the content analysis revealed different focal points to this expectation, such as philanthropic civic experiments, community leadership in daily lives, co-design at public places, transparency of open data to shape the city policy. "Social" issues, "people" and "community" shape a dividing border between two possible participation types. The first belongs to the "living" as geographical concerns and inhabitancy. The second extends the participation for the digital and smart environment by "data," "collaboration," and "empowerment". Consequently, the physical and virtual scenes have been merged into governmental strategies.

The text network, created from closely related university research of the corpus, has the same maximum number of degrees (18) as the corpus mentioned before as well as being quite close to the average degrees of 13.688. Therefore, specific combinations of words are frequent in the corpus. The 1.26 average path length indicates the option of large hubs in the network, as well as the two diameters, which indicates words positioned away from these central hubs. The whole network is equally interconnected as before due to the 0.743 density. Modularity has detected two communities with interconnectedness which is close to what would be expected in a randomly interconnected network (see Fig. 3).

Although the spotlight of "collective" matters was detected by the keyword statistics above, the text network resulted in "participation" as a large hub. In contrast, this hub is on the periphery closely related to "people," "citizens," "living," and "empowerment". The meaning of empowerment presents an analogy of team sport with standards, training, co-operation, engagement, and a further kind of confidence in mutual goals. This approach is significantly connected to the expected participation in the hub mentioned.

An unpredicted result is that "communities" only has one direct connection to the huge hub of "participation". It would be more connected as their functions to the network of "people," "collaboration" or "community". In contrast, the expected participation is strongly tied to citizens or people as their living aspects. Moreover, "community" in singular and plural are more interconnected separately with social-collective-public factors. Studying the details in the texts, the expected community participation appears in general, while in the case of already functioning and real communities, specific goals are formulated, such as public values, safety, aware citizens connected to the private sector, organizations, institutes, and funds.

"Data" is in the absolute centrum with a close connection to both "private" and "public" sectors, and also, to "social" aspects and "people". These extracted topics are in line with the smart city basic criteria (Ju *et al*. 2018), as well as, the mostinterconnected "open data" in the center. However, the large central hubs are the "people" with their communities, and also, "social" or "public" factors. Additionally, "participation" is the peripheral hub with well-connected but less emphasized "empowerment". "Collective" aspects and "collaboration" are medium-size nodes and only situated on the edge of the network. Consequently, the open data is mostly tied to the public sector and social issues assuming the participation of people and their living in urban spaces. Concerning this result and comparing it to the governmental outputs, the university research has more co-operation projects with local governments than the local businesses.

Referring to the first original research question, both individual and collective participation are expected in technology-driven cities by smart citizens, but collective

and the already active participation are expected more, partly by collaboration and partly by empowerment. Regarding the differences in subcorpora, the business has a strong interest in collaborative participation, while the governmental approach expects collective and individual activities with civic experiments or community leadership. Comparing these subcorpora to the university research, "way of life" contribution by individuals is also relevant.

The next section extends these results with smartmentality, as the second research question. Considering the first findings, collaboration, communities, and team play are assumed. This hypothesis will be tested by the most referenced cities of the corpus.

## 5. Extended findings presenting the most referenced cities in the corpus

First and foremost, most cross-referenced cities were filtered in the corpus. Although different kinds of city rankings are available every year with various methodologies, this research study only focused on the data of the corpus and the internal references. There was no goal to use any further sources or rankings. Thus, these cities are not exhaustive when affording smart city features. However, the most highlighted cities in the corpus represent the complex logic of human aspects in technology-driven cities resulting in deeper understanding based on the keyword- and text-analysis.

The text network analysis revealed the frequently mentioned top 10 cities as hubs in the corpus with 29 nodes. It is the sum of the 19 keywords and the top ten cities. This network has 319 edges which compute as an average degree of 22 and the maximum number of degrees is 28. The 1.22 average path length indicates the various hubs in the network, as well as two diameters, reflects words positioned away from these central hubs. The central hubs repeat the above summarized key issues, namely open data and the public-private sectors with strong ties where the public sector is the biggest and one of the most connected hubs. The whole network is interconnected due to the 0.786 density. Groups of nodes, however, are more likely connected than would be expected based on chance in a random network. The strong tie of "people" or "citizens" and their data have the most significant connections, which confirms the previous results of keyword statistics. Although, the private issues present an interrelation to data and community, the community is a bigger hub. In conclusion, collective participation is more expected than individual ones (see Fig. 4).

Amsterdam, Barcelona, Chicago, Copenhagen, Helsinki, London, San Francisco, Singapore, Seoul, and Stockholm represent the top ten cities. In the intersections, "public and open data," "community" and "social" aspects are available. This result again, confirms a focus on collective participation.

"Participation" is partly connected to the center via "social-public" sectors and "communities," and partly to the margin via "collective" matters and the less highlighted "empowerment". The top ten cities expect collective participation but this expectation is only a part of the smart

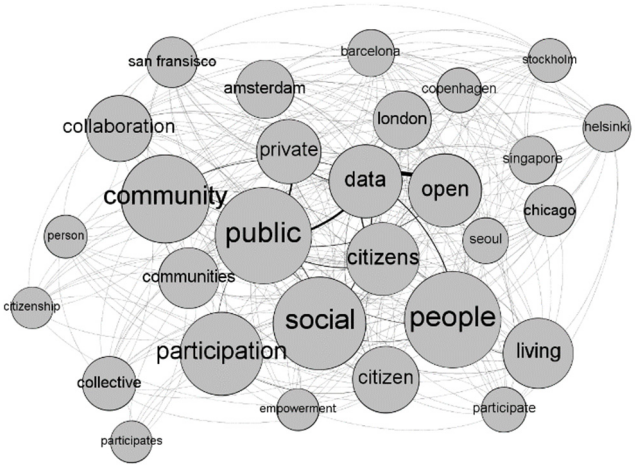


Fig. 4 Text network of top ten cities

city strategy, not a cornerstone in itself. Moreover, the category of "participation" has only indirect connections to the top ten cities. In line with this, the smartmentality with a contribution to policymaking is less emphasized. Otherwise, the "participation" category is connected directly to huge central hubs, such as open data, public-private sectors, social and collective issues, communities, or empowerment. Consequently, the key issues and participation types are available in every strategy of the top referred cities but with different intensities.

Most of the top cities are situated partly or exactly on the periphery in the network as independent cases. However, their majority presents significant interconnectivity with each other and their reference points. Illustrated with examples, Helsinki has a noticeable path tothe "living" factor and further Nordic countries. San Francisco and Amsterdam are strongly connected to each other and "collaboration" projects, while the position of Seoul is more related to "open data" with aspects of "citizens" and "people". These cases are representing cultural and social-economic similarities or differences among the cities and the mutual references to each other.

The most connected and centralized three cities are London, Amsterdam, and Seoul. In contrast, the "citizen" or "community" integration to their city operation by "collaboration" and "empowerment" are less frequent according to the text network. Interpreting this result, the smartmentality is not a strong part of the expectations in strategy and practice. Only San Francisco and Amsterdam have a shorter path to "collaboration" and types of engagement to highlight the role of smartmentality.

The category "private" presents a semi-central position with strong interconnectivity to nodes of London, Barcelona, Amsterdam, and San Francisco. The reason behind this result is probably the personal data regulations in the European Union or the role of giant data companies in the U.S.

Beyond the close reading of the content network of the top ten cities, the human-related contents were filtered manually to reveal the diverse landscape of expected participation and mentality in smart cities. The next subsections will provide a short summary of these contents.

### 5.1 Participation in policymaking, living labs, improved smartmentality

Starting with the most centralized and highlighted node, London presents a holistic concept in a smart city and smart citizen context. According to the corpus, the Smart London Board supports representatives of authorities, academia, and leading technology sectors with interactive communication to individual or organizational participants. Additionally, the platform-based London Data Store and the Open Innovation 2.0 program promotes an information value chain. The digital infrastructure belongs to user-centric services, living labs, and applied research projects to recycle data and provide feedback by citizens to improve city services. Institutional and collective participation is facilitated by empowerment and by access to open data, allowing the collaboration in planning and operation of the city. The Talk London project invites participation in policymaking, online discussion, surveys, and training programs to upgrade digital skills. The Future Cities Catapult supports services for disabilities, such as the navigation program for blind citizens. Privacy issues are in the spotlight with a strong focus on security, protection, and prevention. The final goal is to create the highest quality of life possible.

### 5.2 Neighbourhoods, early adopters, and engagement

Amsterdam and San Fransisco as the most interconnected hubs develop mobility services and support neighborhoods by open data and telecommunication systems. The strategy for Amsterdam interprets inhabitants as end-users and urban contributors with various types of engagement. Citizens, organizations, and the government have a testing ground for new concepts. Collaborative projects are provided by a circular economy between public and private sectors to economic and social values, to liveability and creativity, and also, to a healthy lifestyle and prosperous life. Insight of needs and emotions are available for citizens and communities. Amsterdam interprets itself as a city of early adopters where the well-educated and multilingual population is open to innovation with sustainability. Special education programs are shaping the adaptive attitude towards the usage of telecommunication services and smart applications. San Francisco provides access to the data flow for comfort and demand-responsive pricing. Smartphone applications of local news and intensive usage of social media support data-driven thinking. Additionally, robust community interaction facilitates engagement in neighborhoods.

### 5.3 Citizen-led experiments, the joy of participation, and cybersecurity

Barcelona is a bridge between San Francisco and Amsterdam, and also, directly connected to Nordic cities with a close link to London. This smart city strategy facilitates the citizens and communities to be developers or producers in city life with empowerment. Individuals are interpreted as an integrated part of the technology and the upcoming artificial intelligence in line with the literature review. Human and non-human actors are also involved in the dynamics of projects for Barcelona. To share a brief example, the FabLab community is a highly-technically experienced community with early adopters for knowledge-sharing and smartmentality. Citizens are challenging and translating innovations into action in their districts and neighborhoods. These cities represent strong collaborations.

The top Nordic cities, namely Copenhagen, Stockholm, and Helsinki also define their citizens as open-minded individuals for collaboration. In the case of Copenhagen, open platforms invite citizen-led innovations and the joy of participation. Every implementation is subordinated to quality of life. Data protection, ethical considerations, and also, increased accessibility for smart tourists or disabled people are also highlighted. Helsinki supports on-demand services to motivate citizen participation and to increase digital awareness. The increasing number of young families supports participation in civic activities and experiments. Finally, the needs of citizens shape data-driven decisions and collect the best practices to follow. Stockholm also aims at the best quality of life. Small households, neighborhoods, and districts are involved in smart and intelligent environments. New social meeting spots and testing environments facilitate social and business innovations. Additionally, a high level of cybersecurity is also in the focus.

### 5.4 Surveillance culture, transparency, and anonymity

Singapore and Chicago are situated on the ring of Nordic countries in the text network with open services and community focus. In the case of Singapore, improved smart culture and engagement of the aging population are part of the city references. Human capital, education, and health care services support these. The city strategy in the corpus presents a decentralized concept using the “rainforest” metaphor to interpret the necessary multiple redundancies in services, open data circulation, and interactive communication. Additionally, a surveillance technology system detects actions for a law-abiding society, overall society control, and safety. This approach is in line with the approach of surveillance technology (Hsu *et al*. 2020). Live-work-play environments and commercial activities stimulate participation, interaction, and socialization. Training and integration projects support smartmentality. Talented inhabitants are supported to engage further people into the ICT culture. Closely related Chicago creates meaningful open data and content with smart applications. The goal is to “make every community a smart community”. Training, engagement programs, smart community benchmarking, transparency, and civic hackers support the smartmentality. Last but not least, Seoul with a direct connection to Singapore and Chicago emphasizes the role of anonymity. Three arguments support this approach. First, convenience motivates people to join smart and intelligent services. Second, citizens and visitors of a city share their data anonymously. Third, citizens express their needs and opinion as if there are no personal consequences. This setup is in line with the slogan “city of happy citizens

and a city beloved by the world".

Considering the summarized strategies, a diverse landscape of technology-driven cities has been revealed. The top ten cities have strong ties not only to the key issues, such as open data or communities but also to each other. The reason for this output is the comparative method with cross-references. Studying the highlighted and referred strategic elements, the data-driven thinking facilitates the public and private sector, and also, the communities and citizens. Participation types are connected significantly to activities from data sharing to the contribution of policymaking primarily by technology promoters, early adopters, and young families.

These cultural, economic, or social contexts deeply influence the presented smart city approaches. For instance, Seoul represents the cultural trend of South Korean internet anonymity, Singapore prefers surveillance technology in a highly regulated society, Amsterdam and the Nordic cities emphasize democratic values and transparency, San Francisco focuses on business issues and ICT. These results point out the importance of future research about social-cultural similarities and differences in smart cities.

Answering the second research question, in summary, smartmentality is supposed to be shaped by digital communication technologies causing constant engagement, in certain cases adaptive behavior and empowerment for well-being. Conscious and reflexive usage of digital technology is expected mostly in democratic countries. Smartmentality is also appearing in specific cases, such as with a focus on disabled people or tourists. However, smartmentality and its related aspects are not a crucial part of all the cities discussed. Moreover, ethical issues are hidden. This seems to be a massive challenge for the cities in the context of upcoming AI.

## 6. Conclusions

The paper has discussed the expected participation and mentality of a smart citizen in smart cities. The results confirmed the statement of Gudowsky and his co-authors (Gudowsky *et al*. 2017) about the fundamental role of human factors. Moreover, it also verified that smart citizens are not only datasets (Johany and Bimonte 2016) but also active or facilitated participants of the technology-driven cities with collaborations.

Recalling the research questions, various expected participation types are available and smartmentality has diverse manifestations in most of the cases. Extracted topics of open data of inhabitants and adapted smart services define the ultimate expectations. In contrast, an unpredicted result in data context is that the relevance of anonymity appears only in one city strategy as a key concept. Collective participation is the most highlighted contrary to the individual one. Collaborative engagement concepts confirm the role of proactive "participatory urbanism" (Han and Hawken 2018). The socio-technical engagement (Barns 2018) and the intensive usage of communication technology trigger bottom-up innovations, investments, or contributions to policymaking via digital platforms. Additionally, certain applied smart neighborhoods support communities, adaptive attitudes, and living labs in the local context. These results confirm the significant role of participation in the policy economy (Gudowsky *et al*. 2017) with responsibility (Vanolo 2014) as a result of empowerment. The empowerment is less represented along with the most referenced cities but it is an option for micro-business or civic experiments.

Certain potential is underrepresented or hidden in the corpus. Beyond the local inhabitants, further human roles are available. First, smart tourism has only a few cases in the corpus. Although, all the top ten cities from the corpus are featured tourist destinations. However, scholarly articles highlight the importance of temporary visitors to the cities (among others Lim *et al*. 2018). Second, the interest of temporary residents with special needs and contribution should also be relevant. The competitiveness of the cities, the image of liveability through internet media, or the city rankings influence this group. Consequently, perhaps collective participation should be extended with temporary residents and tourists as well.

An additional crucial point is the lack of a specific spotlight on privacy and ethical issues, particularly with the coming AI-technology and the black-box model. Without these considerations, smartmentality will only be a slogan without meaningful content and with unexpected consequences in different societies and cultures. The local context (Neirotti *et al*. 2014) should be more focused on the interrelation of civil infrastructure and human activities. In line with this, the expected community participation will be managed probably in a "civic" way, instead of a "civil" way. Fine-tuning is required to build the AI-human ecosystem for more sophisticated smartmentality.

Last but not least, metaphors in the corpus are presenting a relevant interpretative framework to understand the interrelation of smart cities and smart citizens. On the one hand, the "rainforest" metaphor captures a redundant city operation with always-available services and their changes. On the other hand, the "team player" metaphor interprets the citizen as an actor to be a member of networked technology and also human networks. Additionally, the metaphor "public agora" from the literature review (Vanolo 2016) expand these approaches with public space as a center for team players in a rainforest. The three metaphors describe the key functions of the human-technology ecosystem.

To interpret the key findings, three recommendations are formulated. First, the forthcoming technology with structural changes and AI should facilitate a strategy of human and non-human symbioses more than ever. A sophisticated approach with ethical and privacy issues is required for the higher level of smartmentality. It is in line with the emerging discussions about AI ethics (Coeckelbergh 2020). Second, understanding the key factors of the participation, such as local context, cultural differences, temporary or permanent human roles, neighborhoods, and communities, resulting in competitiveness and higher quality of life. Third, further metaphors are suggested to interpret the interrelation of the technology-driven city and smart citizens. This

recommendation is particularly relevant for the cultural-social-economic perspectives.

## Acknowledgments

This paper has been written with the support and within the framework: KÖFOP 2.1.2 – VEKOP – 15-2016-00001 Public Service Development for Establishing Good Governance: The Digital Governance and Research Program. Many thanks for the methodological support to ifj. Istvan Boros working at Budapest University of Technology and Economics. During the process of review and publishing, the author has become a Fulbright Research Fellow at Drexel University and Bolyai Research Fellow at the Hungarian Academy of Sciences to continue her work in research of socio-cultural AI.

## Data availability statement

All data, models, and code generated or used during the study appear in the submitted article.

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