SMART CITY INITIATIVES IN THE CONTEXT OF DIGITAL TRANSFORMATION – SCOPE, SERVICES AND TECHNOLOGIES

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Abstract. *Digital transformation is an emerging trend in developing the way how the work is being done, and it is present in the private and public sector, in all industries and fields of work. Smart cities, as one of the concepts related to digital transformation, is usually seen as a matter of local governments, as it is their responsibility to ensure a better quality of life for the citizens. Some cities have already taken advantages of possibilities offered by the concept of smart cities, creating new values to all stakeholders interacting in the living city ecosystems, thus serving as examples of good practice, while others are still developing and growing on their intentions to become smart. This paper provides a structured literature analysis and investigates key scope, services and technologies related to smart cities and digital transformation as concepts of empowering social and collaboration interactions, in order to identify leading factors in most smart city initiatives.*

Keywords: *smart city, digital transformation, scope, services, technology*

1. INTRODUCTION

Digital transformation (DT) means a change of an organization, intending to provide a new or significantly better supply of products or services, using information technology as key enabler or even part of the supply (Nandico, 2016).

The key elements of digital transformation include Social media networks, Mobile connectivity, Data Analytics and use of Cloud technologies (or short SMAC), representing a must for every modern organization, driven by digital technologies (that are built using SMAC as the foundational layer) like Internet of Things, Robotics,

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Automation, Machine Learning, 3D printing, User Experience, Big Data, Wearable, Augmented Reality, Virtual Reality and many more (Sadare, 2017).

A smart space, defined in Gartner's reports (Cearley & Burke, 2018), is one of the top 10 strategic technology trends for 2019, representing an interaction of humans and technology-enabled systems in a physical or digital environment, which becomes intelligent in 5 key dimensions – openness, connectedness, coordination, intelligence and scope. Thereby Smart cities represent the most extensive example of the shift from being isolated systems to becoming intelligent environments.

Devising a smart city is supposed to improve the quality of life with the use of technology, and thereby increase the efficiency of services and meet citizens' needs (Musa, 2018).

At a high level of research, Smart Cities include efforts to make the best use of existing resources in cities, managing thereby congestion, pollution, food production, and maintain living standards under the increasing pressure on natural resources, and the recent radical progress of digital technologies is transforming these efforts (Crisostomi et al., 2016).

Large cities are collecting web produced data streams from car parks, bicycle sharing schemes, online auction data, air quality sensor data and sales data, and there are attempts to analyse them in close to real time so that city planners can employ up-to-date predictive models and use them in short and long term planning (Scriney&Roantree, 2016).

The analysis of EU policy and other relevant documents (Gargiulo, 2013) cities should undertake actions, in order to achieve a smart, sustainable and inclusive growth by: "(1) Adopting models of multilevel governance through the distribution of responsibilities between different government and institutional levels; (2) Promoting integrated urban policies by adopting a holistic and strategic approach; (3) Focusing on new information and communication technologies (ICT) in order to provide citizens with new media opportunities and easier access to the public and cultural contents; (4) Ensuring a sustainable territorial development based on the efficient use of resources" (Gargiulo et al., 2013, p. 367).

In order for cities to become and stay sustainable digital societies, citizen need to participate in opportunities for growth and development, through entitlements for inclusiveness given from the government, like ICT infrastructure, appropriate policy implementation, human capital development, and developed culture of innovation, using thereby digital literacy skills that are acquired and applied by citizens when there is a value proposition (Sharma et al., 2016).

In the existing literature there is a lack of discussions on relevant smart city theories or frameworks and the analyses lag behind actual practice. In addition, the majority of smart city projects and initiatives that do exist, are still in their planning phases or early phases of implementation (Alizadeh, 2018).

Our initial research showed a low number of academic and practical reports on how smart cities initiatives are being related to a new field of digital transformation. Nevertheless, due to the high relevance of "going digital", we developed the following research goals: (i) to provide a basic bibliometric analysis about research in this field and (ii) to investigate key scope, services and technologies related to these two contemporary concepts of empowering

social and collaboration interactions, namely smart cities and digital transformation, as reported in the academic publications, in order to give an insight into the current state of research in this emerging field. The research goals are defined in order to test our initial assumption that out of five key determinants related to DT (according to Pihir et al., 2018) some determinants can be identified as leading factors in most smart city initiatives. Additionally, special focus is set on initiatives in the industry related to energy delivery, since this is relevant for an ongoing research project of innovative platform development for digital transformation of enterprises. This analysis is aiming to investigate which technologies and services are most commonly associated with smart cities in the context of digital transformation initiatives in the energy sector and possibly to suggest implications for practice.

To achieve these goals, first a feasible research methodology was set (Section II) which included a literature review that was conducted by searching Scopus, IEEE and Web of Science databases. Results of the bibliometric analysis are presented in Section III. Next, qualitative analysis of the publications was performed and a systematic content review on three research relevant aspects is given (Section IV). Finally, conclusions are drawn and the suggestions for future research are indicated.

2. RESEARCH METHODOLOGY

This research reviewed the available literature on smart cities and DT in order to summarize existing findings in this field of study. Special focus has been placed on case studies, presenting the initiatives in practice, applying quantitative and qualitative content analysis. The next two subsections present the methodology of choosing the literature and conducting the literature analysis.

2.1. Identifying relevant literature

Literature search was conducted during December 2018, in order to find publications of interest. Three scientific databases were selected due to their relatively good coverage of publications: IEEE, Web of Science and Scopus. The search was carried out based on a combination of keywords (Table 1), whereby synonyms were not used, which can be seen as a limitation of our research.

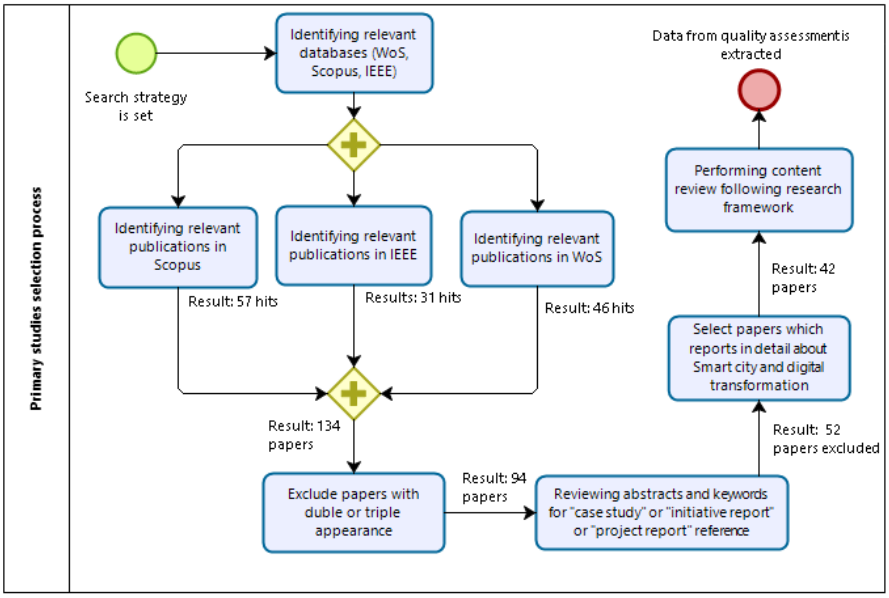
The selection procedure is graphically shown in Figure 1. Search of Scopus resulted in 57 papers, Web of Science (WoS) resulted in 46 papers, and IEEE search gave 31 papers. After merging all 134 papers it became evident that some of the papers were found in more than one database, so the double or even triple appearances had to be checked and resolved. This left us with papers suitable for our qualitative analysis.

Table 1. Search strategy

Database	Search strategy	Hits
Scopus	TITLE-ABS-KEY (smart AND city AND digital AND transformation) AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar"))	57
Web of Science	TOPIC: (smart city and digital transformation) Refined by: DOCUMENT TYPES=(ARTICLE OR PROCEEDINGS PAPER) Timespan=All years. Indexes=SCI-EXPANDED, SSCI, A&HCI, CPCI-S, CPCI-SSH, BKCI-S, BKCI-SSH, ESCI, CCR-EXPANDED, IC.	46
IEEE	(smart city and digital transformation) Conferences and Journals & Magazines	31

Source: Authors

Figure 1. Publication selection process



Since our focus was on the experiences or reports on smart cities initiatives in the context of digital transformation, we developed the following criteria for the selection of papers: (1) the article specifically covers both concepts (smart cities; digital transformation) and (2) the article reports on a case study, initiative or a project.

The review of the abstracts and keywords resulted in 52 papers not reporting about case studies related to smart cities and digital transformation. These were excluded which has left us with 42 promising publications that seemed to report about real implementation cases (listed in the first left column in Table 2).

2.2. Review analysis

In order to achieve the aim of the article, all relevant data (e.g. authors, title, publication source, year of publication, scope with subsections, services with examples, technology/ technologies implemented) from the selected 42 papers have been extracted.

Next, a framework for the study has been developed, as described further in the text. Our first findings show that there is a lack of research on the topic, although it is a growing and developing area. In order to explore the reported experiences or reports on smart city initiatives in the context of digital transformation, we generated a conceptual framework based on the observation of the selected 42 papers. The proposed conceptual framework suggests three dimensions:

1. Scope of the smart city case study – describing strategic alignment of transformation projects and initiatives to specific goals, aims and purpose. The scope is indicative to recognizing beneficiaries in case that it is not explicitly stated who the targeted audience is.

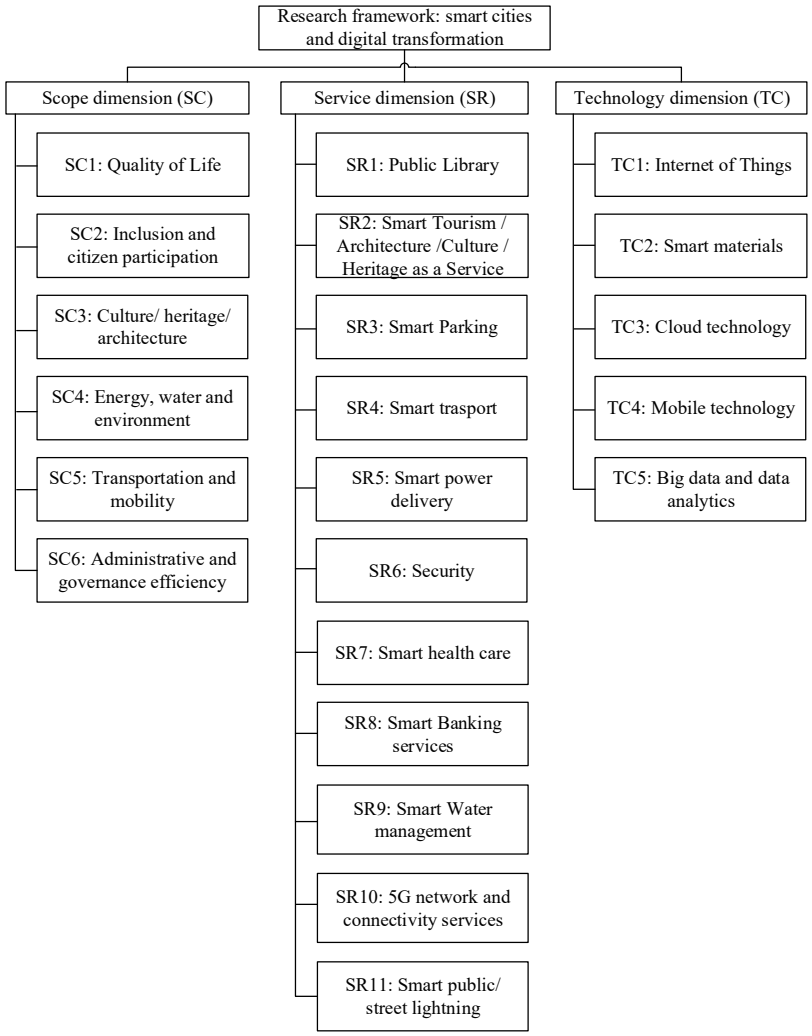
2. Services that were planned or delivered in the case study – this concept is related to specific output, which is

planned for an initiative or a project. This dimension is also indicative to technologies implemented by the initiative.

3. Technology that was planned or used to generate service – with a focus on technologies related to industry 4.0.

Within these dimensions, there are various sub-concepts, as shown in Figure 2. Initial list of sub-concepts was formed by gathering scope, service and technology concepts from various sources (Hashem et al., 2016; Kreutzer, 2017; Schwab, 2017; Sadare, 2017) whereby the most resembling research showed that these categories

Figure 2. Research framework for investigating scope, services and technologies in smart cities initiatives related to digital transformation



Source: Authors.

were described as aims/goals or themes (Ismagilova et al., 2019). However, for the purpose of our analysis, main concepts are our three selected scope, service and technology dimensions and the sub-concepts have been adapted to fit the selected case studies' contents and they are coded as shown in Figure 2. Sub-concepts have been coded by the authors for the purpose of the analysis of scope, service and technology.

The more detailed reports on these three dimensions are presented as results of our study in the following sections, confirming our assumption about the need for further research and tracking of this field.

3. RESULTS OF LITERATURE ANALYSIS

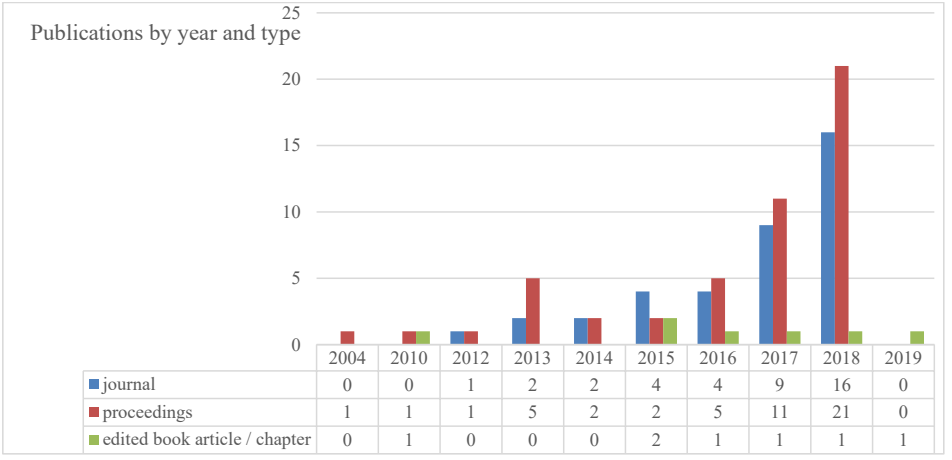
Literature analysis in Figure 3 represents scientific papers in databases Web of Science, Scopus and IEEE including articles selected according to our research strategy. The frequency of published papers regarding smart city and DT has been analysed. The analysis was based on 94 different papers from selected databases and Figure 3 presents their year of publication and type of document, namely: a) journal article, b) conference paper published in conference proceedings and c) articles or chapters published in edited books.

It is evident that since 2016 number of conference papers and journal articles has grown significantly, which is an indicator that the field is still in its developing stage. Furthermore, the lack of articles or chapters published in edited books and the high ratio of conference and journal papers indicate that the topic can be considered as an emerging area and that this topic has not yet reached its the maturity.

4. SYSTEMATIC CONTENT REVIEW

In this section, a short discussion about content review is given. Table 2 shows a systematic overview of the results indicating the scope, services and technologies recognized in the 42 publications that report on case studies. Coded dimension

Figure 3. Publication by year and type on "Digital transformation" and "Smart City"



	2004	2010	2012	2013	2014	2015	2016	2017	2018	2019
journal	0	0	1	2	2	4	4	9	16	0
proceedings	1	1	1	5	2	2	5	11	21	0
edited book article / chapter	0	1	0	0	0	2	1	1	1	1

Source: Authors.

sub-concepts from the research framework (shown in Figure 2) and analysed publications are presented in columns and rows. In the last row, the total of identified scope, services and technology appearances is shown in order to explore the most frequently addressed concepts.

The remarks about the presented results are given in the following subsections. The remarks are divided in accordance with the three dimensions of the research framework, depicted in Figure 2, complemented with a subsection about implications of research results in the selected sector and by a discussion subsection.

Table 2. Content analysis results

	SCOPE						SERVICES										TECHNOLOGY				
Reference	**SC1**	**SC2**	**SC3**	**SC4**	**SC5**	**SC6**	**SR1**	**SR2**	**SR3**	**SR4**	**SR5**	**SR6**	**SR7**	**SR8**	**SR9**	**SR10**	**SR11**	**TC1**	**TC2**	**TC3**	**TC4**	**TC5**
(Amesberger et al, 2018)	x					x					x							x				
(Leorke, Wyatt & McQuire 2018)	x	x				x	x															
(Siountri, Skondras & Vergados, 2018)			x					x												x		
(Lima et al., 2018)	x				x				x									x			x	
(Salem, 2017)	x				x	x												x				x
(Gomez-Exposito et al., 2018)	x			x		x					x								x			
(Boc, 2018)	x	x			x					x											x	
(Sepe, 2014)	x				x					x											x	x
(Physentzides, 2012)	x	x																			x	
(Youssef, 2018)			x																x			
(Péan, 2018)	x															x		x			x	
(Woodhead, Stephenson & Morrey, 2018)	x																	x				
(Djahel, Sommer& Marconi, 2018)	x				x				x	x												
(Li et al., 2016)	x					x		x		x			x					x			x	x
(Makarchenko Nerkararian & Shmeleva, 2016)	x					x								x				x			x	x
(Oliveira & Santos, 2018)	x	x																x			x	x
(Hamidi et al., 2017)	x				x				x	x								x			x	
(Godinho Matos et al., 2013)	x			x							x											
(Sinmaz, 2015)	x			x		x					x											
(Boban& Weber, 2018)	x																	x			x	x
(Zhou, 2018)	x			x											x							x
(Correa, 2015)																						x
(Sajjad et al., 2017)	x												x							x	x	
(Klopp et al., 2015)	x				x					x											x	
(Simeonidou, 2017)	x															x					x	
(Vaishnavi, Kotteeswaran & Begum, 2018)	x												x					x			x	
(Yassine, Singh &Alamri, 2017)	x												x					x			x	x
(Raj, 2015)	x					x														x	x	
(Huang et al., 2016)	x					x		x												x		
(McKenna, 2017)	x																					
(Mohammadi& Taylor, 2018)	x							x										x			x	
(Van Den Bergh et al., 2018)	x			x	x	x																
(Zheng et al., 2018)	x																	x		x	x	x

	SCOPE						SERVICES											TECHNOLOGY				
Reference	**SC1**	**SC2**	**SC3**	**SC4**	**SC5**	**SC6**	**SR1**	**SR2**	**SR3**	**SR4**	**SR5**	**SR6**	**SR7**	**SR8**	**SR9**	**SR10**	**SR11**	**TC1**	**TC2**	**TC3**	**TC4**	**TC5**
(Vuppalapati et al., 2017)	x							x				x						x		x		x
(Sankowska, 2018)	x	x																		x		x
(Perillo, 2013)	x	x								x	x											
(Ikpehai, Adebisi&Kharel, 2016)	x					x										x	x					
(Santos et al., 2018)	x	x																				
(Lopes &Guarda, 2019)	x															x		x			x	
(Komninos&Tsarchopoulos, 2013)	x					x				x						x					x	
(Luzuriaga et al., 2018)	x			x							x					x		x		x	x	x
(Bakogiannis et al., 2017)	x				x					x							x	x			x	
Total appearances:	**39**	**7**	**2**	**6**	**9**	**12**	**1**	**5**	**3**	**9**	**6**	**1**	**4**	**1**	**1**	**6**	**2**	**18**	**2**	**8**	**22**	**13**

Source: Authors.

4.1. Scope dimension analysis

As evident in Table 2 in nearly 93% of the papers the scope of the smart city initiative is related to improving the quality of life of its citizens. This is not surprising since the quality of life is practically a part of the smart city concept definition. In 12 out of 42 papers we found the initiative oriented towards increasing administrative and governance efficiency. Transportation and mobility were third most common scopes which can be related to the fact that most digital technologies are already mainstream technologies in automobile industries. Inclusion and citizen participation appeared in only 7 case studies as a scope, but always together with the quality of life scope, and mostly in combination with mobile technologies or Big data/Data analytics as enabling technologies. Energy, water and environmental scopes are mostly interrelated with smart power delivery as services, while the least recognized scope was addressing the cultural, heritage and architectural initiatives.

4.2. Service dimension analysis

Regarding the service dimension, the sub-concepts are most diversified. The most frequent service presented in the analysed case studies is dealing with smart transport initiatives (21%) and another 3 papers are handling the services related to smart parking improvements. Second most appearing services are addressing a) smart power delivery and b) 5th generation of cellular mobile communications (and connectivity services in general) with 6 case studies. Power systems and connectivity services can be seen as a part of the common infrastructural platforms for smart city concepts because they enable intelligent management and bring more efficiency (Gellert et al., 2019). Third most frequent services set is tourism, architecture/ culture and heritage as a service. The fourth most frequent service is smart health care, whereby it might be interesting to note that it is always related to mobile technologies as enablers for this initiative type. Other services are encountered once or twice.

4.3. Technology dimension analysis

The technology dimension had just five sub-concepts that were discovered in the analysed papers. Mobile technology was the enabler for 22 out of 42 cases studies and it is often combined with Internet of Things (found in 43% of papers) or Big data/ Data analytics (declared in 13 papers).

This trinity or variations of two-paired sub-concepts are often referred in initiatives related to transportation, smart parking and connectivity services. The fourth technology in terms of frequency of use is cloud technology, and the least addressed one is dealing with smart materials.

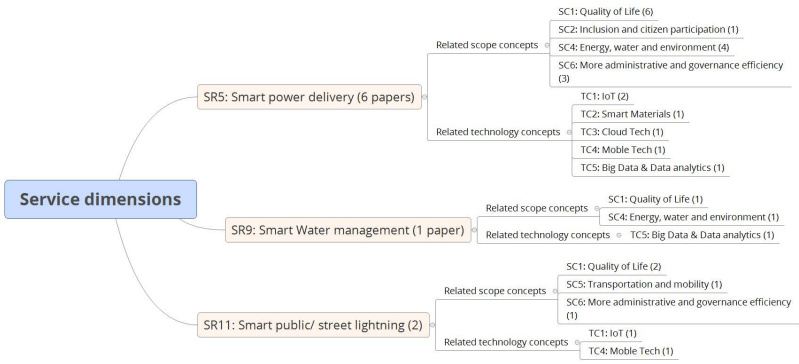
This analysis confirms findings of Ismagilova et al., 2019, regarding two digital technologies (IoT and Cloud technologies) as technologies that are relatively strongly related to smart cities.

4.4. Implications for the selected sector of energy management

As stated earlier, special focus is placed on initiatives in the industry related to energy delivery, due to the significance of this analysis for an ongoing research project of innovative platform development. From the results of content analysis given in Table 2 only service dimension sub-concepts that are dealing with environment sustainability were selected: SR5: Smart power delivery (which was recognized in 6 papers), SR9: Smart water management (appearing in 1 paper) and SR11: Smart public/street lightning (found in 2 papers). For these service dimension sub-concepts related to scope and technology sub-concepts were extracted in order to identify relations between these variables. A visualization of the relations is given in Figure 4.

The analysis shows that service sub-concept SR5: Smart power delivery is mostly (in 6 out of 6 papers) related to SC1: Quality of life, which is important for the citizen perspective. Further it is related to SC4: Energy, water and environment management (4 out of 6 papers) and to SC6: More administrative and governance efficiency (3 out of 6 papers), which are significant to the Governance bodies as beneficiaries of the initiative. Internet of Things, big data and data analytics, and mobile technologies are represented in 2 out of 3 service dimensions related to the selected sector. Other service sub-concepts are encountered only once or twice in this analysis and can be viewed as its strong limitation. Nevertheless, it demonstrates a possible theoretical and practical approach in assessing the applicability of digital technology trends in smart cities initiatives in the context of digital transformation, and in selecting the most appropriate technology to specific aims, goals and scope as well as to outputs or deliverables of the initiative.

Figure 4. Visualization of relations between service, scope and technology concepts in the energy, water and environment sector



Source: Authors.

4.5. Discussion

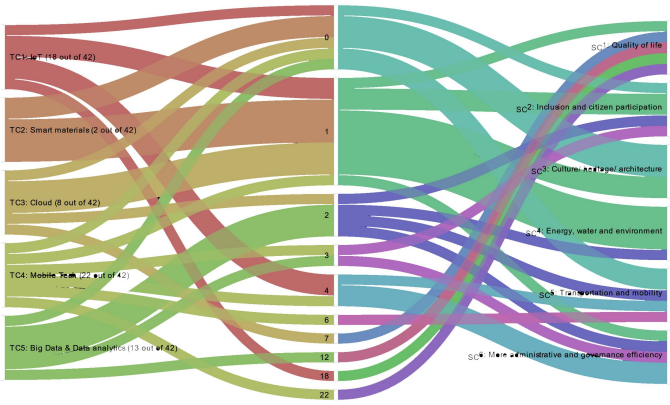
Digital-technology-enabled service transformations promise to improve service delivery in public organisations (Omar et al., 2017) yet while analysing the collected publications we noticed that smart city initiatives report scarcely about outcomes in terms of measurable results. This also indicates the newness of the digital transformation context in public sector and that its scope is still not widely spread outside the profit-oriented industries.

Another issue regarding Omar's statement is related to the term improvement. Improvement is evaluated by customers (in this context by citizens) due to the fact that DT should be used with the purpose of generating new business models that allow organizations to change their value creation processes and deliver new services designed for customers. The analysed papers were mostly declaratively oriented on the quality of life as an improvement scope and didn't demonstrate how this is needed from the customer perspective or achieved by the initiative. This is noticeable from Table 2 since the "services dimension" is the weakest of the three selected dimensions (showing the smallest number of occurrences). As shown in table 2 the "scope dimension" explains the strategy of initiatives and this dimension is very well covered by overall occurrences. In addition, a very strong emphasis on technological aspects was noticed resulting in high number of occurrences in the "technology dimension". Figure 5 shows a detailed content analysis on technology and scope relations derived from Table 2. It consists of Technology subconcept with a number of occurrences in 42 papers in the first column and identified relations to Scope sub-concepts. According to our research, IoT and mobile technologies are most common in smart city initiatives implementing digital transformation, and these initiatives are mostly oriented on the Quality of life as an initiative scope.

Main findings of the analysis can be systemized as follows:

- Smart cities in DT reports deliver no concrete results in terms of measurable values.

Figure 5. Content analysis on technology and scope relations



Source: Authors.

- Scopes fail to demonstrate how DT is perceived by customers.
- Products and services should be more in line with customer/citizen expectations.
- IoT and mobile technologies are most common in smart city initiatives, implementing digital transformation.

Our initial assumption was that out of five key determinants related to DT some determinants can be identified as leading factors in most smart city initiatives. Based on our analysis we are quite confident that strategy orientation and technology can be seen as the leading factors in most smart city initiatives. Customer-centricity, as well as the innovation and capability determinants are not covered enough.

5. CONCLUSION

The paper presents results of a systematic review and identifies gaps and issues in the available studies primarily related to the lack of focus on citizens' needs and scarce evidence of the effectiveness of smart city initiatives. The content analysis reveals that strategy orientation and technological aspects can be seen as key determinants of digital transformation which are at the same time the leading factors in smart city initiatives.

Our research showed that the most case studies related to smart cities and digital transformation confirm Alizadeh's remark that these initiatives are still in their planning phases or that they can be seen as work in progress. Although digital transformation is a long-term process, milestones of progress should be communicated clearly and more frequently. This is also related to the outcomes of such initiatives, since most case studies deliver no concrete results in terms of measurable values. Although a more efficient administration is a promising goal, the absence of an effect analysis with well-defined indicators makes it difficult to learn from previous initiatives. However, theoretical and practical contribution of this paper can be found in our content analysis results, which can be helpful in assessing the applicability of digital technology trends in smart cities initiatives in the context of digital transformation, and in selecting the most appropriate technology to: a) deal with a specific scope or b) deliver outputs of the initiative.

The lack of customer-centricity is another issue that we have discovered in our analysis. Most initiatives are only declaratively oriented on the quality of life, but they fail to demonstrate how this is achieved. Management of citizens' experiences and journey (e.g. by implementing complex prediction algorithms) is poorly discussed, as well as the innovation and capability determinant. Further research of the topic should therefore include investigating in more depth the interrelations between scope, service and technology concepts and refining activities on how to plan strategies and apply digital technologies on products and services that are more in line with customer/citizen expectations and are measurable in terms of contributing to the proclaimed scope.

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INICIJATIVE "PAMETNIH GRADOVA" U KONTEKSTU DIGITALNE TRANSFORMACIJE – OPSEG, USLUGE I TEHNOLOGIJE

Sažetak

Digitalna transformacija je novi trend u načinu razvoja obavljanja posla, kako u privatnom, tako i u javnom sektoru, bez obzira na industriju, odnosno područje rada. "Pametni" se gradovi, kao jedan od koncepata u okviru digitalne transformacije, obično povezuju s lokalnom upravom, s obzirom da je njihova odgovornost osigurati bolju kvalitetu života građana. Neki su gradovi već iskoristili mogućnosti koje pruža koncept "pametnog grada", stvarajući vrijednost za sve dionike živućeg gradskog eko-sustava, pa se mogu smatrati primjerima dobre prakse. Drugi se, pak, gradovi tek usmjeravaju i razvijaju prema ostvarivanju koncepta "pametnog grada". U ovom se radu pruža strukturirani pregled literature i analiziraju opseg, usluge i tehnologije, povezani s "pametnim gradovima" te digitalnom transformacijom, kao konceptima, usmjerenim na jačanje društvene interakcije i suradnje, a s ciljem utvrđivanja vodećih čimbenika u većini inicijativa "pametnih gradova".

Ključne riječi: *"pametni grad", digitalna transformacija, opseg, usluge, tehnologije*