Integration of citizens into the development process of data-driven applications in the context of a smart city in order to achieve high acceptance and system success

Alisa Lorenz[1]

[1] *Technische Hochschule Mittelhessen, Wiesenstraße 14, 35390 Gießen, Germany*

Abstract

With smart cities evolving, they provide opportunities to improve the lives of citizens in urban areas and contribute to a more sustainable future. Focusing on intelligent traffic management, the project VLUID aims to establish a digital platform in a medium-sized German city as well as data-driven applications for intelligent traffic routing to contribute to a more livable city. In this context, my research will focus on the role of citizens as part of a smart city and their acceptance. Building on citizen science approaches in the context of technology acceptance, I try to answer the question how civic engagement can contribute to the selection of applications in order to achieve high acceptance and system success. In this paper, I will show the research model for my dissertation as well as the plan for the next three years of my studies.

Keywords

Smart City, Smart Mobility, Intelligent Traffic Management, Citizen Science, Technology Acceptance

1. Introduction

Data growth and the evolvement of new technologies have been an accelerator of digitalization for the past years [1]. Digitalization improves our everyday lives and contributes to economy and society with data-driven solutions that can be applied to e.g., energy transformation, sustainable mobility, or health care [2]. At the same time, humanity is facing population growth which especially affects cities: it is estimated that 70% of humans worldwide will live in cities until the year 2050 and already today cities generate 80% of greenhouse gases [3]. Further challenges in cities arise through demographic change, globalization, and climate change, resulting in pollution, public health problems, and mobility constraints [4]. Consequently, population growth and urbanization multiply each other, leading to several resulting challenges. They are expected to cause a shortage of living space as well as challenges for social life and coexistence, affecting cities in particular.

The concept of smart cities is a strategy that evolved in the last years as a consequence of these developments to counteract the negative trends in urban areas [3]. Smart cities aim to use the advantages of digitalization and advanced technology to create public value for citizens, especially in urban areas [5]. Examples are initiatives for measurement and improvement of air quality which positively affect livability or smart mobility solutions that make transport more efficient and convenient.

The German city Wetzlar is currently facing such a transformation process towards a smart sustainable city with focus on data-driven traffic management and smart mobility. The city is an important traffic node and economic hub located in central Hesse with a multitude of companies and focus on heavy industry as well as precision mechanics technology. The federal highway B49 is especially important for the economy and citizens since it goes through the city center and links Wetzlar to other big cities and highways. However, the B49 together with another set of important roads will be

ICSOB '22: 13th International Conference on Software Business, November 8–11, 2022, Bolzano, Italy
EMAIL: alisa.lorenz@w.thm.de
ORCID: 0000-0002-8547-1391

partially closed and reconstructed from 2025, causing a challenging traffic situation in and around the city.

To mitigate the negative effects of this construction sites that will last for several years, the "VLUID"[2] project was initiated. In this project an interdisciplinary team is working on the development of data-driven applications for traffic management with myself being responsible for scientific steering and research[3]. During the project, the project team, will connect several data sources and integrate them into one digital platform that we call "Wetzlar data space". The overall goal of VLUID is therefore to ensure fluid traffic as well as accessibility of destinations in and around Wetzlar in a reasonable timeframe in the face of the construction sites by considering effects on livability.

Since VLUID is a public project that is aimed towards improvement of the living environment of citizens, I want to focus my research on citizen centricity as an important part of smart city strategies. I will build on existing knowledge on smart cities, smart mobility, and the relation to sustainability to investigate the role and influence of citizens in the context of digital transformation and the development of Wetzlar towards a smart city. The data-driven solutions emerging from the project are a crucial part of the project and build the basis for data collection, transformation, and information communication towards its users. Therefore, I want to investigate the citizens' acceptance and adoption of the applications as well as the success of our systems. I will work at the intersection of the research fields of smart cities, smart mobility, technology acceptance and system success, sustainability, and citizen science. There is already extensive research existing in each of these fields whereas I want to bring them together and apply them to the traffic management context.

2. Literature Review

Smart City

With population growth and increasing urbanization, cities become more and more populated while space and resources are limited. Countries will face challenges in meeting the needs of their growing urban populations, including for housing, transportation, energy systems, education and healthcare which leads to the need for sustainable development [6]. In the last years, smart city initiatives evolved with the goal to contribute to finding solutions for these challenges and ensuring livability in urban areas. They aspire to make a positive impact on society and nature by using the opportunities of technology, software and data while considering sustainability, resilience, governance, and intelligent management of natural resources to enhance the quality of life [7].

However, even though the use of technology and digital infrastructure are prerequisites for smart cities, they merely are the foundation and don't generate value without usage. The success of a smart city is defined by the people who use the applications and the value created for them. Without usable applications with a clear benefit for citizens, cities will not be able to become smart.

Smart Mobility

The concept of smart mobility is one building block of a smart city and aligned with the sustainable development goals [8]. Benovolo et al. define Smart Mobility as "a set of coordinated actions addressed at improving the efficiency, the effectiveness and the environmental sustainability in cities" which are characterized using information and communication technology (ICT) [9]. Since road traffic is responsible for about 65% of the CO2 emissions and is likely to increase in Wetzlar due to the construction sites and rerouting, it is important to mitigate the negative effects by using the opportunities of smart mobility [10].

There are already several digitalization projects for smart cities that target different aspects of mobility such as smart parking, optimizing traffic routing or predicting traffic lights and might serve as a blueprint for other cities.

[2] The VLUID project is funded by the Federal Ministry for Digital and Transport. „VLUID" is an abbreviation of the German description „Verkehrslösungen für komplexe Umbauszenarien auf der Grundlage intelligenter Datenauswertung", meaning „Traffic Management Solutions for Complex Reconstruction Scenarios Based on Intelligent Data Analysis".

[3] In the project, I am representing the Technische Hochschule Mittelhessen, University of Applied Sciences, where I also conduct my research.

Generally, smart mobility approaches should always aim for advantages for both administrators and citizens. While administration focuses on improved traffic management, route planning and data-based development, citizens benefit from these advances with improved traffic, alternative routes, and cost efficiency [8]. This relationship is a direct indicator for the relevance of citizens as users for the solutions and applications developed.

Sustainability

In 2015 the United Nations (UN) formally acknowledged the need for transformative change towards sustainability by defining 17 goals for sustainable development (SDG) in the agenda 2030. The resulting resolution defines sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs" by considering environmental concerns, social aspects, and economic development [11]. The Sustainable Development Goals have universal relevance as they have been aligned between all nations and thus represent a collective understanding of sustainability. Many of these goals build an important foundation for the conditions and criteria towards the transformation to a smart city.

The application of technology in cities is beneficial, however, making them really "smart" calls for a balance of technology with the needs of citizens that are reflected by the sustainability factors [12]. Recent research shows that there is high potential for analyzing the contribution of smart cities to achieve sustainable development [13]. According to Yigitcanlar et al., sustainability is even a condition for cities to become smart [14]. In conclusion, sustainability is a factor that is directly linked to the development of smart cities and therefore should be considered in any research regarding this field.

User Acceptance Models

To achieve the goals of the VLUID project, high acceptance and regular usage of our data-driven applications as well as adoption of behavior based on the recommendations are mandatory. In this context, the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT) offer guidance for analyzing and measuring acceptance and adoption of information systems by their users.

The TAM explains perceived usefulness and perceived ease of use as the two main influence factors on the attitude towards the use of a technology and also incorporates social influences, cognitive instrumental processes and the variable of experience as additional influences that are reflected by subjective norm, voluntariness, image, job relevance, output quality and result demonstrability [15]. Based on this, the Unified Theory of Acceptance and Usage of Technology was developed to explain user intentions and usage behavior. It points out four key constructs: performance expectancy, effort expectancy, social influence and enabling conditions [16]. Technology acceptance is therefore influenced by multiple factors which also influence each other. A recent study analyzed the factors that particularly influence the intention and use of web applications in smart cities [17]. The authors describe citizens of smart cities as the source of change and simultaneously the object of all target activities and suggest increasing involvement of the population in using the applications in everyday life (ibid). Other authors further call for more people-centric approaches and involvement of citizens in smart city initiatives, e.g., by empowering citizens and using bottom-up approaches [18]. Summarizing, people living in cities play the key role in smart city projects since their adoption decides over success or failure.

Information System Success

The theory for information system success that defines value and efficacy of IS activities goes back to DeLone and McLean who developed it in 1992. They updated their model in 2003 and it is up to today one of the most cited theories in information systems research [19]. It identifies six critical aspects and their relationship that influence the success of information systems: system quality, information quality, use and user satisfaction, individual impact, and organizational impact (ibid). They later enhanced the model by adding service quality as another dimension and combining the dimensions individual impact and organizational impact to "net benefits" (ibid). All factors are interdependent which is why they require special caution and attention when applied to specific research.

Citizen Science

Comprehensible science communication has become more important due to the increasing distance between scientists and citizens. To improve the trust in science, the efforts of information systems researchers towards sustainable impact on society should be made transparent and better communicated [20]. Citizen science approaches can be a medium to do this as they directly include citizens in the processes of data collection and research, however, they are not yet broadly applied in information systems research. Weinhardt et al. propose to use these approaches in technology and methodology such as open innovation, gamification and participatory design and advocate for considering citizen science as opportunity to engage citizens and attract them in IS research (ibid). Other authors also recognize the advantages of including citizens who have an interest in the related field. They describe it as "a movement in IS research towards societally impactful research at the confluence of human behavior, technology, society, and environmental sustainability" [21].

Other researchers identified people-centered and data-driven research as an opportunity for smart city research since smart cities are built for people and not only for profit [22]. They point out that cities require a longer development and transformation process to become "smart", in which they have to align different components and influence factors while respecting diverse human needs (ibid). By working closely together with the target group for which solutions are built, researchers can learn more about human behavior in new IS contexts [21].

3. Research Overview

3.1. Research Model

Based on the project scope and literature analyzed in the previous chapter, I identified potential for further research in the area of smart cities and smart mobility and particularly regarding intelligent traffic management. Intelligent data- and analytics-based traffic management only evolved in the last decade together with the concept of smart mobility. Research highly focuses on technology and possible applications, combining IoT with data processing infrastructure and high performing analytics tools.

However, as pointed out, all technology only creates value when it is used. Data-based traffic management approaches base on existing and well-known technology but go a step further by collecting data from sensors in the city and also from moving vehicles and other personal objects that are able to send data. Further, the VLUID project aims to influence citizen behavior and direct them to the best form of transport or route to avoid traffic chaos. The project therefore wants to make a positive impact and help citizens and the city as a whole. However, citizens themselves might have an aversion against the intervention in their personal decisions which would stand against the success of the systems and applications.

Since usage and adoption play a very important role in the project, I want to focus my research on the influence of citizens on the development process and how their involvement can help to achieve system success of the data-driven applications. Smart traffic management as part of smart mobility and smart cities build the application context of my research that is given through the VLUID project. Building on this research, I want to find out how smart city initiatives can not only ensure high acceptance but also adoption.

Using the Technology Acceptance Model, the Theory of Reasoned Action and Information System Success as grand IS theories, I want to bring them together and find out how smart city initiatives can not only ensure high acceptance but also adoption by using citizen science approaches.

I further want to analyze the impact and importance of sustainability for smart traffic management and citizens as well as the impact that the applications from VLUID will have on it. Positive impacts on sustainability are not only the expected results from these activities but sustainability plays a key part in the overall context. Figure 1 summarizes the research fields and shows how they are related to each other.

Concluding, I will be working on the intersection of multiple research fields which have been each explored in detail but less explored when bringing them all together. By applying them to the specific

context of applications for traffic management and the role of citizen involvement, I hope to contribute to the literature by exploring this specific node further.

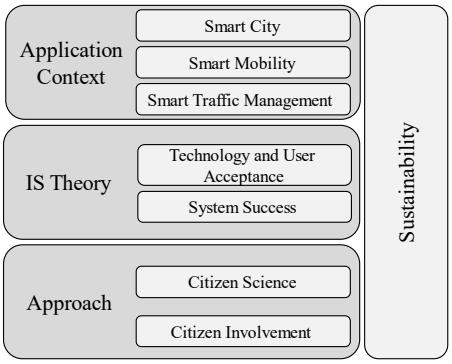

Figure 1: Research Model

3.2. Research Questions

The VLUID project is scheduled until September 2024 with an option to extend it by six months. It is divided into four main phases that are summarized in Figure 2. I will schedule my research mainly around the first three of these phases and the questions and challenges that arise in each of them.

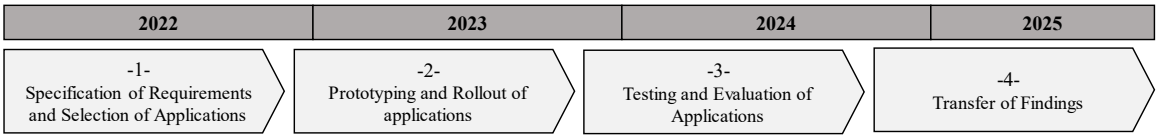

Figure 2: Main project phases and timeline of VLUID

Bringing the project scope, the research model, and the described literature together, I developed the following main research question for my dissertation:

> *How can we integrate citizens into the development process of data-driven applications in the context of a smart city in order to achieve high acceptance and system success?*

This question stresses the importance of citizens in smart cities and focuses on their involvement in the development process of data-driven applications. It also goes beyond seeing citizens as targets for our activities and advocates for their integration and participation in the development process. Further, it highlights the aspect of system success and defines it with acceptance and adoption of citizens to the solutions. Based on this high-level research question, I derived three underlying questions that each contribute to one of the three project phases and that will be further described in the following. All questions are summarized in Figure 3.

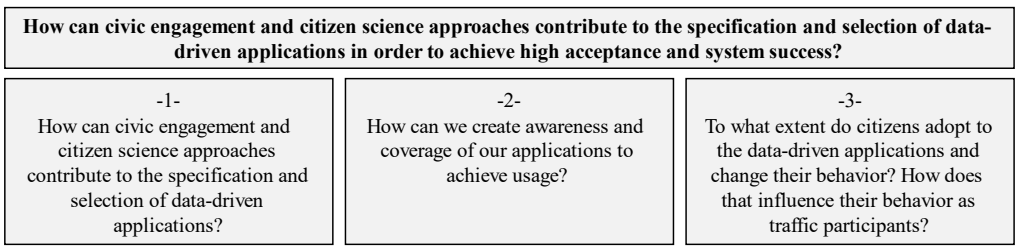

Figure 3: Research questions for the dissertation

The first project phase focuses on requirements and specification of applications. Since VLUID is a project for the city and the requirements defined by the core project team might differ from the requirements and expectations of citizens, I want to include citizens in the specification process. Using citizen science approaches, I want them to collect and define criteria for data-driven applications that they perceive as necessary and useful. Deviated from the main research question and applied to this specific context, the sub-question of the first research phase is:

How can civic engagement and citizen science approaches contribute to the specification and selection of data-driven applications?

With the insights and findings, I would contribute to improving our understanding of participation as well as potential for future inclusion. I will also show whether involvement in the project changes the perception of the resulting applications and how citizen's approaches differ from the core project team.

In the second project phase the prototypes of data-driven applications will be developed and rolled out for testing. To be successful with the rollout, good, comprehensible, and broad communication is necessary so that citizens become aware of the possibilities provided. Building on the need for science communication as well as citizen science and technology acceptance, I want to find out the best ways to make our project and the contribution of our applications visible so that citizens will want to try them. Again, I want to include citizens from Wetzlar in this process to highlight alternative perspectives and promote human-centered approaches. The sub-question for research in this context is:

How can we create awareness and coverage of our applications to achieve usage?

The contribution of the second research increment will be a set of effective ways to communicate the existence of applications and the information through the applications, tested through several case studies.

In the third and last project phase the data-driven applications will be tested and evaluated to rate their success. This is especially important since it will determine the degree of usage and system success that is the result of the previous activities. Hence, it is crucial to evaluate whether citizens not only like, know, understand, and use the applications but also whether usage leads to a change in behavior. Building on the TAM and UTAUT models as well as IS success, the third sub-question is:

To what extent do citizens adopt to the data-driven applications and change their behavior? How does that influence their behavior as traffic participants?

The results of this research increment will contribute to finding out whether involvement in the project from the start and throughout in certain phases increases user acceptance and usage. It will further show whether and how data-driven traffic management applications can influence citizens behavior, and which features of the applications contribute to their success.

3.3. Method and Timeline

As described in the last section, I will orientate my research along the project phases of VLUID. Summarizing these and combining them with the research phases, the plan for my dissertation is divided into three main parts with related studies that are displayed in figure 4.

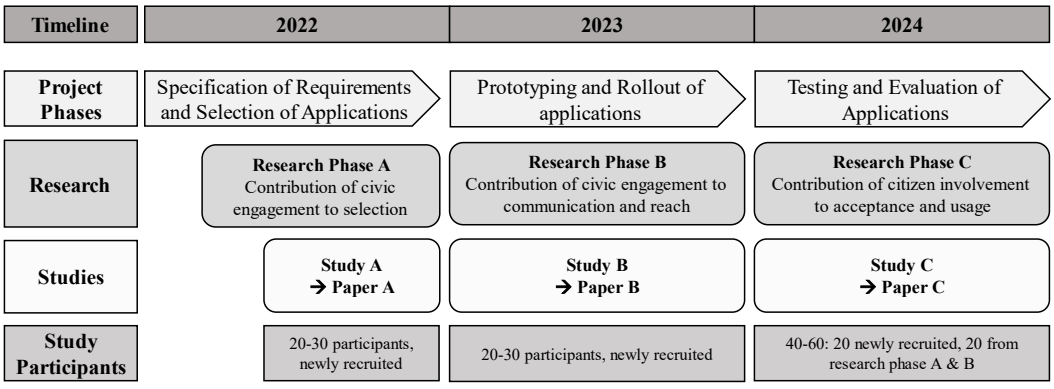

Figure 4: Project Phases of VLUID and related Studies

Since the goal of the research is to analyze the impact of human-centric project approaches, all studies will closely include citizens. The focus will lie on a dialogue an exchange to incorporate new perspectives. To do this, I want to recruit people who live in and around the city Wetzlar to participate in different surveys, workshops, and subprojects.

I plan to 20-30 participants per study. Main aspects of the study will be based on workshops with citizens. Therefore, I will need smaller groups where it is possible to work with each other and discuss.

Groups of 20-30 people should therefore be divided in smaller workshop groups. To get a diverse picture and include enough representatives, I would aim for participants who use different forms of traffic and different routes daily. The definite number of participants to include may change later in the planning process when a more specific amount is determined.

For research purposes, clustering and the identification of possible correlations, each study will start by asking participants to share certain personal information, e.g., on Age, Gender, and Profession. This will be further developed by incorporating suggestions from literature. The detailed elaboration will be part of the preparations for research phase A.

In the following section I will describe each of the research phases A to C further to give an overview of the planned activities and which methods I expect to use in detail.

Research Phase A

The first research focuses on the contribution of civic engagement to the selection process of our data-driven applications and contributes to the first research question: *How can civic engagement and citizen science approaches contribute to the specification and selection of data-driven applications?* In this phase I want to combine different research approaches to get a broad picture of how citizen participation can influence the selection process and system acceptance. In the focus of the study is a workshop that I want to conduct together with citizens of Wetzlar. They will be invited to develop and share their relevant criteria for our data-driven applications and rate the existing concept from a previous study where we evaluated the criteria that are relevant for the members of the project team. The study consists of four parts which are referred to as A1-A4.

With study A1 I want to measure the acceptance of the pre-defined criteria that resulted from the project team. To do this, the workshop will start with a presentation of the general project and also display the catalogue of criteria. Afterwards, each participant will get a questionnaire that asks for their agreement with the predefined criteria. I plan to use closed questions and a Likert scale with values from 1-5 to determine comparable values.

Study A2 focuses on the workshop and the development of criteria. In the workshop the participants will be introduced to methods to determine relevant criteria, such as brainstorming. I will then ask them to define the criteria that they believe would be relevant for our data-driven applications and the impact of VLUID for the city and citizens. These can differ from the criteria presented in A1. Additionally, I will ask them to assign a weight to each criterion that they defined. In a final round, all criteria will be discussed together and again weights assigned from the other participants.

In study A3 I will ask the participants to answer the questions from study A1 again and determine whether there are changes in their perception. One hypothesis is that people would accept their own criteria more than the ones from the project or are more likely to accept the predefined criteria if it aligns with their own perception.

I will finish the experiments with study A4 which will evaluate whether the participants found the workshop valuable, whether they felt involved and whether they think that their contributions matter. Further, I will ask them how likely it is that they will use data-driven applications that fit their defined requirements. This will again be done through a questionnaire with closed questions on the same scale as in A1.

Research Phase B

Research phase B aligns with the prototyping and rollout phase of the VLUID project and focuses on the contribution of civic engagement for coverage regarding the communication of the project. In this study I want to find out whether other forms of communication that go beyond official channels from the city and the project partners would achieve the broad reach that the project requires. Again, I want to include citizens in the development and the communication process. The study consists of four parts which are referred to as B1-B4.

Similar to research phase A, I will start research phase B with a survey before the workshop. In study B1 I want to find out which sources of information participants use daily. This could be classical media like newspapers, television but also modern apps like Instagram or just hearing something from neighbors. In this study it will be especially important to find out which sources of information they generally use and which of them they use for informing themselves about activities in the city. With the

results I want to identify whether there is potential for new forms of communication and which channels would make sense.

In study B2 I want to conduct another workshop that will focus on the development of communication concepts. This will go beyond classical brainstorming since citizen science calls for involvement and the generation of data, information, or insights. I want the participants to develop their own ideas based on communication concepts that they wish for and that they would use. This could be done in small teams that each focus on different approaches, e.g., in areas related to their community, hobby, etc. A prerequisite is that at least one person from each team will continue with their proposal and try to bring them to life with the help of the VLUID project team as a small sub-project. In the best-case scenario this workshop would produce "champions" as communicators that are close to the city but also close to the project. By using more approaches in parallel I estimate to also reach more citizens and develop high reach across the city.

Study B3 will then evaluate the method used and how the participants felt about their contribution as well as the method. I want to focus on their involvement and how they perceive their influence and relevance to the project.

Lastly, in study B4, I want to evaluate how the proposals and sub-projects evolved after some weeks or months. I want to check in again with the participants and find out how much their communication strategy changed, how they further developed it and how much range it gained. This will show whether additional reach can be developed by integrating citizens. Also, the whole research increment B will help in understanding how the involvement of citizens changes the outcome of the project.

Research Phase C

The last research phase C will focus on the acceptance, usage and adoption of the applications developed. This phase will show the degree of success of our applications and participation measures. I want to find out how the efforts from previous studies evolved and whether the behavior of citizens changes through using our data-driven applications. In this phase I want to measure differences between citizens that have been involved in research increment A or B and citizens that have not yet been involved. Therefore, half of the participants will be newly recruited and the other half contacted from the pool of previous participants. This last study consists of three parts which are referred to as C1-C3.

Research increment C will consist of three surveys since this will be an ex-post evaluation of activities of the past and the results of the VLUID project. Study C1 will focus on citizens who have not been actively involved in VLUID to answer a set of questions related to the results from the project. They should especially focus on the knowledge of the applications, the use of the applications, the benefits of the applications and the resulting behavior from using the applications.

Study C2 will consist of the same questions as used in study C1, however, the participants will be citizens who have participated before either in a study of research increment A or B. By asking two groups who were involved in a different extent, I want to determine whether and how the answers differ between citizens who were involved and citizens who were not.

The study closes with C3, where the participants from C2 will asked an additional set of questions. I want to find out more about the methods used and how participants perceived them. This will try to determine whether citizen participation in this form had success and whether participants would like to contribute to other projects and scenarios as well.

4. Outlook

I will conduct my first studies approximately in fall 2022. After structuring and defining the methods I want to use in my research, I will further detail my study design and begin recruiting citizens for the studies. Since research increment C and A are linked together with a longitudinal study, it is of most importance to find participants that are willing to participate over the course of several years.

After the theoretical and methodological foundation, I will start conducting the studies, collecting the results, and analyzing them. I plan to at least submit one scientific paper for each research phase to stay in close contact with the scientific community and share interims results.

With my work, I hope to contribute to the hypothesis that involvement of citizens in smart city projects like VLUID can lead to higher acceptance and adoption of applications. I am looking forward

to working on an innovative project and approach that might provide findings for research on information systems for a sustainable society.

5. References

[1] P. Kravchenko, M. Leshchenko, D. Marushchak & Y. Vdovychenko: Digitalization as a Global Trend and Growth Factor of the Modern Economy. SHS Web of Conferences, 65, 2019

[2] H. Kagermann: Change Through Digitalization – Value Creation in the Age of Industry 4.0. In: Management of Permanent Change, Wiesbaden, Springer Fachmedien, 2015, pp. 23-45.

[3] S. Mohanty: Everything You Wanted to Know About Smart Cities. IEEE Consumer Elecronics Magazine., 5, 2016, pp. 60-70.

[4] F. Chan & H. Chan: Recent research and challenges in sustainable urbanisation. Resources, Conservation and Recycling, 184, 2022.

[5] R. Dameri: Smart City Implementation. Creating Economic and Public Value in Innovative Urban Systems. Cham: Springer International, 2017.

[6] General Assembly of the United Nations: Resolution adopted by the General Assembly - 71/313 Work of the Statistical Commission pertaining to the 2030 Agenda for Sustainable Development, 2017. URL: https://ggim.un.org/documents/a_res_71_313.pdf

[7] Al Nuaimi, N. Mohamed, J. Al-Jaroodi & H. Al Neyadi: Applications of big data to smart cities. Journal of Internet Services and Applications, 6., 2015

[8] S. Paiva, M. Ahad, G. Tripathi, N. Feroz & G. Casalino: Enabling Technologies for Urban Smart Mobility: Recent Trends, Opportunities and Challenges. Sensors, 21, 2021.

[9] A. Benovolo, R. Dameri & B. D'Auria: Smart Mobility in Smart Cities. Action Taxonomy, ICT Intensitiy and Public Benfits. In T. Torre, A. Braccini & R. Spinellig (Eds.), Empowering Organizations. Enabling Platforms and Artefacts, Cham, Springer, 2016, pp. 15-28.

[10] L. Chapman: Transport and climate change: a review. Journal of Transport Geography, 2007, pp. 354-367.

[11] World Commission on Environment and Development: Our Common Future, Chapter 2: Towards Sustainable Development, 2015. URL: http://www.un-documents.net/ocf-02.html

[12] D. Soeiro: Smart Cities, Well-Being and Good Business: The 2030 Agenda and the Role of Knowledge in the Era of Industry 4.0. In F. V. Matos, Knowledge, People, and Digital Transformation - Approaches for a Sustainable Future, Springer Nature Switzerland, 2000, pp. 55-67.

[13] A. Toli & N. Murtagh: The Concept of Sustainability in Smart City Definitions. Frontiers in Built Environment, 6, 2000.

[14] T. Yigitcanlar, M. Kamruzzaman, M. Forth, J. Marques, E. Costa & G. Ioppolo: Can cities become smart without being sustainable? A systematic review of the literature. Sustainable Cities and Society, 45, 2019.

[15] V. Venkatesh & F. Davis: A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies. Management Science, 2000, pp. 186-204.

[16] V. Venkatesh, M. Morris, G. Davis & F. Davis (2003). User Acceptance of Information Technology: Toward a Unified View. MIS Quarterly, 27(3), 2003, pp. 425-478.

[17] Y. Popova & D. Zagulova: UTAUT Model for Smart City Concept Implementation: Use of Web Applications by Residents for Everyday Operations. Informatics, 9(27), 2022.

[18] P. Cardullo & R. Kitchin: Being a 'citizen' in the smart city: up and down the scaffold of smart citizen participation in Dublin, Ireland. GeoJournal, 2019.

[19] W. DeLone & E. McLean: The DeLone and McLean Model of Information Systems Success: A Ten-Year Update. Journal of Management Information Systems, 19(4), 2003, pp. 9-30.

[20] C. Weinhardt, S. Kloker, O. Hinz & W. van der Aalst: Citizen Science in Information Systems Research. Business & Information Systems Engineering, 62, 2020, pp. 273-277.

[21] M. Levy & M. Germonprez: The Potential for Citizen Science in Information Systems Research. Communications of the Association for Information Systems, 40, 2017, pp. 22-39.

[22] W. Qi & Z. Shen: A Smart-City Scope of Operations Management. SSRN Electronic Journal, 2018.