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Management Systems in Production Engineering

2024, Volume 32, Issue 2, pp. 156-161

Date of submission of the article to the Editor: 11/2023
Date of acceptance of the article by the Editor: 04/2024

DOI 10.2478/mspe-2024-0015

SMART CITY CONCEPTUAL FRAMEWORK IN THE CONTEXT OF ACHIEVING SUSTAINABLE DEVELOPMENT GOALS

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Abstract:
The article presents the conceptual assumptions of the Smart City in its different phases of development - Smart City 1.0, Smart City 2.0, Smart City 3.0, Smart City 4.0, Smart City 5.0 and Smart Sustainable City. With reference to „Transforming our world: the 2030 Agenda for Sustainable Development" containing 17 Sustainable Development Goals, the article specifically presents the assumptions and practical solutions for SDG Goal 11. A critical analysis of the literature on the subject and a content analysis of the SDG reports revealed a juxtaposition of the diverse capabilities of smart technologies and their insufficient implementation to meet the Sustainable Development Goals in Smart Cities. The reality is not encouraging. The population of people living in slums is growing rapidly, social inequalities are widening, and there is a lack of access to convenient urban transport. There is chaotic urban sprawl, air pollution and insufficient public open spaces. Solutions to urban problems are often interventionist rather than preventive. The rational and sustainable use of modern technology can change this.

Key words: *Smart City, Smart Sustainable City, Sustainable Development Goals, Sustainable Development Goal 11*

INTRODUCTION

Protecting the natural environment and improving the quality of human life are overarching goals of the concept of sustainable development. Since the first Earth Summit held in Rio de Janeiro in 1992, these issues have been continuously present in all documents constituting the concept of sustainable development. These include, first and foremost, the Global Programme of Action Agenda 21 (1992) and the Rio Declaration (1992), the Johannesburg Plan of Implementation (2002) and the Johannesburg Declaration (2022), the final document RIO+20 The Future We Want (2012). The current document setting out the Sustainable Development Goals and the tasks assigned to them is the Resolution adopted by the General Assembly on 25 September 2015 „Transforming our world: the 2030 Agenda for Sustainable Development"., which specifies 17 Sustainable Development Goals. Goal 11. („Make cities inclusive, safe, resilient and sustainable") relates directly to enhancing the quality of life in cities. Smart technologies can play a big role in achieving the Sustainable Development Goals. Their application is indicated by researchers in the different generations of Smart City and Smart Sustainable City.

LITERATURE REVIEW

In the development of the Smart City concept, we can distinguish five generations.

- Smart City 1.0 – the use of modern information and communication technologies in cities was initiated by the thriving ICT sector, which offered its products to city authorities [1];
- Smart City 2.0 – the initiator of the implementation of modern technologies was city authorities [1];
- Smart City 3.0 – the initiators of the implementation of ICT solutions and other modern technologies in the city are the citizens [1];
- Smart City 4.0 – modern technologies, networking and knowledge sharing are used to achieve the goals of sustainable urban development and its inhabitants [2];

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- Smart City 5.0 – an ecosystem of smart services based on multi-agent technology that can harmoniously balance all spheres of life and the conflicting interests of different urban actors [3].

When defining the Smart City, it is also worth mentioning the definitions of W. Mitchell (2007) [4] and N. Komninos (2008) [5], (2020) [6]. Komninos definition is close to the understanding of a Smart Sustainable City.

Researchers from the Vienna University of Technology contributed to the popularisation of the Smart City concept. In their report they referred to 6 perspectives of the Smart City [7, 8]:

- smart economy – competitiveness,
- smart mobility – transport and ICT,
- smart environment – natural resources,
- smart people – social and human capital,
- smart living – quality of life,
- smart governance – participation.

The publication popularity on Smart City is quite high. For example, the Scopus database displays for the query „Smart City" (title, abstract, keywords) almost 50,000 publications (accessed 15.04.2024). The number of publications is different if we directly query a specific generation of Smart City. For the query „Smart City 1.0", the database provides only 5 publications, „Smart City 2.0" – 9 publications, „Smart City 3.0" – 9 publications, „Smart City 4.0" – 15 publications and „Smart City 5.0" – 10 publications (accessed 15.04.2024).

Referring to Cohen's concept Zwick and Spicer [9] demonstrate that concepts are not always reflected in practical action. Their research shows that practitioners overwhelmingly understand building smart cities as a government-led (local government) and data-focused endeavour (Smart City 2.0). They understand the Smart City concept as a gradual modernisation process undertaken by public administration to solve urban problems through the application of modern technologies. P. Szarek-Iwaniuk and A. Senetra [10] also refer to Cohen's three generations of Smart City. However, they focus on smart City 3.0 referring to sustainable development and improving quality of life. The main objective of their research is to determine the role and importance of e-participation methods in the Smart City concept. Similar topics are addressed in the article by M. Giela [11] and M. Legutko-Kobus [12]. The public participation model is also highlighted in the article A. Kuzior and P. Kuzior [13].

Some researchers emphasise that Smart City 3.0 is synonymous with the concept of the Smart Sustainable City, defined as „…innovative city that uses ICTs and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social, environmental as well as cultural aspects"(UNECE – United Nations Economic Commission for Europe) [14]. Is this right? Such assumptions, as in the UNECE definition, only appear in the Smart City 4.0 concept, so this concept is closer to that of the Smart Sustainable City. It focuses on improving the quality of life for the current generation, but also assumes responsibility for future generations in line with the concept of sustainability. The Smart City 5.0 concept again places more emphasis on modern technologies, including artificial intelligence, which can lead to dehumanising processes.

The Smart City is considered from a number of perspectives in the literature. It addresses, for example, the functioning of cities during the COVID-19 pandemic. They write about it, among other: Fatewar and Vaishali [15], Kuzior et al. [16, 17], Vasilyeva et al. [18], Ober and Karwot [19], Rachmavati et al. [20], Sadjadi [21], Oh et al. [22], Apostu et al. [23]. Similarly, in the case of health care Guo et al. [24], Thomas et al. [25].

The issue of the use of modern and smart technology in cities is also present in the articles [26, 27, 28, 29, 30, 31, 32, 33, 34, 35]. Modern technologies are helpful for the design and implementation of a Smart Sustainable City. However, some researchers also point out the negative sides of using innovative technologies [36, 37, 38, 39, 40] and the stress and anxiety associated with their implementation [41, 42].

METHODOLOGY OF RESEARCH

The aim of the study is to show the evolution of the Smart City concept towards a Smart Sustainable City and the impact of the implementation of smart solutions on the achievement of the Sustainable Development Goals, in particular Goal 11. of the 2030 Agenda for Sustainable Development. The research focuses on a literature analysis and a content analysis of selected publications and reports.

RESULTS AND DISCUSION

As demonstrated above, it can be considered that the Smart City 4.0 concept is close to the Smart Sustainable City concept. Smart City tools can be used to achieve sustainable development goals. United Nations Resolution adopted by the General Assembly on 25 September 2015 „Transforming our world: the 2030 Agenda for Sustainable Development" (A/RES/70/1) contains 17 Sustainable Development Goals. Cities are directly dedicated to Goal 11.: „Make cities inclusive, safe, resilient and sustainable". However, in the other goals of Agenda 2030, such measures that enhance the development of sustainable cities are also present. Table 1 shows the range of tasks in the implementation of Goal 11 (cf. Table 1).

The implementation of the sustainability goals is systematically monitored. The 2023 [44] report on the achievement of Goal 11. is not optimistic. The number of people living in cities is constantly increasing.

It is estimated that by 2050, 70% of the world's population will live in cities. Currently, more than one billion people live in slums. It is estimated that in the next three decades the number of people living in slums will increase to 2 billion. Smaller cities in many regions are experiencing faster slum population growth than large cities. Social

inequalities are worsening and urban poverty is increasing.

Table 1
Sustainable development goals in the context of shaping sustainable cities

Goal 11.	Tasks
11.1	„By 2030, ensure access for all to adequate, safe and affordable housing and basic services and upgrade slums"
11.2	„By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons"
11.3	„By 2030, enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries"
11.4	„Strengthen efforts to protect and safeguard the world's cultural and natural heritage"
11.5	„By 2030, significantly reduce the number of deaths and the number of people affected and substantially decrease the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations"
11.6	„By 2030, reduce the adverse per capita environmental impact of cities, including by paying special attention to air quality and municipal and other waste management"
11.7	„By 2030, provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities"
11.a	„Support positive economic, social and environmental links between urban, peri-urban and rural areas by strengthening national and regional development planning"
11.b	„By 2020, substantially increase the number of cities and human settlements adopting and implementing integrated policies and plans towards inclusion, resource efficiency, mitigation and adaptation to climate change, resilience to disasters, and develop and implement, in line with the Sendai Framework for Disaster Risk Reduction 2015-2030, holistic disaster risk management at all levels"
11.c	„Support least developed countries, including through financial and technical assistance, in building sustainable and resilient buildings utilizing local materials"

Source: based on: Transforming our world: the 2030 Agenda for Sustainable Development. United Nations A/RES/70/1. Resolution adopted by the General Assembly on 25 September 2015 [43].

Half of the world's urban population does not have access to convenient public transport and the demand for urban transport is growing exponentially (this is especially true in developing countries). There is chaotic urban sprawl, air pollution and a lack of sufficient public open spaces. However, the number of countries with national and local disaster risk reduction strategies has doubled since 2015 [45]. However, these are only strategies. They are far from concrete actions. Strategies are a necessary but initial stage of development. The practice so far shows that by 2030 it will not be possible to achieve the set goals at such a pace of taking action and implementing innovative solutions to achieve the goals of sustainable development and improving the quality of life of the global population, including city dwellers. A certain solution to the emerging problems and the realisation of the sustainable development goals may be smart tools for managing various urban processes. In Poland, the Central Statistical Office prepares experimental statistics for individual sustainable development goals. Such statistics are available, inter alia, for Goal 9. and Goal 11. (GUS) [46].

Research studies show a direct correlation between the implementation of smart city solutions and sustainable development, mainly through talent attraction, inflow of intellectual capital, development of investment and new business opportunities [47]. Chen et al. [48] pointed out the interaction between urbanisation and environmental ecological performance in terms of resource consumption, greenhouse gas emissions and the overall ecological well-being of urban areas. They also drew attention to the level of digitalisation, which supports, among other things, the promotion of effective sustainable practices.

There are relatively few academic articles on the Smart Sustainable City in the context of achieving the Sustainable Development Goals. The Scopus database finds only 27 publications in titles, abstracts and keywords. Most of these highlight the positive relationship between smart innovative solutions and the realisation of the Sustainable Urban Development Goals. Chatti and Khan (2024) [49] indicate that environmentally friendly innovations support the development of sustainable cities and the achievement of sustainable development goals. Switching to cleaner energy from conventional energy production allows for a significant reduction in CO_2. Beck et al. (2023) [50] emphasise the importance of networking strategies, technology development, the circular economy, the sharing economy, corporate social responsibility, entrepreneurship, knowledge sharing, open innovation, ethics and creativity on achieving smart city development goals. Smart technologies are used to create awareness of sustainable development [51]. Smart cities must evolve towards environmental efficiency to effectively address emerging issues [52]. The Smart Sustainable City is considered from the perspectives of the environment, clean green energy, safety, the application of smart technologies, people and politics. The shortcoming of these studies is the lack of a holistic approach to all dimensions of SSC, and only such an approach is optimal to solve the emerging problems of modern cities. Modern technologies are tools in shaping the Smart Sustainable City. Properly targeted innovations can serve to solve the problems of civilisation not only in cities, but also in rural areas [53].

CONCLUSION

In conclusion, it should be stated that the Smart City conceptual assumptions, in particular Smart City 4.0 and Smart Sustainable City, respond to the problems defined in Agenda 2030 and, by definition, with the use of smart technologies, can contribute to the achievement of sustainable development goals. Nevertheless, it should be emphasised that the conceptual assumptions are not effectively implemented, as indicated by reports monitoring the implementation of the sustainable development goals. Numerous solutions appear in scientific studies, but it is difficult to translate theory into practice. Cognitively valuable are studies based on case studies that present good practices and can be treated as a kind of benchmarking for the creation of a Smart Sustainable City, which, with the support of smart technologies, meets the needs of the present generation and takes sufficient care to preserve the necessary qualities of the city for future generations. In doing so, it is important to take a holistic approach to urban management and consider all pillars of sustainability: economic, social and environmental. In the perspective of responsibility for future generations, environmental protection is particularly important. In cities, however, this is difficult. Green enclaves of cities are insufficient. Urban heat islands emerge, reducing the comfort of living. The problem is particularly acute in large cities, where concrete pavements prevail instead of greenery. Realising a Smart Sustainable City requires the systematic implementation of environmentally friendly solutions and considerable financial resources, as well as a corresponding level of environmental awareness among city dwellers.

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