Civil Engineering Research Journal
ISSN: 2575-8950

Juniper Publishers
key to the Researchers

Mini Review
Volume 14 Issue 1 - September 2023
DOI: 10.19080/CERJ.2023.14.555883

Civil Eng Res J

Municipal Engineering of Intelligent Settlements of Europe

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Submission: September 06, 2023; **Published:** September 25, 2023

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Abstract

In this paper, the authors present their perspective on the urban engineering of intelligent residential structures, which integrates the vision of an ideal human settlement and the latest smart solutions - IoT an BIM (Internet of Things, Building Information Model). Based on their European knowledge, the authors present their holistic definitions of road engineering, municipal engineering and green infrastructures as an integral part of integrated transport infrastructure. The authors consider the perception of a smart city as an intelligent city to be outdated and identify with the concept of Intelligent Cities and Regions (ICaR). The article presents the integrated sectors of smart cities, the concept of a smart self-government applying principle 3I (innovation, integration, inclusion) and tools for achieving goals with a long-term impact. The authors emphasize a need the implement behavioral psychology for the perception of outside factors of settlements and present European examples of green infrastructure implemented within highways, urban roads and residential estate.

Keywords: Municipal Engineering; Smart Cities and Regions; Green Infrastructures; Behavioral Psychology

Abbreviations: ICT: Information and Communication Technology; IoT: Internet of Things; MI: Municipal engineering; RI: Road Engineering; RU: Residential Units; IcaR: Intelligent Cities and Regions

Introduction

In the presented article, the authors deal with the issue of smart cities and regions (SCR) and municipal engineering. The authors consider the perception of a smart city as an intelligent city to be outdated and identify with the term of Intelligent Cities and Regions (ICaR). They present their definition of municipal engineering [1,2] in the context of Central Europe, not only as smart cities. Details of these matters are presented in the next chapter. For now, the authors consider defining SCR as an open system and are trying to connect urban engineering and smart cities. They try to find the "modus vivendi" of technological and utopian ideas of the "ideal residential unit (city, village, region)".

Saint Thomas More (Figure 1), an English lawyer, politician and writer, who held the office of Lord Chancellor of King Henry VIII in 1529-1532, considered the best English lawyer and one of the greatest European scholars of his time, published his idea of the ideal settlements. In his work Utopia - Two books about the best state of the state and the new island of Utopia, a truly golden work and as useful as it is entertaining, which was published in 1516 in Antwerp, he described the island of Utopia, (the name is from the Greek negative ú-union and topos-place, i.e. in a place that does not exist or Nowhere) of a dream, ideal (non-existent) society. The inhabitants of the island of Utopia followed strict but fair laws, everyone had enough food and the necessary comforts, there were no poor or rich. Idleness was not allowed there, no excuse for inactivity was tolerated, every free moment belonged to education. The main source of livelihood was agriculture. Every 2 years, the inhabitants of 54 cities, in which they engaged in crafts, repaired and built houses, were replaced by rural people, who mostly returned to the cities. The part of the book describing the settlement of the island belongs to the first efforts to formulate the idea of planning human settlements in relation to wider territorial ties [3].

In Utopia, cities with water mains, extensive public hospitals and carefully landscaped gardens created an interconnected network of settlements about a day's walk away from each other. The streets in them were purposefully designed to serve traffic and protect them from the wind. The buildings were clean,

handsome, and the facades lined the streets in continuous rows on both sides. Each city quarter had a spacious social hall for lunches and dinners, there were no pubs, and the appearance was influenced by a uniform and generally beneficial order [4].

Urban morphology and integrated sectors of smart cities and regions

According to [5] SCR is a technologically modern urbanized area (urban area) using various types of electronic methods and sensors to collect specific data (collect specific data) used for effective management of assets, resources and services [6]. According to [7], an urban area (built-up area or urban agglomeration) is a human settlement with a high population density and the infrastructure of the built environment. Urban areas are created by urbanization and are categorized according to urban morphology as: cities, municipalities (in Slovak legislation there is only a municipality, a city is referred to as a municipality with the status of a city), agglomerations and suburbs. In urbanism, the term is contrasted with rural areas such as villages and hamlets, in urban sociology it is contrasted with the natural environment. The integrated sectors of smart cities according to [8] are presented in Figure 2.

Figure 1: Thomas More (1478-1535) and illustration his work Utopia from 1516 [3].

Figure 2: Integrated sectors of smart cities according to [8].

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Information from citizens, facilities, buildings and property is processed and analyzed to monitor and manage transport systems, power plants, engineering networks, water networks, waste, achieving the required level of safety (persons, property, environment...), information systems, schools, libraries, hospitals and other community services. smart cities are defined as intelligent in the ways in which governments (a system or groups of people managing organized communities) use technology, as well as in how they monitor, analyze, plan and manage the city [8]. A hackathon is usually a competitive event where people work in groups on software or hardware projects with the goal of creating a working product by the end of the event [9].

The SC concept integrates ICT (Information and Communication Technology) and various physical devices connected to the Internet of Things (IoT) to optimize the efficiency of city operations and services and connect with citizens. The Internet of Things (IoT) is a term in computer science for connecting devices/objects/people to the Internet. This type of device often uses Wi-Fi and/or Bluetooth connectivity. The connected device should be mainly wireless and should bring new possibilities for mutual interaction not only between individual systems, but also bring new possibilities for their control, monitoring and provision of advanced services. SC technology allows city (municipality, region) representatives to directly interact with the community of interest and monitor what is happening and how the area in question is developing. SC should be better prepared to respond to challenges than a city with a conventional "transactional" relationship with its citizens.

However, the concept of SC itself remains vague in its specifics and is therefore open to many interpretations. On the other hand, with the development of society, new, serious risks have appeared, which arise mainly from technical and technological development, the emergence and promotion of the information society, the expansion of job opportunities and human interference with nature. More complex technologies increase the danger, as a source of technical and technological risks, which can cause incidents, accidents, malfunctions, interruption of activities, accidents and disasters, with extensive negative consequences for people, property (production), but also in a certain way for the environment.

Action plan for smart cities and regions

The authors consider the perception of smart city as only intelligent for city to be outdated, as evidenced by the ongoing (07.12.2022) interdepartmental comment procedure LP/2022/825 Action plan for smart cities and regions for the years 2023-2026 [10]. Each existing definition of a smart city and region reflects the hidden or public goals and interests of its creator and the environment in which it was created. For the purposes of the Smart Cities and Regions Action Plan for 2023-2026 and its other activities in the area of supporting smart cities and regions, MIRRI SR comes up with the following definition. This definition is based on current international developments and knowledge in the field of SCR (Smart City and Region) and takes into account the tasks and competences of MIRRI SR in the area of regional development support, coordination of investment projects and computerization defined by Act no. 575/2001 Coll. [11]. We consider smart cities and regions to be those that use data, ICT and participation, i.e. the involvement of a wide range of stakeholders in decision-making, as tools for achieving goals conducive to saving financial and material resources, providing better, more convenient and efficient public services and meeting measurable indicators. (at the city or region level). When making decisions and creating projects, they apply the principles of integration, inclusion, innovation and strategy, while the implemented activities have a demonstrable positive impact on the long-term improvement of the quality of life in the city and region and sustainable development (Figure 3) in the city and region [10].

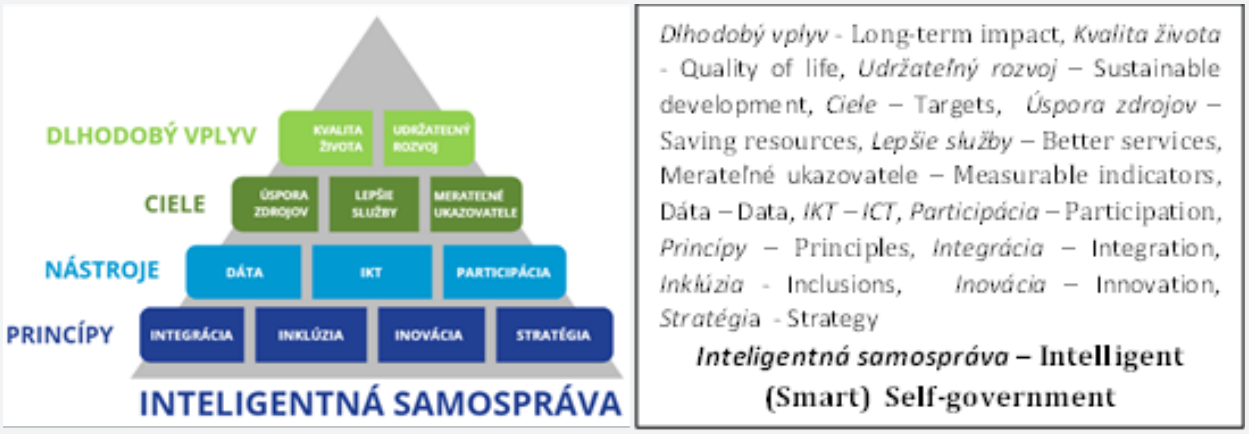

Figure 3: Smart self-government in its management applies principles and tools for achieving goals with a long-term impact [10].

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Author's definition of road and municipal engineering

In university textbooks (Figure 4), the authors presented their own definition of road and municipal engineering based on their many years of experience in local government, scientific and professional as well as educational activities.

Road engineering (RI) - represents a set of activities related to the optimization of processes in planning, modeling of dynamic systems and their applications in the construction and management of the entire life cycle of elements of the transport infrastructure, especially roads. Road engineering mainly includes the following substantial integral subsystems:

- material engineering in transport constructions,
- environmental engineering in transport constructions,
- sustainable technologies of construction and management of roads,
- transport infrastructure planning and integrated transport systems,
- information systems for managing PKs, including their components and objects,
- intelligent transport systems,
- a subsystem of taking into account the requirements of users and residents of the road vicinity.

f4

The RI of the beginning of the 21st century must imply interdisciplinary globally established holistic approaches to the preparation, construction, management, recycling, rehabilitation, liquidation of roads with a significant emphasis on the circulation (circular) economy and their implementation into (sustainable preparation, construction and management) of integrated transport infrastructure (IDI) EU. All RI activities must be carried out at an appropriate price, in an appropriate quality, with the aim of ensuring multimodal, interoperable, safe transport with the lowest possible carbon footprint aimed at the development and cohesion of regions and ultimately contributing to the satisfaction of citizens and their quality of life.

Municipal engineering (ME) - represents a multidisciplinary set of competences, knowledge, skills, tools and procedures used in the application practice of self-governing management, aimed at the development and subsequent implementation of the intentions of the development strategies of residential units (RU). MI must imply holistic planning of the RU, both physical (urban planning) and socioeconomic (city planning), with significant sustainable development and adaptive, integrated management corresponding to the complex potential of the respective RU. The strategic goal of MI is the achievement of optimal indicators set by holistic planning, and the processes to achieve them must be guided by the principle of value for money. Through the synergy of individual components and their compliance with national and European standards, MI ultimately contributes to the satisfaction of the citizens of RU. The strategic goal of MI must be realized by the synergy of partial planned values of individual indicators, in particular:

- public and psychology (mental) health,
- education and culture,
- nature and landscape protection, ecological, integrated transport, people and goods transport,
- rationalization of activities ensuring the technical equipment of the territory, protection of monuments and cultural heritage,
- comprehensive security,
- social standards and
- the economic prosperity of people living in the communities of the respective RU [1].

Green infrastructure is an institute with a multi-beneficiary meaning. Within the Slovak administrative science, it is understood as a public interest incorporating several partial issues ranging from the primary interest of environmental protection, economic development of settlements, support of public and mental health, social issues, and sport, which in the Slovak Republic is a public interest.

The term BIM (Building Information Modeling) is closely related to the concept of MI and SCR, which is the documentation of the object during its entire life cycle from pre-project preparation to demolition. The original goal of BIM was to capture all information about the design and construction of the object with the prospect of using this data during the use and maintenance of the object [12]. BIM can be synchronized with other technologies in order to use innovative methods in construction, it can be connected with drones for data collection and storage. With the advent of the Internet of Things, there is more talk about the possibilities of integrating sensors with BIM [1]. In the framework of the identification and sustainability of critical places of resident mental health, the authors try to implement the principles of Behavioral Community Psychology to the Slovak Municipal Engineering.

Behavioral community psychology

Contemporary society puts pressure on all of us. More and more stressors have their source in the environment and operate in our daily lives [13]. The authors consider the positive impact of green infrastructure, as part of road infrastructures (Figures 5-9), of settlements as one of the possible minimization measures. They are trying to involve such scientific disciplines as behavioral psychology, sociology and, of course, economics and the science of public administration alongside the already traditional environmental science, ecology, urban planning or urban engineering in this investigation.

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Figure 4: Authors' books from 2021 and 2023 containing their definition of road and municipal engineering and green infrastructures.

Figure 5: Views from 8/7/2023 of the green infrastructure within the motorway in Morges, Switzerland.

Figure 6: Views from 6/7/2023 of the green infrastructure within urban road in Laussane, Switzerland.

In the 1960s, an interplay of factors led to the emergence of behavioral community psychology as a subspecialization of psychology focused on integration:

- applied behavior analysis - which can tell us how things work and how to make a change,
- community psychology - which tells what is, was and can be.

Planned changes in communities are the subject of study and practice in a wide range of areas including:

- community development,
- social work,
- public administration,
- urban planning and
- psychology.

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Figure 7: Views from 7/7/2023 of the green infrastructure within housing estate Fourmi (Ant), Switzerland.

Figure 8: Views from 20.8.2022 on the combination of elements of green infrastructure and road traffic noise reducing devices in Laussane, Switzerland.

Figure 9: Views from 28/04/2023 on the elements of the green infrastructure of the urban road in the city of Žilina.

Across disciplines, there has been growing recognition that new and integrated approaches are needed to solve complex and multi-determined problems. In the 1970s, the goal of behavioral community psychology was to unite scientists across disciplines through a shared vision for advancing behavioral community research and action to address societal conditions. However, the evolutionary path of behavioral community psychology, including its rise and revival, was the result of selection by consequence. Furthermore, it was recognized that no single discipline can do it all, but that multiple disciplines have something to offer together in

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solving many and varied, multifaceted societal problems. Richard Rakos summarized in the Behaviorists for Social Action Journal the importance of multidisciplinary approaches to advancing social change [14]. To be effective, we need to balance our enthusiasm for an analytical approach with the sophistication and humility of multidisciplinary data sources. Behavioral analytics is a powerful heuristic and methodology for analyzing, organizing, and using data-what it can't provide is the data itself.

At least in the field of behavior analysis science, these disciplines can be seen to fulfill their moderating role by becoming an integral part of an internal database-and it is this more complex database that will then influence the goals and objectives, that is, the values, of behavioral social intervention. From the mid-1970s to the early 1990s, behavioral community psychology was a bastion of interdisciplinary and behavioral approaches to solving social problems. Bogat and Jason [15] stated that "the field of behavioral community psychology has emerged as a subspecialty of community psychology and applied behavior analysis.

The current society puts pressure on each of us. More and more stressors appear to have their source in the environment and work in our everyday lives [16]. The environment, landscape, etc., is the space to which we assign meaning, give a bond, and an emotional connection, and is the place in which we live, exist, feel, think, behave, and act. The perspective of place can integrate a space saturated with benevolence, sources of fulfilling needs, experiencing psychological well-being, and on the other hand, experiencing a state of distress. Contemporary society puts pressure on each of us with an increasing number of stressors having their source in the environment and operating in our daily lives. This influence of the urbanized environment on our psyche, perception, experience, and behavior is a stimulating topic for the cognitive-behavioral approach, which in this context focuses on the study of how external stressors affect our internal reactions, feelings, emotions, thoughts, beliefs, and behaviors. The impact of an urbanized environment can have different effects on people, their quality of life, and their mental health, with some experiencing increased tension, anxiety, depression, or other psychological difficulties. Negative cognitive patterns may be present, such as catastrophic thinking, a focus on danger, experiencing helplessness (a cognitive aspect of stress), increased irritability, and aggressive, flight behavior (a behavioral aspect of stress). The intention is to identify negative, dysfunctional cognitions and behavioral patterns which can be associated with this environmental impact and to gradually modify them through appropriately chosen interventions (e.g., cognitive restructuring, and behavioral techniques). This can promote individual tolerance to stress responses, resilience, coping strategies, and adaptation to urbanized environments without negatively impacting psychological (mental) health. People's reactions to stressors vary widely, and consequently, a cognitive-behavioral perspective may better enable us to understand how different urbanization factors influence cognitive-behavioral responses to stress. It can be an effective tool for intervening and overcoming the challenges associated with modern urbanized lifestyles to make the environment a place of home.

Conclusion

There are many issues that engineers face in their day-to-day jobs working in municipal engineering and many valuable experiences can be shared within the activities of the International Federation of Municipal Engineering [17]. As an examples, this article discusses the holistic perception of the term municipal engineering, emphasizes the importance of green infrastructure (Figures 8-9) of settlements, draws attention to the need to implement the principles of behavioral community psychology in the planning of settlements. Their visions are compatible with the authors [18] which presented the vision of planning a community where sustainability policies were applied to the design of a site in the form of tangible practices.

There are many issues that engineers face in their day-to-day jobs working in municipal engineering and many valuable experiences can be shared within the activities of the International Federation of Municipal Engineering [17]. This article discusses the holistic perception of the term municipal engineering, emphasizes the importance of green infrastructure of settlements, draws attention to the need to implement the principles of behavioral community psychology in the planning of settlements. Their visions are compatible with the authors [18] which presented the vision of planning a community where sustainability policies were applied to the design of a site in the form of tangible practices. They specifically focused on storm water management, pedestrian and bicycle movement and lowered infrastructure costs, and illustrates the vital role of the engineer in the move towards livable, affordable and ecologically sound communities.

The authors consider the perception of a smart city as an intelligent city to be outdated and identify with the concept of ICaR (Intelligent Cities and Regions) corresponding to SCR (Smart City and Region). The article also draws attention to the fact that settlements exist in an uncertain, ever-changing environment, they must have the ability to adapt or change in order to achieve a certain consistency of their own activity, their own goals with environmental conditions that are changing and that can be a source of instability with all its effects on individual factors of the wider and immediate external environment. In this paper, the authors more detailed present their perspective of an ideal human settlement as the synergy of urban, smart, green infrastructures and behavioral psychology solutions. As part of further research activities, they want to devote themselves to the contextual design of the transport infrastructure of settlements, taking into account colors, scale, proportion, rhythm, contrast, symmetry, harmony, signs and symbols [19].

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DOI: 10.19080/CERJ.2023.14.555883

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