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# Budapest Residents' Views on Smart City Developments as Revealed by a Questionnaire Survey

## ABSTRACT

The world is facing numerous global socio-economic and socio-environmental challenges. One of them is climate change, which through its complexity, affects all aspects of human life, the economy, and ecosystems. One of the main contributors to this climatic change is cities, through their share of the population, use of land for urban purposes, energy consumption, and emission of greenhouse gases (GHGs in $CO_2$ equivalent). Therefore, cities are good/appropriate testing grounds for investigating innovative solutions to complex challenges and shaping city dwellers' awareness. At present, one of these innovative approaches is the 'smart city' concept, which is mainly based on the development of digitalisation, and information and communications technology (ICT). As a combination of these two statements, this article examines two factors: 1) the main challenges of Budapest, according to its dwellers, and 2) the applicability of relevant available smart city solutions to improving inhabitants' environmental consciousness. This study presents the results of quantitative research method that was conducted in 2022 among the city dwellers of Budapest. Based on the questionnaire – thus according to inhabitants' opinions – the paper describes the main areas of urban development that should be focused on. According to the former, the main problems are intensive pollution, the heat island effect, and intensive land use. The main smart solutions, which have been implemented and are known by the residents, have limited educational potential for raising environmental awareness.

*Keywords: climate change, environmental awareness, smart city solution, questionnaire survey*

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## INTRODUCTION

The increase in greenhouse gas emissions (GHGs, as defined by the Kyoto Protocol (United Nations, 1997) has started with the Industrial Revolution and the intensive use of coal to boost productivity. Since then, the global average monthly $CO_2$ concentration in the atmosphere has been steadily increasing – proof of the contribution of human activities to the global warming process. The related activities, except for agriculture, are located mostly in cities, which according to UN-Habitat (United Nations, 2020), represent just 2% of the Earth's surface but are home to 55% of the population, and account for the majority of the contribution to climate change – being responsible for 78 % of the world's energy consumption and emission of more than 60% (United Nations, 2020), 75% (UNEP, 2021), or 80% (Hoornweg et al., 2020) of GHGs emissions. The top emitters, based on the 2019 available data (Climate Watch, 2022), are China, the United States, the European Union, India, Russia, Japan, Brazil, Indonesia, Iran, and South Korea. These countries also represent the main carbon emission hotspots, based on their local emission performance and trade and production networks, which can be changed over time. For instance, the main carbon footprint hotspots of the United Kingdom during its EU membership were located in the EU (Cologne, Brussels, Milan, Bucharest, Oslo, and in a handful of cities in Hungary, Slovakia, and Poland), in China (coastal and the greater Beijing/Hebei province), in Bangkok, and Kuala Lumpur, according to Kanemoto et al. (2016). More precisely, as Wei et al. in their 2021 research stated, the Top 25 emitter cities represent 15 % of the 167 cities, and 52% of the total GHG emissions. They are mainly located in Asia (including Handan, Shanghai, Suzhou [CH], Tokyo [JP], Bangkok [TH]), Europe (Moscow [RU], Istanbul [TR], Frankfurt [DE]), and America (New York city [US], and Los Angeles [US]) (Wei et al., 2021).

According to Angel et al. (1998), Collier (1997), Collier & Löfstedt (1997), DeAngelo & Harvey (1998), Feldman & Wilt (1993), Harvey (1993), Lambright et al. (1996), McEvoy et al. (1999), and Wilbanks & Kates (1999), although cities account for a significant share of energy consumption, waste generation, and commuting-related emissions, they can also have the essential resources such as the political power, platforms, and institutions that control financial and human capital, environmental resources and information, and they may play a major role in addressing the issues of sustainability and climate mitigation or adaptation. As a result of their interconnectedness and urbanization, cities represent different stakeholders through the provided services, as well as their industrial activities, urban developments, and decision-making processes (Szalai & Fabula, 2021; Fekete, 2022). The aim of this study is to examine the environmental consciousness of smart solutions in Budapest from the perspective of its inhabitants using primary data collection. Furthermore, the sub-goals of the study are to present the related literature on the topic, the current urban challenges defined by the city respondents, and their knowledge related to the term 'smart city.' Finally, a partial goal of the research is to examine the environmental focus of the smart solutions mentioned by the respondents. Based on these aims, the author intends to provide, through a novel multidisciplinary approach, a more diversified understanding of the main obstructive factors that decrease city dwellers' well-being, in

their own opinions, and the environmental potential of smart developments to tackle climate change. For this reason, based on Bertalan (2015), Pakainé Kováts et al. (2015), Molnár et al. (2021) and Fekete (2022), the following research questions were defined during the investigation to cover these usually separately investigated fields:

1. What are the challenges considered most important by the city dwellers of Budapest?
2. What type of development is considered essential for the inhabitants of Budapest?
3. How familiar is the sample population with the term 'smart city'?
4. What types of smart solutions are known by the residents of Budapest?
5. To what extent do these smart city solutions increase the environmental awareness of the population?

## LITERATURE REVIEW

The importance of technology in economic development was recognized as early as the start of the 1970s, by Meadows et al. (1972). With innovative technological solutions – such as the elevator and mass transit systems – the boundaries of natural resources can be further extended. Currently, besides nature-based solutions (Balatonyi et al., 2022), the rapid development of the Internet, and information and communications technologies (ICT) are driving economic development, while these advanced technology solutions combined with a stable economic and institutional background can improve the urban resilience, sustainability, and the well-being of the inhabitants. One of these potential innovative solutions is the 'smart city' concept (Fekete, 2022).

The term 'smart city' dates to 1974, when the first urban big data project, "a cluster analysis of Los Angeles", was held (Los Angeles Community Analysis Bureau, 1974). Since then, interest in the topic has risen, despite the fact that there is no globally accepted definition of the term. However, there are several approaches to it based on different distinguishing factors. The main determining element in each case is the focus on smart development, and the role of the respective tools (Fekete, 2022). A more technology-driven point of view can be identified (TDM) (Letaifa, 2015), whereby a smart city is considered a network, and through the use of ICT-based solutions (Su et al., 2011), all services and stakeholders within cities can be connected and involved. The other approach is a more human-centric one (HDM) and envisions that human capital should be prioritised within smart urban development to achieve any improvements (Neirotti et al., 2014) and to put in the focus of the development.

Another distinction was made by Szendi et al. (2020), according to whom the related approaches can be divided into three different groups. One of them is the technocratic approach, which is dominated by ICT implementation: its representatives include Hall et al. (2000); Caragliu et al. (2011); Harrison et al. (2010); Lombardi et al. (2012). The second group covers those approaches which consider the 'smart city' to be a complex term that includes human capital and innovative thinking, besides the essential technological tools. Proponents include Hollands (2008) and Komninos (2011). The final group contains ranking models, such as the Smart City Index (SCO, 2021); the A. T. Kearney Global

Cities Index GCI (Kearney, 2021); and the IESE Cities in Motion Index (CIMI) (Berrone et al., 2020). According to these models, in terms of performance, Budapest is ranked in the second half of the list of examined cities (Table 1).

Currently, the importance of sustainability, 'greenness,' and resilience has increased, and the approaches to the smart city have started to include these elements (Köbli, 2021). Based on Giffinger et al. (2007), and Pelton & Singh (2019), their 'smart city' frameworks' have environmentally-related characteristics. In Giffinger et al.'s (2007) work, it is 'smart environment', in Pelton & Singh's (2019) research '*suitability* and the circular economy' are claimed to be key elements (Szalai, 2020). As Bakici et al. (2012) said, the target of the use of 'smart city' development is the creation of a *sustainable*, *greener* city, and as Kumar & Rattan (2020) stated, 'Smart' is considered as '*Sustainable*' and '*Green*.'

Table 1. Budapest smart performance

| Ranking Model | Ranking of Budapest |
|---|---|
| Smart City Index 2021 | 97. (– 20 place drop compared to 2020) |
| Global Cities Index 2021 | 71. (same as 2020) |
| IESE Cities in Motion Index (2020) | 74. |

Source: own edition based on (SCO, 2021); (Kearney, 2021; Berrone et al., 2020)

According to various sources, such as Meadows et al. (1972); United Nations (1987); United Nations (2012); OECD (2010), UN-Habitat (2011); Revi et al. (2014); UN-Habitat (2020); Kocsis et al. (2016); Kovács et al. (2017), the main urban challenges that cities have to face are urbanisation; arable land consumption for urban purposes; intensive dependence on the Hinterland in terms of agricultural production and energy generation; intensive air, water, waste, noise and thermal pollution; heat islands that result from a combination of a reduction in green space and the vigorous use of the built environment; energy use; the problem of accessing affordable, safe housing; the lack of efficient waste(water) management; transportation and related emissions; and GHG emissions. Smart solutions should be able to contribute in a sustainable, green, and efficient way to the operation of cities and raise the living standards of its inhabitants (Fekete, 2022).

In Hungary, besides the capital city, there are a few cities which could be or have been considered smart cities, including but not limited to Sopron and Miskolc. In these cities, scientific curiosity about the potential of the smart city is significant. In the case of Sopron, the study of Bertalan (2015) examined the attitudes of its population to urban problems. She identified significant underdevelopment in Hungarian cities in general in terms of the implementation and transmission of the concept. In the case of Sopron, "the biggest demand would be for the improvement of a feeling of safety, reduction of crowdedness, more effective traffic organization, a strengthening of environment consciousness and the stopping of the dilapidation of the inner city" (Bertalan, 2015, p. 28). The aim of a study by Pakainé Kováts et al. (2015) "was to analyse the environmental awareness of the population of Sopron in order to elaborate programmes innervating sustainable development supported by ICT technologies

in the future alongside the Sopron Smart City concept" (Pakainé Kováts et al., 2015, p. 29). The main problems, according to the Sopron city dwellers, were air and noise pollution, shrinking green spaces, and the issue of public cleanliness. Regarding environmental awareness, the former were conscious of the use of electricity, the energy efficiency of electrical devices, and waste-related matters such as the 3Rs (reduce, reuse, recycle). In the case of Miskolc, Molnár et al. (2021, p. 11) looked "for the main focus points that should be given priority in urban smart developments according to the inhabitants' opinion". The results showed that knowledge of the term 'smart city' was at a strong medium level, being recognized by more than two-thirds of the dwellers. The biggest challenges were mainly related to safety and health, and these two fields, expanded by education and fire protection, were seen as areas where smart solutions should be implemented.

Additionally, some initiatives have been implemented by local municipalities to monitorize? the city-dwellers knowledge or attitude of the term, including in Győr and Tata.

## METHODS

The aim of the research is to define the main challenges the inhabitants of Budapest face and, according to its dwellers and concerning their knowledge of smart cities, to identify ways of improving inhabitants' environmental consciousness through smart city solutions. To answer the previously presented research questions, quantitative research methodology was implemented (Molnár et al., 2021; Fekete, 2022). In the Hungarian online questionnaire, non-probability, random sampling methodology was applied using three 3 different social media platforms (Facebook, LinkedIn, and Instagram), which may be considered as the first form of the screening of potential respondents, as it assumes internet access and application use. Sampling was carried out during the Summer of 2022 within a 12-day timeframe, resulting in the collection of 320 complete answers. Within the questionnaire, direct, indirect, and open/closed questions were asked.

The questionnaire included two questions about demographic variables (gender, and age) (Table 2). One question was designed to gather information about what respondents consider the most significant challenges faced by the inhabitants of Budapest. To do this, respondents selected those urban problems they considered most important from a predefined list based on Meadows et al. (1972); United Nations (1987); United Nations (2012); OECD (2010), UN-Habitat (2011); Revi et al. (2014); UN-Habitat (2020); Kocsis et al. (2016); and Kovács et al. (2017) or could specify their own. Additionally, they were asked to identify any further essential fields of development. The respondents' self-reported knowledge of the term 'smart city' was classified into three categories (high level of knowledge – 'expert', 'familiar', 'not familiar') and examined using a Chi-Square test (Turhan, 2020) according to gender and age. All respondents were asked whether they could name any smart solutions deployed within the city or internationally, and if so, to list those solutions.

Table 2. Sample composition

| Attribute | Frequencies |
|---|---|
| Gender | Male: 34.69% (111); Female: 65% (208); Other: 0.31% (1) |
| Age | 0–25: 5.94% (19);<br>26–35: 28.75% (92);<br>36–45: 25.00% (80);<br>46–55: 20.94% (67);<br>56– : 19.38% (62) |

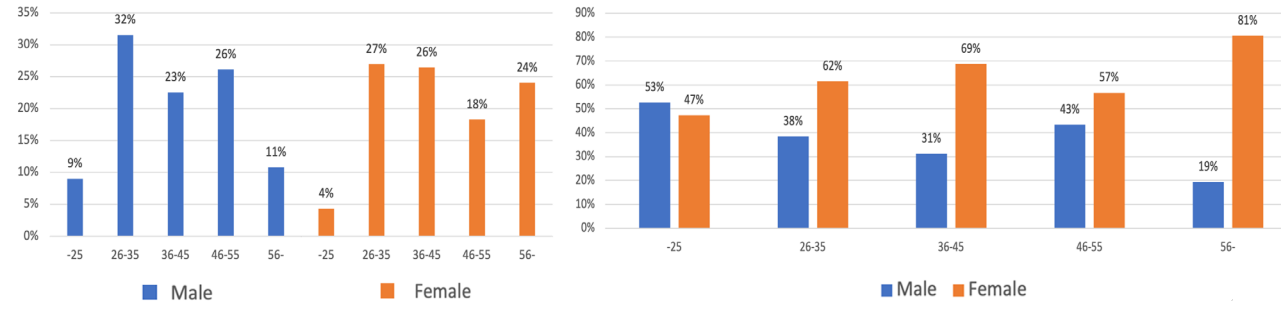
Source: own edition

Based on the answers, the challenges faced by inhabitants of Budapest are presented, as perceived by respondents and their general and environment-related knowledge about smart city solutions. The results do not reflect the general knowledge of all Budapest inhabitants. The methodology that was applied is limited in terms of the reliability of the respondents' answers, and its one-off nature. However, the results may be an excellent basis for further research that expands the variable list by including education, income categories, residence, car ownership, etc. Additionally, comparing responses from different districts could further increase the value of later research.

## RESULTS

As can be seen in Table 2 and Figure 1, there were twice as many women (n=208) respondents as men (n=111), and the proportion of women in all age groups is greater than men, except for the 0–25. The majority of responses came from female residents of Budapest aged 26–35 (56 people), 36–45 (55 people), and 56– (50 people). In terms of age, individuals in the group of 26–35 years old were overrepresented, both in terms of male (32%) and female (27%) respondents.

Figure 1. Division of City Dwellers according to Gender and Age




Source: own edition

Based on the previously presented literature, eleven areas were defined, including intensive heat waves (heat island effect), lack of affordable housing etc., and the participants were asked to select all those problems that they had experienced or considered as "challenges".

Table 3. Most important challenges for city dwellers in Budapest

| Challenges | Responses % | Responses |
|---|---|---|
| Notable pollution | 78.44% | 251 |
| Heat island effect | 75.31% | 241 |
| Intensive land use | 70.94% | 227 |
| Lack of affordable housing | 56.56% | 181 |
| No improvement and/ or maintenance of the urban infrastructure | 53.13% | 170 |
| Strong urbanisation | 47.81% | 153 |
| The ecological footprint of commuting | 41.56% | 133 |
| Significant greenhouse gas emission | 37.19% | 119 |
| Intensive dependence on Hinterland | 34.69% | 111 |
| Inadequate waste management | 32.50% | 104 |
| Security of energy supply | 6.25% | 20 |
| Other - Mobility | 3.75% | 12 |
| There are no problems in my city | 2.19% | 7 |
| Other - Security | 1.56% | 5 |

Source: own edition

The three most important challenges in Budapest (Table 3), based on the experiences of the respondents, are the notable pollution (n=251, 78.43%), followed by the heat island effect (n=241, 75.31%), and intensive land consumption or the lack of green spaces (n=227, 70.94%). These ecological or environment-related problems were followed by two more problems that more than half of the respondents identified as urban challenges. One of them was the difficulty of finding affordable housing (56.56%, n=181), and the inadequate quality of the urban infrastructures (53.12%, n=170). Strong urbanisation was ranked in the middle of the list, although this is a catalytic process which affects and intensifies the other challenges. The least emphasis was placed on the potential security challenges associated with energy supply (6.25%, n=20), and the second least, added by the respondents, was mobility-related problems (3.75%, n=12) , such as the commuting time and the quality, and reliability of the public transport system. The last issue, also added by respondents, was the issue of the security, more precisely, the situation of homeless people and public safety.

Compared to the Smart City Index 2021 (SCO, 2021), the responses have some similarities. In the SCI model, 15 challenges were listed. Of these, according to their respondents, the most significant problems (declining in importance to the least significant) are the following: "*1. affordable housing*, 2. health services, 3. corruption, *4. security, 5. air pollution*, 6. fulfilling employment, 7. *road congestion, 8. green spaces,* 9. unemployment, *10. public transport*, 11. basic amenities, 12. school education, *13. recycling*, 14. social mobility, 15. citizen engagement" (SCO, 2021, p. 36). Of these 15 problems, 8 were not included in the present research. The other seven problems in the order (housing; security; pollution; infrastructure; green space; mobility– road congestion, public transport; GHGs

emissions - recycling) had almost equal weight in terms of mobility and GHGs-related matters, but in this research environment-related problems dominated the list compared to the infrastructural ones. In the case of Sopron, studies (Bertalan, 2015; Pakainé Kováts et al., 2015) have shown that the main problems were mostly related to the increase in the number of city inhabitants, highlighting the issue of the cleanness and safety of the city, and acknowledging the significant pressure on the waste management system. In Miskolc, however, results showed that the main problems were safety, similarly to Sopron, and the health system, which was not a relevant concern in the other two cities (Molnár et al., 2021).

In terms of the potentially necessary developments, city dwellers suggested 244 times any (simple or complex) needs or solutions. The most dominant of these was the *green space*-related development, which was seen as essential. A significant proportion of the respondents (52.05%) believe it is important to protect the currently available green areas during various constructions and renovation programmes, as well as to create additional green spaces, community gardens, and parks. If investing in this is not possible, planting and protecting trees is perceived as the next most important thing that the city needs. This need of the city dwellers is strongly connected with two of the previously determined TOP 3 challenges of the city (heat-island effect, and intensive land consumption). Furthermore, except for three occasions, all the 'green space'-related answers came from those who also stated that the most important challenge for Budapest is the intensive land use.

Besides the green space-related suggestions, the respondents also assigned outstanding importance to reforming the *urban transport system* and developing the related *infrastructure* (Although the latter two combined did not receive as many votes as the protection/creation of green spaces). These two categories include providing alternatives types of transportation (such as sharing systems, bicycle, and scooter, etc.), and ensuring their appropriate quality and necessary infrastructural background, the organization of an inclusive public transport system (that reaches suburban areas), the expansion of parking options (underground garage, P+R options), the development and expansion of road networks (repair of potholes, construction of bypasses, and bicycle paths), and the exchange of the equipment parks for environmentally friendly solutions. Finally, suggestions for further developments were made (in the following order of importance) in the field of waste management (more public bins and public cleanliness), reducing and limiting car traffic, using environmentally conscious devices/solutions, increasing public safety, supporting energy efficiency investment, and last, in healthcare and public housing development. After a detailed discussion of the urban challenges, the participants were asked about their knowledge of the term 'smart city'. To help the classification of their own knowledge, four groups were formed, 'expert', 'familiar', 'not familiar' and 'other' (Fekete, 2022).

*"Which statement best describes your knowledge?"*

"I have great knowledge of the concept of the 'smart city'" – classified as 'expert'

"I am familiar with the term 'smart city', but I am not an expert" – classified as 'familiar'

"I am not familiar with this term" – classified as 'not familiar'

"Other" – classified as 'other'

Based on the respondent's self-reporting (Table 4), two answers were excluded, 27 (8.49%) considered themselves to be 'experts', 108 (33.96%) as 'familiar', and 183 (57.55%) of the 318 thought they are 'not familiar' with the term 'smart city'.

Table 4. Familiarity of population with the term of 'smart city' according to gender

| | Male | Female |
|---|---|---|
| "I have great knowledge of the concept of the 'smart city'" - EXPERT | 14.55% | 5.29% |
| "I am familiar with the term smart city, but I am not an expert" - FAMILIAR | 24.55% | 38.94% |
| "I am not familiar with this term"- NOT FAMILIAR | 60.91% | 55.77% |

Source: own edition

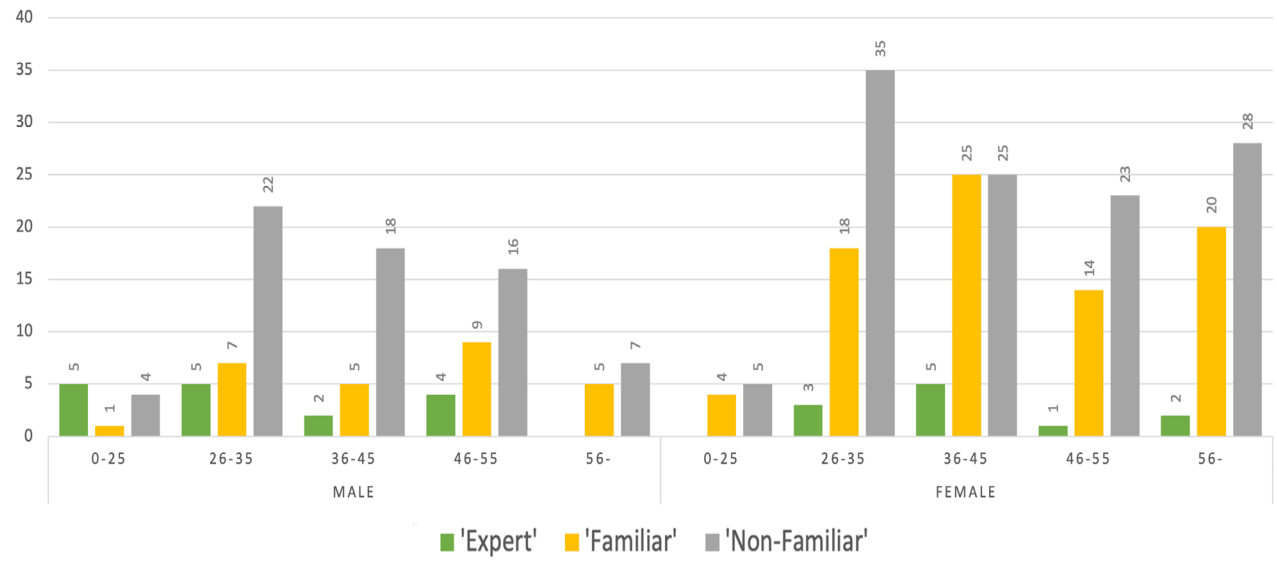
In terms of the influence of gender, 11 (5.29%) out of the female respondents (total 208) considered that they had a high level of knowledge about the term; 81 (38.94%) had heard of it; and for 116 (55.77%) it was a new concept. For male respondents, the proportion was 16 (14.55%) 'expert', 27 (24.55%) 'familiar', 67 (60.91%) 'not familiar', and 1 (0.9%) 'other', which answer was not incorporated into the analysis.

Based on the questionnaire in Sopron, 75.1 % of the respondents were not widely familiar with the term (Bertalan, 2015, p.27; Pakainé Kováts et al., 2015), while in the case of Miskolc, 66.9% of the respondents knew of it (Molnár et al., 2021, p. 15).

In this research, a significant relationship was detected between gender and knowledge (significant at $p < 0.01$. Chi-Square $X^2$ [1, N = 318] = 11.9829, $p < 0.0025$) (Molnár et al., 2021, p. 15; Fekete, 2022), thus it appears that more men consider themselves to be 'expert' on this topic than women. More female citizens were 'familiar' with the term (81 people out of 318 [25.47%]) than men (27 [8.49%]), but more male citizens (n=16, 5.03%) had a 'great knowledge' of the concept than women (n=11, 3.46%). However, in sum, more female respondents had at least some knowledge about the term 'smart city' (n=92, 28.93%) than male respondents (n=43, 13.52%). There was no significant relationship between age and knowledge (not significant at $p < 0.01$. Chi-Square $X^2$ [1, N = 318] = 12.5655, $p < 0.127698$). Therefore, further investigation was necessary. In terms of both attributes (gender, age) and knowledge (Figure 2), most people who stated that they had considerable knowledge were men aged a maximum of 35 years old and women in the 36–45 age range (although women between 36 and 45, and over 56 have the most general knowledge about the term, while women between the ages of 26 and 35 are most likely to have no knowledge about the concept of the 'smart city').

To test the accuracy of self-reporting about the general knowledge of the term 'smart city,' respondents were asked whether they knew of any local or international smart solutions. Table 5 shows that 26.33% (84 people) claimed that they would be able to list at least one such solution, while 73.67% (235) said that they could not. Despite the fact that they considered themselves to have great knowledge about the term, five 'Experts' could not provide an example. 58 people thought they are 'Not Familiar' with the concept of the 'smart city,' however, they stated that they could provide an example for this term.

Figure 2. Familiarity of the population with the term of 'smart city'according to gender and age




Source: own edition

However, the biggest difference was found with the 'Familiar' category of respondents, of whom only three respondents could give an example and 105 could not. In a follow-up question, the city dwellers were asked to list and / or explain the solutions they knew. Of the 84 respondents, one was not able to list any solutions, 68.67% (57 answers) were received from those who are 'Not-Familiar' with the term, 27.71% (23) from those who claim to have 'great knowledge,' and just 3.61% (three answers) from those respondents classified into the 'Familiar' category (Table 5).

Table 5. Knowledge regarding smart solutions

| | Know of Solutions | Not know of Solutions | SUM |
|---|---|---|---|
| 'Expert' | 23 | 5 | 28 |
| 'Familiar' | 3 | 105 | 108 |
| 'Not Familiar' | 58 | 125 | 183 |
| SUM | 84 | 235 | 319 |

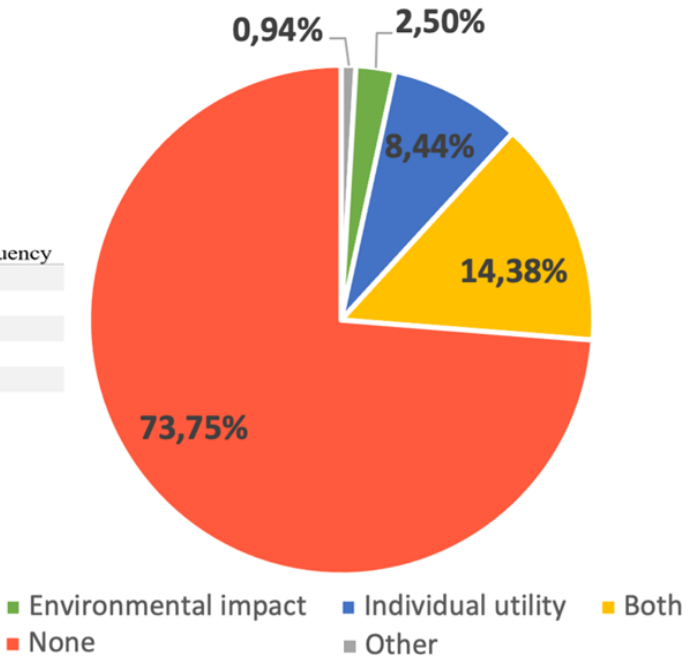
Source: own edition

The most frequently mentioned solutions were applications related to various public transport management systems that can be used to plan and purchase travel tickets and passes. This was followed by references to smart benches and the different vehicle-sharing systems (car, bike, scooters, etc). In addition, a significant number of mentions were made of the controllable and solar-powered public lighting systems, parking assistance applications, traffic control systems, and smart pedestrian crossings. Among the answers were also solutions that take environmental aspects into account, such as devices suitable for the utilization of renewable energy. Solutions (Figure 3) that specifically contribute to increasing people's well-being or comfort through their personal utilization were better known

(27 answers – 8.44%), such as smart charging benches, parking apps, and pedestrian crossings, while those solutions with a purely environmental protection or sustainable function (8 answers – 2.50%) were relegated to the background. However, it is cause for optimism that most respondents who mentioned devices connected to personal utility were also able to mention at least one solution with a positive environmental impact (46 answers – 14.38%).

Figure 3. What types of smart solutions are known by the residents of Budapest?

| Type of Solution | Frequency |
|---|---|
| Other | 3 |
| Environmental impact | 8 |
| Individual utility | 27 |
| Both | 46 |
| None | 236 |
| SUM | 320 |




Source: own edition

Most of the purely environment-related answers were received from the 56+ female respondents who consider themselves to have no knowledge about the 'smart city' (Table 6). Female members of this 'not familiar' category, despite their critical mindset, also contributed the most individual-utility-related solutions in the age ranges 46–55, 36–45, and 26–35.

Male citizens identified most solutions classified as mixed. Six solutions were mentioned by male citizens aged between 26–35 years, and five between 46–55 who considered themselves 'not familiar' with the term 'smart city'. 'Experts' mostly identified solutions which can be considered to have both individual and environmental utility (57.14%).

However, these answers represent just 5.03% of all answers that were received. In the case of the 'Familiar' group, 97.2% of respondents could not contribute to the research with any solutions. Finally, the 'Not Familiar' category, accounting for 17.61% of all solutions that were mentioned, specified environmental-impact-related ones (3.83%), and ones with individual-utility (10.38%), and both (16.39%). Bertalan (2015) and Pakainé Kováts et al. (2015) found a similarly low level of environmental awareness using a similar survey method in Sopron.

Table 6. Distribution of types of smart solution

| Status | Age | Gender | Both | Environmental impact | Individual utility | None |
|---|---|---|---|---|---|---|
| ‚Expert' | 0–25 | Male | 3 | | | 2 |
| ‚Expert' | 26–35 | Male | 2 | | 2 | |
| ‚Expert' | 26–35 | Female | 1 | | 1 | 1 |
| ‚Expert' | 36–45 | Male | 1 | 1 | | |
| ‚Expert' | 36–45 | Female | 4 | | 1 | |
| ‚Expert' | 46–55 | Male | 4 | | | |
| ‚Expert' | 46–55 | Female | | | | |
| ‚Expert' | 56– | Female | 1 | | | 1 |
| ‚Familiar' | 0–25 | Male | | | | 1 |
| ‚Familiar' | 0–25 | Female | | | | 4 |
| ‚Familiar' | 26–35 | Male | | | 1 | 6 |
| ‚Familiar' | 26–35 | Female | | | 2 | 16 |
| ‚Familiar' | 36–45 | Male | | | | 5 |
| ‚Familiar' | 36–45 | Female | | | | 25 |
| ‚Familiar' | 46–55 | Male | | | | 9 |
| ‚Familiar' | 46–55 | Female | | | | 14 |
| ‚Familiar' | 56– | Male | | | | 5 |
| ‚Familiar' | 56– | Female | | | | 20 |
| ‚Not-Familiar' | 0–25 | Male | 1 | | | 3 |
| ‚Not-Familiar' | 0–25 | Female | | | 1 | 4 |
| ‚Not-Familiar' | 26–35 | Male | 6 | | 2 | 13 |
| ‚Not-Familiar' | 26–35 | Female | 3 | | 4 | 28 |
| ‚Not-Familiar' | 36–45 | Male | 3 | | 1 | 14 |
| ‚Not-Familiar' | 36–45 | Female | 4 | 2 | 4 | 15 |
| ‚Not-Familiar' | 46–55 | Male | 5 | | 1 | 10 |
| ‚Not-Familiar' | 46–55 | Female | 3 | 1 | 4 | 15 |
| ‚Not-Familiar' | 56– | Male | | | | 7 |
| ‚Not-Familiar' | 56– | Female | 5 | 4 | 2 | 17 |

Source: own edition

## CONCLUSIONS

Based on the results of the research, the following conclusions can be drawn: all of the most highly ranked (TOP3) urban problems, according to the respondents of Budapest, have an environmental focus. These problems are significant pollution, intensive land use, which, with the reduction of green areas, further aggravates the heat-island effect, which is also considered a significant urban challenge. Based on the benchmark model presented here, these problems are middle-ranking ones, while the

additional problems indicated by the respondents are awarded higher importance within the model. These environment-related problems were followed in perceived importance by infrastructural challenges, for which several efficiency-enhancing solutions are available (which is an important finding, since these problems are interlinked).

Accordingly, the protection, maintenance, and care of the current green areas, as well as the creation of additional green areas, landscaping, and tree planting in several places in Budapest, are of particular importance to the interviewees. Furthermore, the need for mobility and related infrastructural investments is also considered indispensable. The need for the development of public transport systems and other alternatives to the car; furthermore, for related infrastructural investments such as repairing potholes, road network development, etc. was often specified. Finally, the respondents' demand for public cleanliness and public safety is also significant.

The majority of respondents treated their own knowledge critically. More than half did not accurately appraise their own knowledge, even though they were able to provide examples related to smart city solutions at later stages of the questionnaire (most of both individual- and environment-related solutions were given by 'not familiar' male respondents in the age range 26–35). On the other hand, a significant number of respondents, even among those who claim to be 'experts' on the topic, could not mention smart city solutions. Based on this result, it can be questioned whether these 'experts' were aware of the term, or they only wanted to succumb/give in to the pressure of social conformity.

No significant relationship was found between knowledge and age, while a link was found between gender and knowledge. More men than women think of themselves as having 'great' knowledge about the smart city concept, while the latter are predominant in the 'familiar' category. Less than one third of respondents could give an example of the concept, but the majority of these respondents were able to indicate more than one such solution. Overall, most of the smart solutions that were specified by the respondents can be considered mixed solutions because they primarily lead to individual gains in utility, but they indirectly have a positive environmental impact, or they are solutions with a direct environmental focus.

The results show that several smart applications related to the public transport system are well known among Budapest residents; however, the latter are not as relevant in terms of environmental awareness or environmental protection. Accordingly, providing more (or more detailed) information about pre-existing environmentally-conscious solutions to the city dwellers would be a useful approach as well as introducing more environmentally-focused smart solutions.

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