The smart city as dynamic digital ecosystem

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Abstract

For the time being, we witness the convergence of the speed up of urbanization and digitalization.
In the new era of digital transformation, the cities are creating genuine ecosystems in light to enhance the modernisation of administration, businesses, based on digital technologies and new business models.
The big cities are considered adaptive and complex systems holding powerful connections of various components.
A sustainable digital ecosystem should be based on smart governance and powerful leadership, easy access to technologies and platforms in view to apply solutions for the local problems, enhancement of digital competences in light to accelerate the digital transformation, as well as digital infrastructures for the optimization of the allocation of resources, generation of high quality jobs, innovation, competitiveness and business growth.
A citizen centered smart city should address the local challenges, should be interactive, competitive, transparent, responsive and attractive.
The paper presents the result of a survey concerning the evaluation of the citizens' perception and expectations about the innovative development of Bucharest as smart city and assesses the major areas for investment.

1. Introduction

"Cities are becoming smart not only in terms of the way they can automate routine functions serving individual persons, buildings, and traffic systems but in ways that enable them to monitor, understand, analyse and plan the city to improve the efficiency, equity and quality of life for its citizens in real time" (Batty et al., 2012).

Several authors highlight the use of ICTs in a smart city (Lee et al., 2013; Odendaal, 2003; Walravens, 2012). Washburn et al. (2010: 2) present a comprehensive definition: "the use of smart computing technologies to make the critical infrastructure components and services of a city – which include city administration, education, healthcare, public safety, real estate, transportation, and utilities – more intelligent, interconnected, and efficient".

Other authors emphasise the user-centered perspective with more focus on citizens and stakeholders (Calderoni et al., 2012). It is important to connect knowledge centers to the actions of key actors in the smart city in view to create "innovation hubs" (Kourtit et al., 2012). Also, Kourtit et al. (2012) reveal the importance of collaboration through networks of urban actors.

Caragliu et al. (2011) state: "We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance".

McKinsey Global Institute Report estimates that "the top 100 cities in the world already account for 38% of total global GDP, with the top 600 cities generating 60% of global GDP" (McKinsey, 2018).

At the same time, a relevant vision is important, taking into consideration the fact that worldwide the cities compete for investments and talent people, in light to foster prosperity and eliminate extreme poverty.

Fostering the development of smart cities could lead to the advancement of 70% of the Sustainable Development Goals.

According to McKinsey Report (2018), cities that implement relevant applications could "reduce fatalities from homicide, road traffic, and fires by 8–10%. In a city with the population and crime profile of Rio de Janeiro, this could mean saving some 300 lives each year. By 2025, cities that deploy smart mobility applications could cut commuting times by 15–20% on average, with some people enjoying even larger reductions. The potential associated with each application is highly variable, depending on each city's density, existing transit infrastructure, and commuting patterns.

The emergency response times could be 20–35% faster. In a city like New York, smart technologies save the average commuter almost 15 minutes a day.

At the same time, emissions could be cut by 10–15%; lower water consumption by 20–30%, the volume of solid waste per capita could be reduced by 10–20%".

It is noteworthy to mention that the digital solutions represent only a component of the whole tool kit for developing a smart city.

"City government has a dual role to play. It has to execute intelligent solutions on its own, and it has to orchestrate and enable the evolution of a broader ecosystem. Since governments cannot do everything, it often makes sense to turn to companies and institutions that have the necessary capabilities or to let the private sector handle solutions that offer revenue potential. But governments are in a unique position to choreograph all of this activity: providing and tracking data, bringing stakeholders together, ensuring communication and coordination, and addressing unintended consequences" (McKinsey Report (2018).

As mentioned by Vrabie (2018a), cities "can be associated with living scientific laboratories, with the participation of all citizens as specialists of the city's lifestyle. They are the only ones who have the ability to explore the problems they face and to find solutions – either with the use of smart technologies or new business models or even complete new public services".

People living and working in a city should have a voice in shaping its future.

2. The smart city as ecosystem

The smart city represents a complex ecosystem of people, processes, policies, technology, facilitators working together in view to deliver a set of outcomes.

As asserted by Vrabie (2018b), the ecosystem of a smart city "comprises both public organizations, holding the power of management and the private organizations, which are involved either in financing or interaction.

According to the field literature, a smart city is created on several layers.

A smart city represents an ecosystem with so called "capability layers" (Chan, 2018), which should be integrated and coordinated in view to achieve its mission.

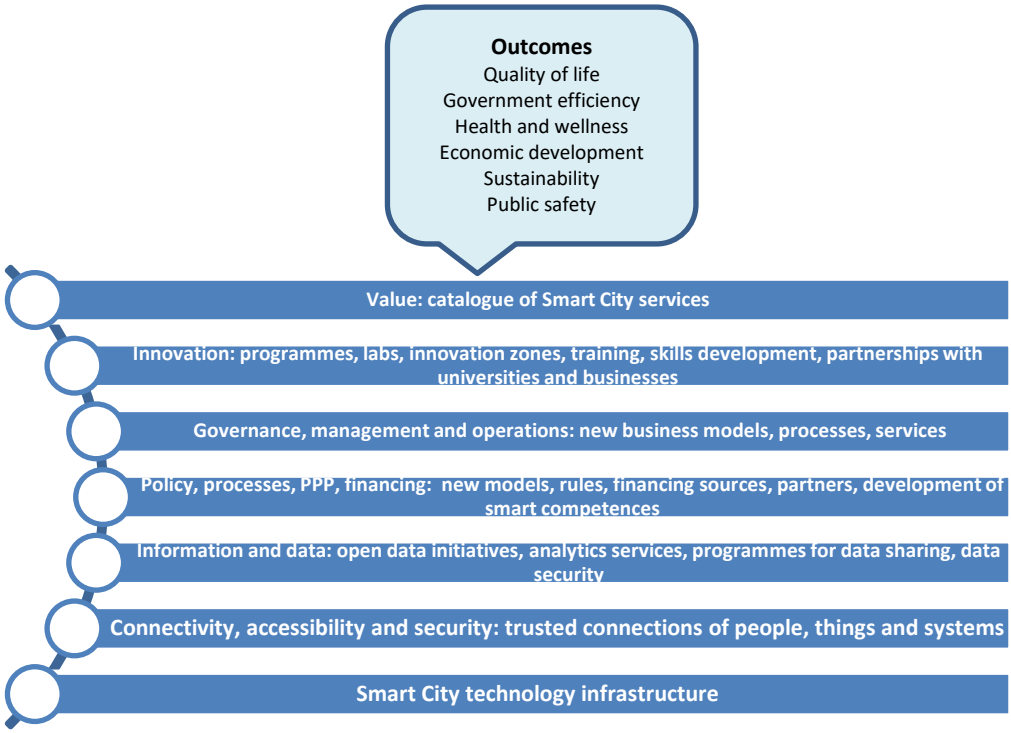

Figure 1. The ecosystem of a smart city
Source: the authors, based on Chan (2018)

Value layer **-** represents a catalogue of smart city services or "use cases", centered on the outcomes (Figure 1).

Innovation layer **–** based on continuous innovation and updating the services, through innovation programmes, labs, innovation zones, training, ideation workshops, competences development, partnerships with universities and businesses.

Governance, management and operations layer **-** Smart city management models should integrate the ecosystem of value creators and innovators, planning, supporting new business models, processes and services. Upgrading the existing infrastructure and management processes in view to support smart services is of major importance. Measuring the performance of the city with a set of metrics is also important.

Policy, processes, and public-private partnerships, and financing layer **-** New set of engagement models, rules, financing sources, partners are essential in order to build, operate and maintain the smart city. Therefore, the cities should develop a new set of smart competences.

Information and data layer - The smart city should facilitate open data initiatives, data marketplaces, analytics services, should own programmes encouraging data sharing and privacy policies.

Connectivity, accessibility and security layer **–** Interconnection of people, things and systems. The ability of trusted connections and the protection of information and users are essential.

Smart city technology infrastructure layer **-** The smart city technology infrastructure should support the value creators as well as the users.

3. Study concerning the analysis of the perception and expectations of citizens about the innovative development of Bucharest

The study is based on the *idea of a citizen centered administration*, taking into consideration the fact that improving the citizens' satisfaction level on the public services represents the pillar of a competitive, efficient and modern administration.

The research aims to evaluate the citizens' perception and expectations about the innovative development of Bucharest as well as to analyse their opinions concerning the achievement of the main dimensions of Bucharest as smart city.

We consider that the application of a questionnaire represents an eloquent research instrument for a concrete and actual analysis, which could be useful to the public institutions and authorities. In view to design the statistic community, four criteria have been taken into consideration: age, gender, education and job. In light to design the questionnaire, we took into account to ensure the confidentiality, thus assuring a high sincerity level on behalf of the respondents.

The specific objectives of the study have been focused on the following issues:

- Initiating the design of a database comprising information about the dimensions of a smart city, as well as the innovative development of Bucharest.
- Identification of the most relevant aspects of Bucharest as a smart city depending on the citizens' needs, requirements, expectations and preferences.
- Quantifying the citizens' attitude versus the investments needed.
- Formulating conclusions based on the results.

The statistic community comprised 120 persons and complied with the structure of the total population on groups of age and gender provided by the National Institute of Statistics. The method to gather the information was based on

direct interview with the respondent who completed a questionnaire. The period for collecting information was September - October 2018.

The questionnaire was designed in view to comprise relevant aspects aimed to identify the citizens' expectations and perception concerning smart administration, smart energy, smart safety system, smart health system, smart mobility, education, smart housing, green energy, smart touristic services in Bucharest, as well as the openness and responsiveness of administration, the innovative development of Bucharest, the aspects that could be improved through digitalisation and innovation: quality of citizens' life, personal development, environment, mobility, economy, governance.

Concerning the question: «*How do you evaluate the openness and responsiveness of public administration towards the citizens*?», the graphic representation of the citizens' appreciations is reflected by Figure 2. Thus, 3% respondents evaluate the openness of public administration towards the citizens as non-existent, 37% qualify to be weak, 48% sustain that it is normal, 10% consider being good and 2% respondents evaluate it as exceptional. Taking into consideration this distribution, there are necessary modalities to improve the responsiveness of administration towards the citizens' needs, requirements, expectations, preferences in view to achieve a genuine citizen centered administration.

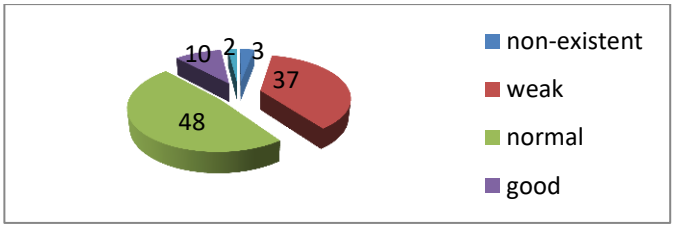

Figure 2. Analysis of the appreciations concerning the evaluation of openness and responsiveness of public administration towards citizens
***Source*:** the authors

Regarding the question: «*How do you appreciate the innovation level of public administration*?», Figure 3 reflects the respondents' evaluation. It results that 23% respondents apreciate it as non-satisfactory, 37% as satisfactory, 22% respondents consider to be good, 13% assert as very good and 5% do not answer.

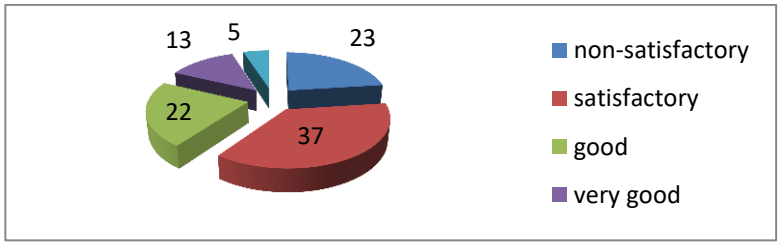

Figure 3. Analysis of appreciations on innovation
Source: the authors

In 'Innovative Governance. Impact of Information Technology', (Săvulescu, 2015), innovation is defined as "a dynamic process in view to identify problems, challenges, to implement new and creative ideas, to address issues such as pollution, demography, economic-financial crises, climate changes, globalisation".

The respondents had to evaluate the aspects that could be improved through digitalisation and innovation: quality of citizens' life, personal development, environment, mobility, economy, governance.

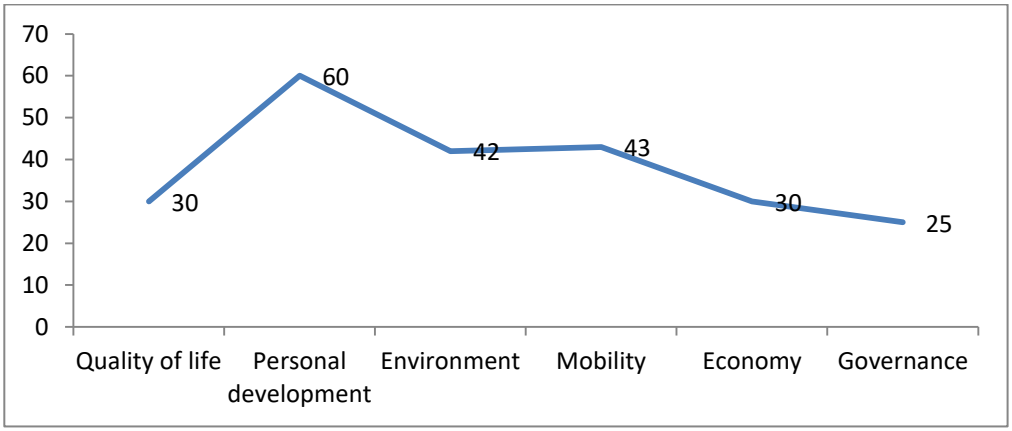

Figure 4. Evaluation of aspects that could be improved through digitalisation and innovation
***Source*:** the authors

Figure 4 presents the analysis of the respondents' answers. Thus, 30% respondents assert that the quality of life could be improved, 60% highlight the importance of innovation and IT on personal development, 42% express the opinion of improving the environment, 43% consider being important for mobility, 30% for economy and 25% for governance.

For example, economy could be improved by stimulation of e-commerce, e-business.

Governance could be improved through reduction of corruption, enhancement of social security, open government, better e-government services, transparency, improvement of ICT infrastructure, public-private partnerships.

Mobility could be improved by modernising the public transport system, for example procurement of new public buses endowed with Wi-Fi, procurement of electric vehicles, building bicycle paths, finalising the underground routes.

The environment could be improved by using generable energy, green energy, diminishing pollution, increasing the quality of air and water.

Analysing the respondents' requirements, some of them could be found in the definition of e-governance (Baltac, 2016), namely smart governance represents "a feature of a smart city in view to reach specific objectives, to enhance transparency and open governance, by e-governance development, ICT infrastructure and private partnerships".

Regarding the assertion «*Please be so kind to evaluate the advantages of innovation, awarding a mark from 1 to 5*», the respondents awarded marks

according to the scale: 1 – very weak, 2 – non-satisfactory, 3 – satisfactory, 4 – good, 5 – very good to the items presented in Table 1.

Table 1. Advantages of innovation

Item	Average mark	Coefficient of variation
Solving social problems	3.19	0.16
Improving life quality	2.76	0.24
Enhancing the quality of public services	2.53	0.28
Improving the users' satisfaction	2.82	0.18
Decreasing the costs of public services	3.29	0.16
Enhancing the efficiency of the administrative activities	2.87	0.22
Others	1.65	0.18

***Source*:** the authors

Concerning the *evaluation of the successful factors for a smart city ecosystem* in Bucharest, the distribution of respondents was as follows: 80% highlight «leadership and collaboration for a smart governance of the local digital ecosystem», 90% emphasise «digital skills to accelerate the digital transformation process», 89% mention «access to data and information technologies for applied solutions to local challenges» and 95% reveal «key infrastructures and investments», as presented in Figure 5.

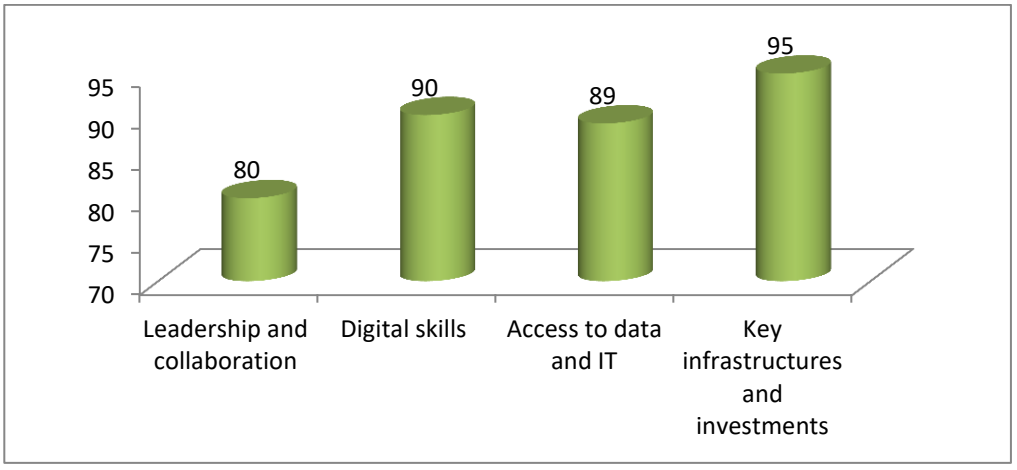

Figure 5. Analysis of the successful factors for a smart city ecosystem in Bucharest
***Source*:** the authors

Regarding *the necessity of investments and use of European funds for Bucharest development*, 73% respondents appreciate it as very necessary, 23% consider it necessary while 4% are not interested (Figure 6).

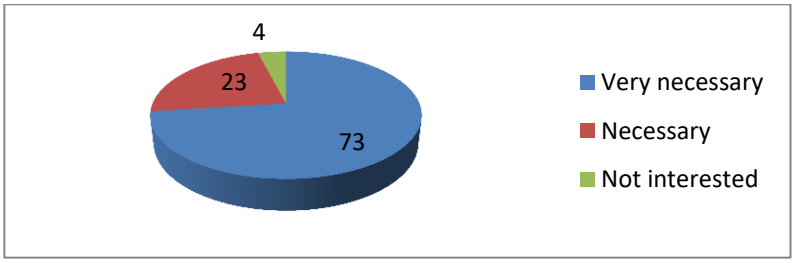

Figure 6. Analysis of the necessity of investments and use of European funds for Bucharest development
***Source*:** the authors

Concerning the *evaluation of the areas that need investments for a genuine Bucharest smart city*, the respondents assessed the following dimensions: smart administration, smart energy, smart safety system, smart health system, smart mobility, education, smart housing, smart touristic services.

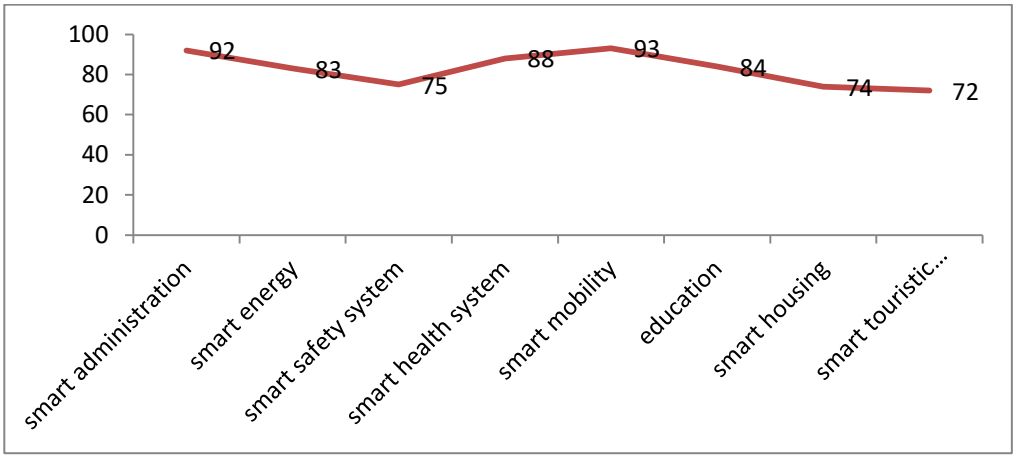

Figure 7. Evaluation of the areas that need investments for a genuine Bucharest smart city
***Source*:** the authors

According to Figure 7, investments are absolutely needed in all areas. The respondents consider that most investments should be directed to smart mobility (93%), smart administration (92%), smart health system (88%), smart energy (83%). Also investments are necessary for smart safety system (75%), education (84%), smart housing (74%) and smart touristic services (72%).

Regarding the question: «*Which theme(s) do you associate with Bucharest as smart city in present*? (multiple answers possible)

- Infrastructure and ICT
- Citizens and Living
- Energy, Water and Waste
- Mobility
- Governance
- Education
- Health»

the respondents awarded marks according to the scale: 1 – very weak, 2 – non-satisfactory, 3 – satisfactory, 4 – good, 5 – very good, as presented in Table 2.

Table 2. Theme(s) associated with Bucharest as smart city

Item	Average mark	Coefficient of variation
Infrastructure and ICT	2.54	0.20
Citizens and living	2.86	0.16
Energy, water and waste	2.78	0.22
Mobility	1.82	0.14
Governance	2.16	0.18
Education	3.40	0.20
Health	3.26	0.16

***Source*:** the authors

The distribution of the answers is reflected by Table 2.

For the question: «*Which key words do you find applicable to the development of a smart city?* (multiple answers possible)

- ICT
- Efficiency
- Environmental Sustainability
- Access to big data and open data platforms
- Safety
- Liveability
- Citizen involvement - Social innovation
- Transparency»

the respondents awarded marks according to the scale: 1 – very weak, 2 – non-satisfactory, 3 – satisfactory, 4 – good, 5 – very good, as presented in Table 3.

Table 3. Key words applicable to the development of a smart city

Item	Average mark	Coefficient of variation
ICT	3.6	0.24
Efficiency	1.8	0.14
Environmental sustainability	2.12	0.22
Access to big data and open data platforms	3.20	0.18
Safety	3.12	0.16
Liveability	3.4	0.18
Citizen involvement - Social innovation	3.8	0.22
Transparency	2.5	0.16

***Source*:** the authors

Concerning the question: «*Do you consider that the users and citizens' requirements and needs represent a successful factor for innovative development of*

Bucharest», the distribution of respondents according to Figure 8 is as follows: 1.2% respondents consider that users and citizens' requirements and needs do not represent a successful factor, 2.6% respondents appreciate that it is a non-significant successful factor, 8.2% respondents appreciate as moderate, 43% specify significant, 45% mention to a large extent.

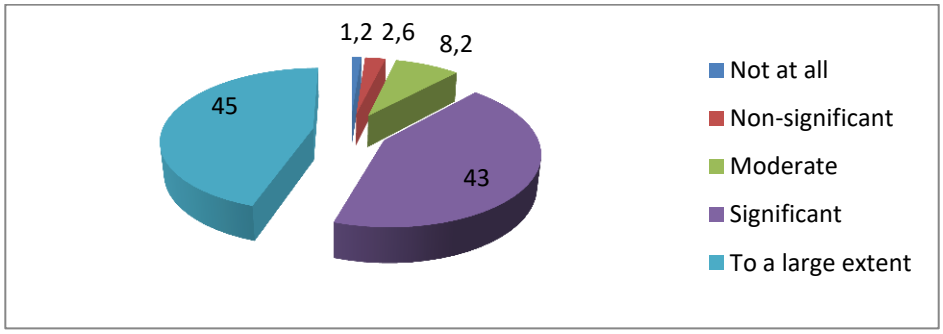

Figure 8. Evaluation of the users and citizens' requirements and needs
***Source*:** the authors

Analysing the above outcomes, we may assert that Bucharest is a city that needs investments in governance, economy, education, health, mobility, environment in view to enhance the citizens' life quality.

The respondents consider that large and faster investments for a smart Bucharest would attract more tourists, thus enhancing its economy.

4. Conclusions

According to our study, Bucharest is a city that needs investments in governance, economy, education, health, mobility, environment in view to enhance the citizens' life quality. At the same time, it needs open system approach in order to support innovation and investments.

The respondents are not convinced that the above investments would be made on short term. However, most respondents are optimistic and do believe that Bucharest will become a genuine smart city, where they could adapt to a new life style, learning new things, embracing new experiences.

It is worth to imagine how smart Bucharest of tomorrow will be. We hope to witness modernization of key infrastructure, development of mobile services, more public-private partnerships engaged in implementing IT based projects, and definitely smart governance, centered on co-design and co-creation of new services together with the citizens.

As a relevant conclusion, Bucharest needs smart projects from smart leaders for smart citizens.

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