Analytical analysis of approaches to assessing the quality of life in smart cities

Andrii Sverstiuk[1,2,*,†], Lyubomyr Matiichuk[2,†], Uliana Polyvana[2,†], Andrii Stanko[2,†] and Vyacheslav Nykytyuk[2,†]

[1] I. Horbachevsky Ternopil National Medical University, Maidan Voli, 1, Ternopil, 46002, Ukraine
[2] Ternopil National Ivan Puluj Technical University, Rus'ka str. 56, Ternopil, 46001, Ukraine

Abstract

Today, there is an urgent need to introduce new trends in the development of a smart city. This problem is solved by the introduction of information and communication technologies, the Internet of Things (IoT) to ensure the comfort, convenience, economy and safety of people's daily life. An analytical analysis of publications evaluating the quality of life in smart cities was carried out using the Web of Science Core Collection scientific-metric database. Analytical query was formulated using the following search terms smart city, data quality, analysis, assessment, assessing initiatives, success factors, climate, requirements, integrating, criteria, method, comfort, convenience, security, modern technology, health, evaluation, monitoring, determination, observation, research, question, quality of life, efficiency of life, economic feasibility of life, satisfaction of life. The total number of works by year, types of publications, scientific institutions, categories, directions of research, year of publication and citation of scientific works are shown. The publications with the highest citation rating were analyzed.

Keywords

data quality assessment, success factors, smart cities, integrated approach, evaluation, forecasting

1. Introduction

In order to effectively use the city's resources and improve the quality of life of its citizens [1], extended support for the development and operation of programs in a complex and dynamic environment is necessary. Middleware platforms can provide an integrated infrastructure that enables smart city solutions by bringing together disparate city devices and providing a unified, high-level means of developing applications and services.

Currently, there are still open research and development issues related to scalability, serviceability, compatibility, and reuse in the context of different cities. In addition, the existing platforms do not have extensive scientific confirmation, which prevents a comparative analysis of their applicability [2].

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* Corresponding author.
† These authors contributed equally.
sverstyuk@tdmu.edu.ua (A. Sverstiuk); mlpstat@gmail.com (L. Matiichuk); uliana28.91@gmail.com (U. Polyvana); stanko.andrjj@gmail.com (A. Stanko); slavik_89@ukr.net (V. Nykytyuk)
0000-0001-8644-0776 (A. Sverstiuk); 0000-0001-6701-4683 (L. Matiichuk); 0000-0003-3677-7295 (U. Polyvana); 0000-0002-5526-2599 (A. Stanko); 0000-0003-1547-8042 (V. Nykytyuk)

Biosensors are very important in assessing people's quality of life. Biosensors are characterized by high efficiency and are widely used in the monitoring of environmental parameters, in medicine as means for establishing diagnoses, in the military industry [3, 4].

Various computer diagnostic systems are used to diagnose people, which are implemented in mathematical methods of biomedical signal (EEG signal, ECG signal, EMG signal, ERG signal, RR-interval signal, PCG signal, human voice signal and others) processing [5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15], algorithmic support and software.

In the work, an analytical analysis of publications assessing the quality of life in smart cities was carried out. The analysis was carried out using the Web of Science Core Collection scientific and metric base, which makes it possible to optimize the complexity of this search for scientific sources according to the relevant topic. The Web of Science Core Collection search engine allows you to query the database of scientific sources. The aim of the work was to optimize the analytical review of literary sources when assessing the quality of life in smart cities using the Web of Science Core Collection scientific metric database.

2. Main part

Elaboration of the relevance of studies of the analysis of approaches to the assessment of the quality of life in smart cities in the Web of Science Core Collection scientometric database, an analytical query was formulated using the following search terms - TS=(“smart city”) AND (TS=(“data quality”) OR TS=(“analysis”) OR TS=(“assessment”) OR TS=(“Assessing Initiatives”) OR TS=(“Success Factors”) OR TS=(“climate”) OR TS=(“requirements”) OR TS=(“integrating”) OR TS=(“criteria”) OR TS=(“method”) OR TS=(“comfort”) OR TS=(“convenience”) OR TS=(“security”) OR TS=(“modern technology”) OR TS=(“health”) AND (TS=(“evaluation”) OR TS=(“monitoring”) OR TS=(“determination”) OR TS=(“observation”) OR TS=(“research”) OR TS=(“question”)) AND (TS=(“quality of life”) OR TS=(“efficiency of life”) OR TS=(“economic feasibility of life”) OR TS=(“satisfaction of life”)).

Our search query on this topic found the Web of Science Core Collection of 76 scientific works from 2015 to 2024 in the search platform. The largest number of literary sources on the researched topic falls on the last 5 years. In particular, in 2020 – 19 scientific publications, in 2021 – 8, in 2022 – 6, in 2023 – 13, in 2024 – 5, that is, the relevance of the study of this issue and the constant growth of interest in it all over the world are quite relevant (Fig. 1). Many scientists continue to work tirelessly on this topic, because according to their understanding, a smart city is a coherent system of innovations and technologies that are used to interact with state bodies and obtain administrative services, in the transport network and road traffic, health care, housing, energy and water supply. And this, in turn, additionally confirms the high scientific interest in the researched topic, namely the keywords pulmonology, data quality assessment, success factors, sustainable and smart cities, integrated approach, climate, requirements, criteria, convenience, safety, modern technologies, health i, public services, modeling, evaluation, forecasting.

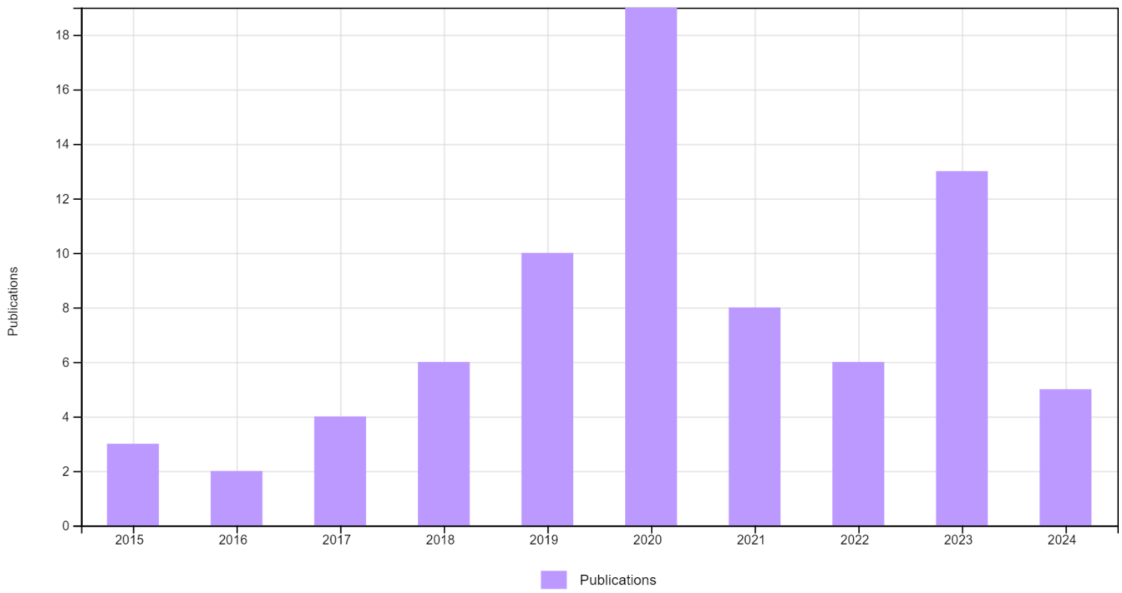

Figure 1: Query results in the Web of Science Core Collection search platform (total number of papers by year).

Research articles in journals – 52, and Proceeding Paper – 22 prevailed among scientific works (Fig. 2).

Figure 2: Query results in the Web of Science Core Collection search platform (types of publications).

The largest number of articles were published in such categories as Computer Science of Information Systems – 11, Computer Science Theory Methods– 7, Energy Fuels – 6 (Fig. 3).

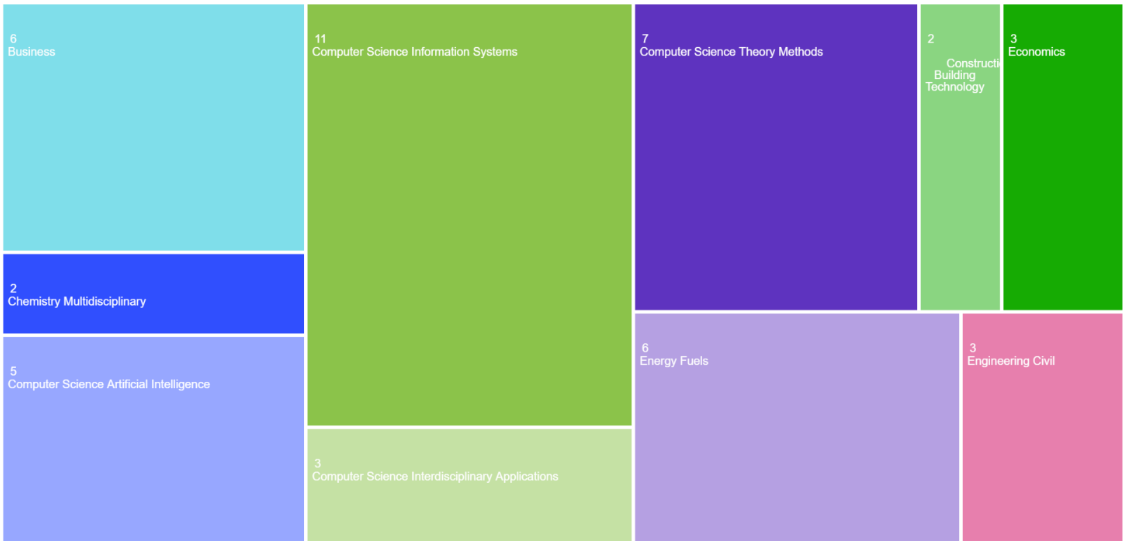

Figure 3: Query results in the Web of Science Core Collection search platform (categories).

Leadership among profiles of researchers in the study of this problem have such scientists as Ivaldi, Enrico. – 4, Isola, Gabriele – 2, Ciacci, Andrea – 2, Musso, Enrico – 2 scientific works (Fig. 4).

Figure 4: Query results in the Web of Science Core Collection search platform (speaker profiles).

Leading positions are held among scientific institutions University Of Genoa School Of Social Sciences – 4, University Of Genoa Department Of Political Sciences – 3 scientific works (Fig. 5).

Figure 5: Query results in the Web of Science Core Collection search platform (scientific institutions, departments).

Leading countries, the number of publications by scientists is greatest: Poland – 12, Italy – 11, China – 9, Spain – 6 works (Fig. 6).

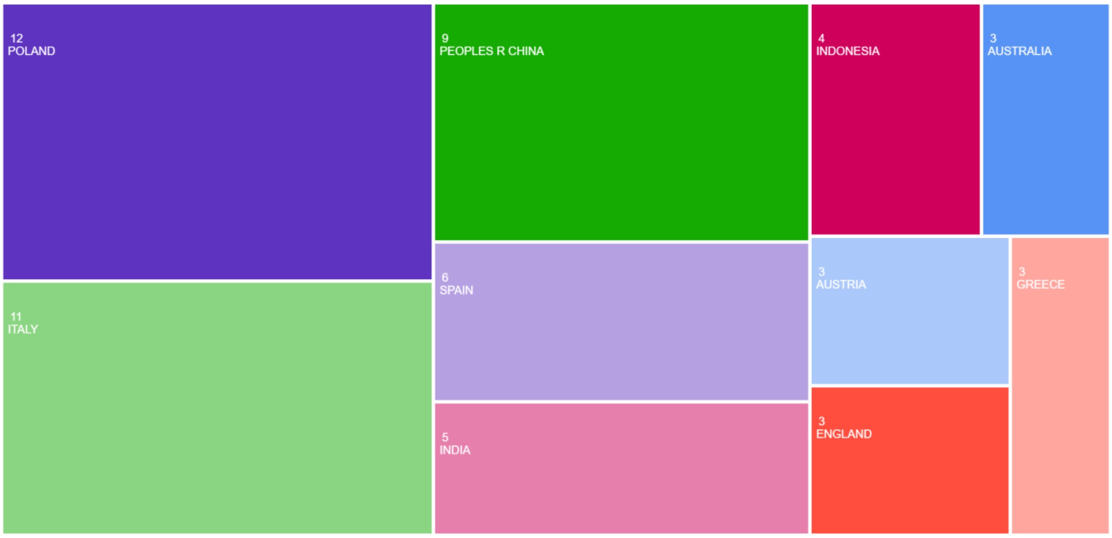

Figure 6: Query results in the Web of Science Core Collection search platform (countries).

By areas of research, it is possible to distinguish: Engineering - 25, Computer Science - 20, Science Technology Other Topics - 16, Environmental Sciences Ecology - 12, Urban Studies - 12 scientific works (Fig. 7).

Figure 7: Query results in the Web of Science Core Collection search platform (directions of research).

According to the number of citations and publications from 2015 to 2024, the following results were obtained: the highest indicators are data from 2020 to 2023 (Fig. 8). Although the number of publications over the last 3 years does not exceed the figures of 2020, the number of citations is the highest during the last 2 years, which confirms the high scientific interest in the scientific and applied problem of assessing the quality of life in smart cities.

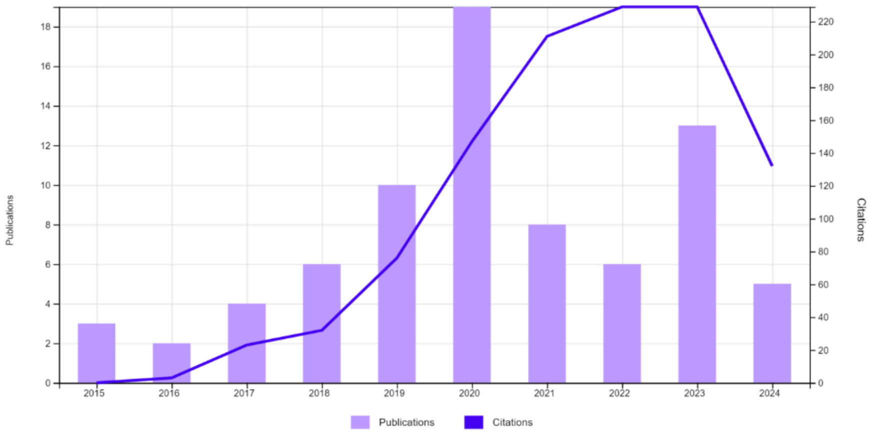

Figure 8: Query results in the Web of Science Core Collection search platform (year of publication and citation).

After characterizing the publications by the highest citation rating, the following results were obtained: the greatest interest of scientists during the past year was in publications [16, 17, 18, 19, 20] - «A novel big data analytics framework for smart cities» indicator of which 133, «Smart city intellectual capital: an emerging view of territorial systems innovation management» - 76, «Determinants of multi-service smartcard success for smart cities. development: A study based on citizens' privacy and security perceptions» - 73, «Identifying and prioritizing barriers to implementation of smart energy city projects in Europe: An empirical approach» - 68, «Blockchain and Building Information Management (BIM) for

Sustainable Building Development within the Context of Smart Cities» indicator of which (Fig.9).

76 Publications — Sort by: Citations: highest first — 1 of 2	2020	2021	2022	2023	2024	Average per year	Total
Total	147	211	229	229	133	120.33	1,083
1. A novel big data analytics framework for smart cities Osman, AMS Feb 2019 | FUTURE GENERATION COMPUTER SYSTEMS-THE INTERNATIONAL JOURNAL OF ESCIENCE 91, pp.620-633	28	36	18	25	5	22.17	133
2. Smart city intellectual capital: an emerging view of territorial systems innovation management Dameri, RP and Ricciardi, F 2015 | JOURNAL OF INTELLECTUAL CAPITAL 16 (4), pp.860-887	12	18	8	4	3	7.6	76
3. Determinants of multi-service smartcard success for smart cities. development: A study based on citizens' privacy and security perceptions Belanche, D; Casaló-Ariño, LV and Pérez-Rueda, A Apr 2015 | GOVERNMENT INFORMATION QUARTERLY 32 (2), pp.154-163	12	10	15	10	5	7.3	73
4. Identifying and prioritizing barriers to implementation of smart energy city projects in Europe: An empirical approach Mosannenzadeh, F; Di Nucci, MR and Vettorato, D Jun 2017 | ENERGY POLICY 105, pp.191-201	13	15	11	10	4	8.5	68
5. Blockchain and Building Information Management (BIM) for Sustainable Building Development within the Context of Smart Cities Liu, Z; Chi, ZY; (...); Demian, P Feb 2021 | SUSTAINABILITY 13 (4)	0	7	19	19	12	14.25	57
6. Design and evaluation of a scalable smart city software platform with large-scale simulations Del Esposte, AD; Santana, EFZ; (...); Kon, F Apr 2019 | FUTURE GENERATION COMPUTER SYSTEMS-THE INTERNATIONAL JOURNAL OF ESCIENCE 93, pp.427-441	9	4	8	11	7	7.33	44
7. Access to ICT in Poland and the Co-Creation of Urban Space in the Process of Modern Social Participation in a Smart City-A Case Study Szarek-Iwaniuk, P and Senetra, A Mar 1 2020 | SUSTAINABILITY 12 (5)	4	12	10	11	4	8.2	41
8. Smart City Architecture: Vision and Challenges Bawany, NZ and Shamsi, JA Nov 2015 | INTERNATIONAL JOURNAL OF ADVANCED COMPUTER SCIENCE AND APPLICATIONS 6 (11), pp.246-255	10	6	7	5	1	4.1	41
9. IoT Technology Applications-Based Smart Cities: Research Analysis González-Zamar, MD; Abad-Segura, E; (...); López-Meneses, E Aug 2020 | ELECTRONICS 9 (8)	4	16	9	3	4	7.2	36
10. Smart and Age-Friendly Cities in Romania: An Overview of Public Policy and Practice Ivan, L; Beu, D and van Hoof, J Jul 2020 | INTERNATIONAL JOURNAL OF ENVIRONMENTAL RESEARCH AND PUBLIC HEALTH 17 (14)	2	6	5	10	4	5.4	27

Figure 9: Query results in the Web of Science Core Collection search platform (citation rating)

After analyzing several scientific works, it is safe to say that smart cities help define the potential path for urban innovation and development in general to improve the quality of life. A sustainable future for cities and innovation depends on smart cities and smart communities. The driving force behind sustainable urban growth and competitiveness is intellectual capital. A smart city enables citizens not only to participate in innovations, but also to create their spaces [17].

The case studies analyzed show that smart city and smart community visions unite and enable all components of IS and help cities introduce and sustain technology-driven and collaborative urban innovation that builds on strong community development.

Several approaches to the role of information technology in serving collaborative processes that support innovation are identified:

• information technologies, participation and cooperation; social engagement for innovation and policy development. The "Smart City" is seen as a technological community that works on the basis of inclusiveness and can stimulate social innovation;

• the use of information technologies as a means for better coordination between all components of the urban community. Technologies help provide better information and help engage citizens in innovation;

• focus on shaping the city as an inclusive and innovative community. Technology allows citizens to participate and engage in promoting innovation as a driving force for sustainable urban development. As drivers of innovation, cities are evolving as smart, collaborative and sustainable communities [21].

The concept of a smart city was born to ensure the best quality of life for citizens. The key idea is to integrate information system services in every area of the city, such as health care, education, transportation, power grids, to provide efficient and sustainable services to citizens. Such expectations require great efforts and demands. Taking into account the importance of efficient collection, storage, retrieval of data and efficient provision of network resources, a high-level architecture for a smart city is proposed [22]. The proposed framework is based on a hierarchical data storage model and defines how different stakeholders will communicate and offer services to citizens.

The smart city creates enormous information challenges. Smart city initiatives are based on ICT. The latest developments in the field of cloud computing, the Internet of Things [23, 24, 25], and open data are becoming the leading technologies for the development of a smart city. Together, these technologies can provide the infrastructure, applications, and turnkey solutions to deliver a variety of services. ICT infrastructure is the basis of a smart city, the foundation for other components (Fig. 10), which includes high-speed connection to a wired and wireless network, high-quality data processing centers (including implemented on the basis of artificial intelligence [26]), enrichment of physical space with smart devices, sensors, devices. The level of electronic governance promotes the development of strategic connections between various departments of the public sector organization [27].

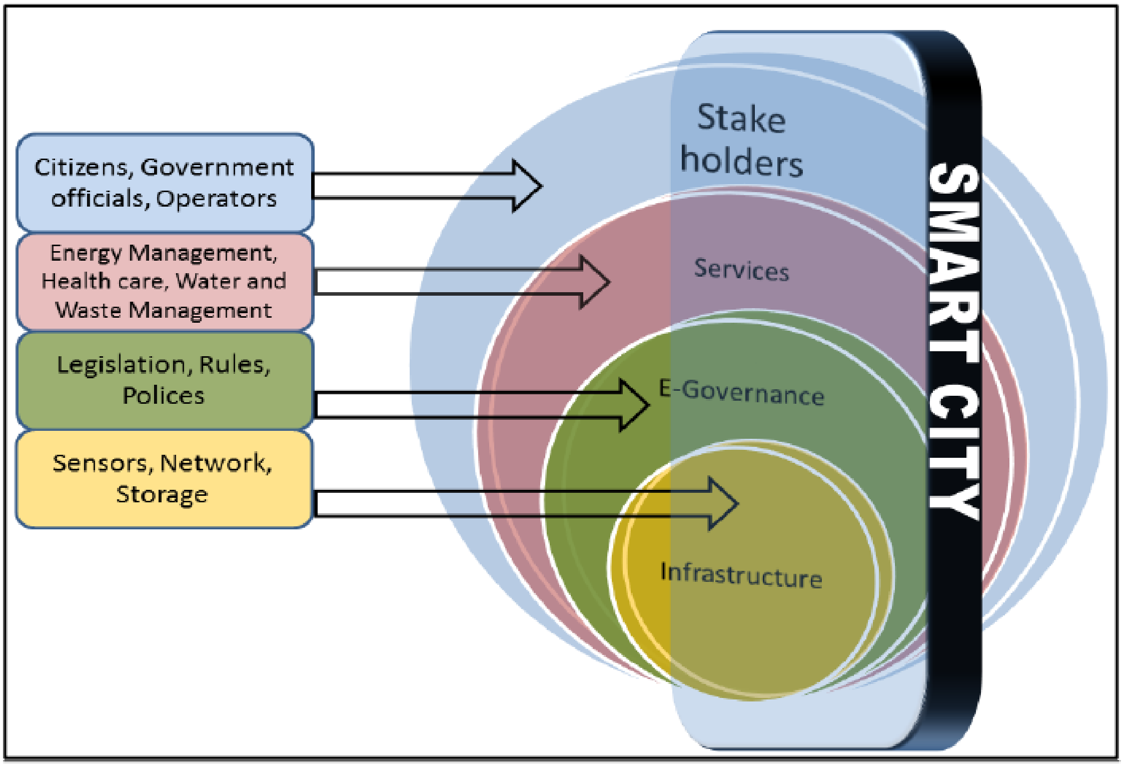

Figure 10: Key levels of a smart city.

During the transmission/reception of informative data in ICT within the framework of a smart city, there is a constant influx of various types of interference, which leads to distortion of the informative flow of data. Effective detection of useful data in the information flow during the provision of various services in environments under the influence of various interferences is an important aspect. To solve this problem, mathematical and algorithmic software for detecting useful data are proposed in these works, in particular: synphase [28, 29], component [28, 30] and wavelet [31] detection.

In Table 1, the author lists the key challenges for smart city architecture along with a proposed solution.

Table 1
Key problems and their solutions

№	Challenge	Proposed model
1.	**IT Infrastructure**	**Zonal Sites of each public utility** Zonal implementation of each public service does not require the entire infrastructure at the same time. The proposed model optimizes the gradual implementation of a smart city, which does not reduce the need for IT infrastructure, but promotes the movement towards a

		smarter city.
2.	**Cost**	**Zonal Sites of each public utility** Zonal implementation of each service does not require huge investments right away. In the long term, the use of ICT for public service delivery will reform the speed and efficiency of public service delivery and administration, in turn delivering improved service delivery, reduced consumer spending and social benefits.
3.	**Heterogeneous environment Interoperability**	**Service Oriented Architecture** The model is based on service-oriented architecture. Exposing data services as web services can make information about data services available to a wide range of customers. Web services allow systems to integrate with each other regardless of the underlying platform.
4.	**Availability and Scalability**	**Zonal Sites of each public utility** The proposed model supports horizontal and vertical scalability. Horizontal scalability means that more and more public services can be easily connected. The zonal implementation of each public service provides vertical scalability, providing zone-level quality of service (QoS). The hierarchical cloud model is characterized by high availability and scalability, and each zone can expand its resources when needed to ensure 24/7 availability for its users.
5.	**Security**	**Service Oriented Architecture – Using Web Services** The proposed model recommends exposing data as a web service. WS-Security is useful in that it provides security information at the level of encrypted messages.
6.	**Privacy**	**Service Oriented Architecture – Using Web Services** The model defines the user as the owner of the data. However, policies and regulations may be defined by the e-

		government level. Data is only provided to a known authentic party. It is recommended that anonymous data be disclosed through web services with the consent of the user.
7.	**Efficiency**	**Hierarchical Cloud Model** The proposed model will perform better as requests at the data zone level will be processed by the zone data center. Cross-domain services can handle requests from multiple domains in real-time. Different departments can instantly coordinate and collaborate and share their data through web services. Since real data is available for analysis, resource planning in a central data management system (CDMS) and at each utility center will result in efficient resource planning and utilization.
8.	**Big data Management**	**Hierarchical Cloud Model** **Zonal Sites of each public utility** Zoning data helps to store and analyze data efficiently. For example, the city's transportation system will have zonal data centers throughout the city. Data obtained from each zone will be collected, stored and analyzed at the zone level. Aggregated data for each zone will be sent to the city's main transport system. Such a model helps to effectively manage big data.
9.	**Social Adaption and app development**	**Open data model – Smart city App store**

By increasing the efficiency, availability and scalability of services, a hierarchical data management architecture is proposed that facilitates distributed data management at the zone level. The service-oriented nature of the proposed architecture corresponds to the heterogeneous environment of a smart city. An open data model for a smart city will contribute to the development of smart city applications, in turn creating a smart city app store.

In the scientific work [2], the author proposes InterSCity, a smart city platform with open source code based on microservices, which enables the joint development of large-scale systems, applications and services for cities of the future, contributing to their transformation into a smart cyber-physical environment. Experiments were conducted using a smart city simulator to create realistic workloads that were used to evaluate the platform under extreme conditions. The experimental results demonstrate that the platform can scale horizontally to meet the highly dynamic requirements of a large smart city while maintaining a low response time. Experiments show the effectiveness of the technique used to create synthetic loads.

Most major cities around the world face challenges related to population growth, lack of resources, air pollution, traffic congestion, and public safety. The author proposed three new fundamental contributions:

• A detailed study of the current architecture and implementation of the InterSCity platform, supported by a deeper analysis of design decisions.

• Advances in performance evaluation of smart city platforms with the proposal of a new workload generation method.

• Application of an experimental strategy based on simulation to evaluate the InterSCity platform based on the Smart Parking application scenario [32].

Key requirements for the design of the InterSCity platform include: flexibility and extensibility, achieved through modular, decoupled, distributed services that allow independent evolution of components and facilitate the addition of new features; interoperability achieved through the adoption of open, accepted standards and protocols; productivity and reliability of code writing, achieved through the reuse of reliable, proven open source tools, libraries and frameworks (Fig. 11) [16].

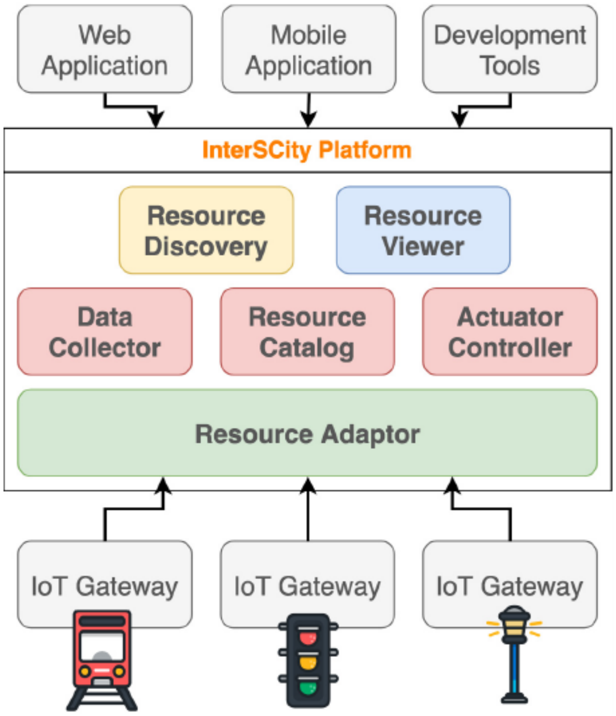

Figure 11: InterSCity platform architecture.

Important aspects of the InterSCity platform are presented:

• Microservices architecture of the InterSCity platform provides elasticity and scalability.

• A simulation-based method to create a realistic workload for a smart city.

• Extensive analysis of InterSCity's architectural design indicates its scalability.

• The results of the experiments demonstrate the high scalability of the InterSCity platform [33].

A promising area for assessing the quality of life in smart cities is the use of biosensors and immunosensors [34] with their stability on rectangular [35, 36] and hexagonal [37, 38] grids, intelligent big data systems based on machine learning [39], neural network clustering technology [40] with the possibility of using new diagnostic features [41, 42] in cyber-physical systems of medical and biological processes [43-46].

3. Conclusion

This article provides an analytical review of publications on the use of artificial intelligence in smart city technologies. An analysis of works by year in the scientometric database of the Web of Science Core Collection was carried out. An analysis of works by year was carried out. Authors with the largest number of works are presented, taking into account countries and educational institutions. Based on the data obtained from the analytical review of literary sources using the Web of Science Core Collection search platform, it is possible to conclude that there is a growing scientific interest in the problem of researching the criteria for evaluating the quality of a smart city, therefore, such research is extremely relevant for improving people's lives, health care, improving innovation and technology systems, energy conservation. Smart cities of the future will require quality research in many areas. In further research, it is planned to apply the questionnaire to better assess the standard of living of people in smart cities.

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