Journal of Theoretical and Applied Information Technology
30th April 2023. Vol.101. No 8

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

TECHNICAL CHALLENGES REVIEW AND READINESS FOR ADOPTING SMART CITIES IN KUWAIT

[1]ABDULLAH ALSHEHAB, [2]THALAYA ALFOZAN, [3]MOHAMMAD ALAHMAD, [4]JASEM ALOSTAD, [5]ABDULRAHMAN ALKANDARI

[1 3 4 5] Public Authority for Applied Education and Training (PAAET), College of Basic Education, Computing Department, Kuwait
[2] Ministry of Finance, IT Consultant, Kuwait

Email : [1]aj.alshehab@paaet.edu.kw, [2]drthalaya@gmail.com, [3]malahmads@yahoo.com, [4] jm.alostad@paaet.edu.kw, [5]aam.alkandari@paaet.edu.kw

ABSTRACT

The trend towards smart cities is a growing phenomenon among governments worldwide, driven by the need to keep pace with the rapidly evolving technological landscape and the increasing demand for improved social services from citizens. In metropolitan areas across the globe, policymakers are investing heavily in technologies that enable the transformation of traditional cities into smart cities. To better understand the technical challenges facing smart city initiatives in Kuwait, a research study was conducted that analyzed more than 100 papers in an attempt to identify the technical challenges that could potentially hinder the successful implementation of smart city projects in Kuwait. The experiment was carried out through a focus group session that was held with six experts in ICT. During the session, the experts rated the readiness of each of the identified technical challenges, providing valuable insights. The outcome indicated that the level of readiness for smart city initiatives in Kuwait needs to be increased were the top challenges that were identified (i) Blockchain, (ii) AI, and (iii) Cybersecurity. The study suggested that this could be achieved through a comprehensive and well-defined national ICT scale strategic vision. The study suggested that smart cities' initiatives could be achieved through a comprehensive and well-defined national ICT scale strategic vision. The findings of this study can be used to inform future policy decisions and guide the development of smart city projects in Kuwait.

Keywords: *Smart Cities, Technology Challenge, Digital Transformation, IoT, Blockchain, Cybersecurity.*

1. INTRODUCTION

Policymakers globally are observing a growing trend towards the adoption of smart cities in order to stay current with technological developments and meet the needs of social services by utilizing technological advancements in various fields, which can also help conserve natural resources [1], [2]. Smart cities are designed to integrate the latest technology, including the Internet of Things (IoT) devices, sensors, and modern information and communication technologies, in order to solve governance challenges, increase efficiencies, and empower residents. Smart cities offer a digital-friendly atmosphere and encourage learning, leading to a sustainable environment and improved well-being [3]. In addition, smart cities focus on the needs of individuals, allowing them to adapt to changing economic, cultural, and social conditions [4], [5] and achieve intelligence and efficiency in the use of resources to enhance the quality of life [6], [7], [8].

The trend towards smart cities is evident as policymakers in metropolitan regions across the globe are rapidly investing in these technologies to transform their cities into smart cities. Smart cities can be newly built with smart technology from the beginning or traditional cities that are gradually transformed through a set of transformation mechanisms [9]. These mechanisms can include upgrading infrastructure, implementing smart city solutions, and implementing policies to promote sustainable development.

According to [10], technology spending on smart city initiatives worldwide is forecast to more than double between 2018 and 2023, increasing from

81 billion U.S. dollars in 2018 to 189.5 billion in 2023. This increase in spending is a clear indication of the growing trend towards smart cities and the importance placed on the development of these cities by governments worldwide. However, smart city projects do fail and could face some obstacles that lead to failure project [11], [12].

As part of Kuwait Vision 2035, one initiative of the Kuwaiti government is to build a 'smart city' from scratch located in South Saad Al Abdullah city that will eventually be home to 400,000 people which will be managed by an artificial intelligence (AI) system [13]. However, transforming or establishing a city into a smart city requires the availability of some dimensions, technology, vision, strategy, and finance. These dimensions are crucial for the successful implementation of smart city solutions and for ensuring that the city is able to meet the needs of its residents.

The aim of this research is to focus on the Technology Dimension of smart cities initiatives by reviewing the technical dimension's challenges and investigating the applicability of found challenges for adopting smart cities in Kuwait. The research will involve a thorough review of the literature to identify the technical challenges and an experiment will be carried out by forming a focus group session for a problem-solving activity [15] to rate each challenge. Six ICT experts in the field were selected, holding a minimum of a bachelor's or graduate degree in computer science and experience ranging from 20 to 33 years of experience in Kuwait. Three of them work as high-ranking managers in government entities involved in the field of e-Government, Smart-Government, Network, Fintech, and regulating local IT policies. The other three experts are from academia majoring in IT security, IoT, and software engineering. This diversity of expertise and experience in the field will provide a well-rounded perspective on the technical challenges and readiness for adoption in Kuwait.

R1: What are the technical challenges that exist in the literature?

R2: What is the level of readiness level for addressing each technical challenge in the adaptation of smart cities in Kuwait?

This research aims to comprehensively examine the technical challenges associated with the implementation of smart cities in Kuwait. To accomplish this, the research will begin by conducting a thorough review of the literature to identify the technical challenges that have been previously identified in existing research. After identifying these challenges, an experiment will be carried out by forming a focus group session for a problem-solving activity [15]. This focus group session will allow for a more in-depth examination of the identified challenges and will provide valuable insights into the readiness for addressing these obstacles in the implementation of smart cities in Kuwait.

2. LITERATURE REVIEW

Smart cities are complex entities that encompass various dimensions, including government, socioeconomic, and environmental aspects [16], each with unique dynamics and a level of context sensitivity [17]. Information and communication technology serves as the foundation for smart city initiatives [18]. The technology dimension of smart cities includes various factors such as telecommunications [19], artificial intelligence [20],[21], sensors [22], cloud computing [23], smartphones, tablets, RFID technology [24], NFC technology, wearable devices, and Global Positioning System devices [25], [26]. To execute a smart city project, it is necessary to have an effective Internet of Things (IoT) system [27], [28], whether it includes smart facilities [29], facilities management, or Building management [30], and/or smart health care. The standardization of deployed devices, the level of communication, the type of data accessed, and the applications used to process information must be taken into account [31].

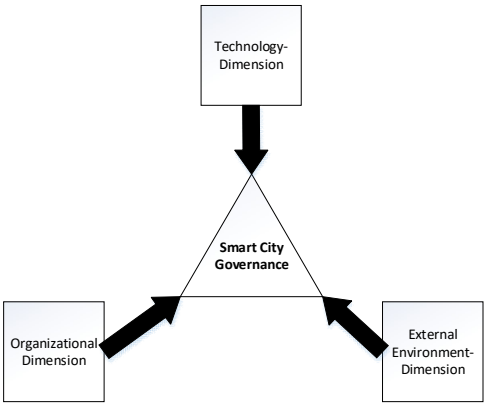

Figure 1: Smart Cities Dimensions (adopted from [17].

A literature review was conducted in two steps. The first step involved examining more than 100 papers from reputable journals using the keyword of "smart cities" through searching databases such as Scopus, Web of Science, ScienceDirect, and Google Scholar during the period of 2016–2022. The second step was reviewing papers produced in the first step that related to technology dimension challenges. A thorough examination of technology-related challenges produced 17 challenges [32], [33], [34], [35], [28], [36],[27], [26], [37], [25], [38],[39],[40]; [41],[40],[42],[43],[44],[45],[46],[47],[29],[48],[49].

Table 1: Technology Challenges in adopting Smart Cities adopted from [47]

	Challenge	Description	References
C1	**IoT Management**	a city could rely on a central technological hub to control its core infrastructure which could raise challenges. Already, many cities have been paying large amounts when subjected to ransomware attacks. Hackers will continue to attack IoT devices by either taking control of the device, stealing information, or disrupting the service it is offering. technology-related risks cover networking and transport issues, security issues, heterogeneity issues, denial of service, and IoT big data management.	[32]; [33]; [34]; [35]; [28];[36]; [27]; [26]; [37]; [25];[38]; [39]; [41];[42]; [43];[44];[45]; [46]; [47];[29]; [48]
C2	**Big Data Integration**	Due to the dynamic and evolving nature of smart cities, it is always a challenge to design and deploy Big Data systems. Contentious characteristics of Big Data, its associated benefits, cost, the accuracy of the information extracted affects the performance of services of smart cities. The key focus of relevant studies includes infrastructure management, security management, finance, urban transits, perceptions, urban tree management, smart banking and bank loan prediction. The key actions such as rational planning of city infrastructures, establishing and improving long-acting mechanisms and the effective performance of city managerial functions for integrating big data in smart Cities	[50]; [40]; [51];[52]; [53]; [54]; [55]; [56];[47]
C3	**Blockchain Management**	Smart home, cybersecurity and privacy risk. The decentralized nature, open access, transparency and deterministic approach of blockchains make it a mandatory technology for sustainable smart cities. It can address the core challenges associated with the resilient environment, interoperable and flexible systems, decision support systems, behavior monitoring, energy sources and distribution, intelligent infrastructure, scalability, smart healthcare and secure infrastructure. Similarly, list key advantages of blockchain in smart cities: managing cryptocurrencies, smart contracts, public services, record and rights management, logistics and decentralized applications (DApps) for smart tourism.	[57];[14];[58]; [47]; [48]

C4	**Cyber Security Management**	More technology creates more risks. Smart cities with thousands (and, someday, millions) of interconnected devices offer hackers plenty of targets to attack, any of which could permit access to the network as a whole. And once inside that network, hackers could disable key pieces of civil society everything from police dispatch to water sanitation and cause overwhelming chaos.	[59]; [57]; [60]; [61];[62]; [63]; [47]; [64]; [48]
C5	**GIS And Remote Sensing Implementation**	Remote Sensing Data, compounded by the velocity and variety of data from connected devices (e.g., Internet of things devices, such as smart watches, cars, etc.), pose several new technical challenges for traditional High-Performance Computing (HPC) platforms, such as clusters and supercomputers, which have been widely used in the past for data processing, analysis, and knowledge discovery.	[25];[65]; [26];[66]; [45]; [67];[68]; [69]; [70];[47]
C6	**UAVs Management**	there is currently no way to seamlessly integrate UAVs (unmanned aerial vehicle) into smart cities, applications may require gathering and processing a tremendous amount of data, which could be challenging given the resource-constrained nature of these flying units and may necessitate offloading some of the processing. Moreover, for some of the applications, high-precision positioning and navigation of the UAVs is crucial, which may require solving complex UAV routing problems.	[71]; [72]; [45]; [47]
C7	**Digital Platforms Management**	Smart community, e-Commerce, Building design management In business enterprise terms, a digital platform can be thought of as the sum total of a place for exchanges of information, goods, or services to occur between producers and consumers well as the community that interacts with said platform. It's imperative to understand that the community itself is an essential piece of the digital platform—without that community, the digital platform has very little inherent value. We interact with digital platforms on a constant basis thanks to the success of the digital platform approach. Digital platforms take a lot of different forms depending on the business model they employ and the specific purposes they seek to serve. Examples of successful digital platforms are: -Social media platforms -Knowledge platforms -Media-sharing platforms -Service-oriented platforms	[57];[73];[37]; [74];[60]; [30] ; [49]; [47]

C8	**Fintech Adoption**	Financial computations, Supply chain, Security, Tax control, Mobile banking	[75];[76]; [77]; [78];[79]; [80]; [81]; [47]
C9	**AI Management**	certain systems powered by AI in smart cities may be expensive to incorporate or may need to comply with several regulations before implementation, making them 'high-risk' AI applications.	[28];[36]; [27];[82]; [24]; [20];[83]; [22]; [46]; [84]; [85]; [86];[78]; [47];[21];[48]
C10	**Cyber physical Components Management**	handling massive data production, new technologies will transform how huge input of data handled and keep showing, in the case of CPS. Besides this thriving volume, the mixing diverse data from different sources will create the need for applications focusing on query, integration, analysis, high-performance computing devices, and methodologies for data reduction	[87]; [88];[47]
C11	**Digital Information Management**	Urban regeneration, Urban Resilience, Business, Cyber security City Information Management (CIM) is an output tool for smart city planning and management, which assists in achieving the sustainable development of urban infrastructure, and promotes smart cities to achieve the goals of stable global economic development, sustainable environmental development, and improvement of people's quality of life. The influx of knowledge-based talents brings strong innovation momentum to the society and the ability to face the challenges of urban development;	[87]; [88];[47]
C12	**Crowd Density Management**	IoT network, Disaster response, Urban mobility, Crowd flows	[89]; [90]; [91];[47]; [92]
C13	**Wireless Sensors Management**	Cyber security, performance, and Wireless sensor networks are sensor network technologies, environmental monitoring, atmospheric monitoring, process monitoring, mater sensesing, sensing applications, etc.	[34];[93]; [94]; [84]; [22]; [95];[29]; [47];[21]
C14	**Next-Generation internet Adoption Management**	adoption management, IPv4 to IPv6, Web 2.0 to Web 3.0 costly & complicated. Cloud to Decentralized Cloud, etc.	[47]; [94]; [45]
C15	**Technology Optimization**	Engineering structure monitoring, Smart phone Connectivity, Frequency of technology enhancements	[96]; [97]; [47]
C16	**Fog Computing Management**	Health management, Location management, decentralized infrastructure.	[98];[99]; [100]; [101]; [102];[23];[47] [23]
C17	**Virtual Reality AR Adoption**	Pedestrian behavior monitoring, Property management	[103];[104]; [105]; [106]; [97]; [107]; [108]; [109]; [110]; [66]; [111]; [112]; [113]; [114]; [115];[116]; [117]; [118]; [9] ;[47]

The following section details a measurement technique and an example of the methodology used by participants in conducting the experiment to address question two.

3. EXPERIMENT

[119] created a measurement scale for evaluating organizations in smart cities projects, but this research does not cover that scale. [120] developed a different measurement scale for evaluating the performance of smart cities projects, which includes four factors: people, governance, technology infrastructure, and environment. However, this research focuses on measuring the readiness of Kuwait and not on evaluating specific projects, resulting in the omission of the environmental factor.

The diagram in Figure 2 was presented to the participants to evaluate the readiness of each challenge listed in Table 1.

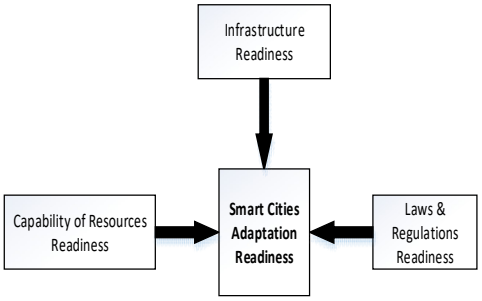

Figure 2: Adaptation Of Smart Cities Measuring Scale Adopted From [120].

The evaluation of Kuwait's readiness for smart cities projects was an important step in determining the feasibility and potential success of these projects in the country. The three key factors - Infrastructure, Laws & Regulations, and Capability of Resources - were chosen as they are crucial to the implementation and sustainability of smart cities projects.

Infrastructure is vital for the smooth functioning of smart cities projects, as it includes the necessary technology and environment required for the projects to operate efficiently. Laws & Regulations are also crucial, as they provide a framework for the operation and management of smart cities projects, ensuring compliance with relevant laws and regulations. Capability of Resources is important as it determines the ability of local resources to execute smart cities projects, including manpower, funding, and technology.

The evaluation was conducted using a qualitative approach, with participants rating each challenge on a scale of High, Med, or Low. This approach allowed for a subjective assessment of the readiness of Kuwait for smart cities projects, based on the participants' perceptions and experiences. The focus group session served as a platform for participants to discuss and justify their ratings, providing valuable insights into the challenges and opportunities for smart cities projects in Kuwait.

The results and discussion of this evaluation will provide valuable information for policymakers, stakeholders, and investors in determining the feasibility and potential success of smart cities projects in Kuwait. It will also serve as a useful tool for identifying areas that need improvement and developing strategies to address any challenges identified. Overall, the evaluation will play a crucial role in supporting the development and implementation of smart cities projects in Kuwait, helping to create a more sustainable and livable future for the country's citizens. The results and discussion of this evaluation will be presented in the next section.

4. DISCUSSION AND RESULTS

Table 2 (listed at the end of the paper) shows the measurement of each participant of High, Medium, Low on all measurements were C3-Blockchain (C3), AI Management (C9), and Cyber Security (C10). None of the 17 challenges Readiness was rated High.

Table 2 revealed that while some challenges received a full agreement rating, others received a partial agreement. However, not one challenge received a high rating, indicating that Kuwait may not have sufficient readiness for smart cities projects.

Table 3: Number of Low measurements of full agreement

Infrastructure Readiness	Capability of Resources Readiness	Laws & Regulations Readiness
6	7	12

According to Table 3, the readiness of infrastructure in Kuwait received the lowest rating of Low. This is despite the fact that Kuwait ranks 6th in the world for 5G telecom availability and 2nd among Arab states for 5G speeds [121]. On the other hand, the readiness of laws and regulations in Kuwait received the highest rating due to the lack of updates to the law of electronic transactions since 2014.

The Internet of Things (IoT) received partial agreement from participants due to the availability of 5G Telecom in Kuwait. The country is ranked as number six worldwide in terms of 5G availability, which can be used partially to support IoT. However, for Big Data and AI, participants have agreed that the concept of Big Data does not exist in the local environment, whether in the public or private sector or in academia.

Blockchain was considered a highly important challenge by the participants, as it is being used in neighboring countries. However, it is not currently being utilized in Kuwait. Cybersecurity was identified as one of the most important challenges that could face smart cities projects in Kuwait. While some initiatives have been implemented regarding

laws and regulations, such as the Central Bank of Kuwait introducing a Cybersecurity Framework for local organizations, the oil sector has regulations covering aspects of cybersecurity, but the government sector is not yet mature in this area.

The Geographic Information Systems (GIS) and Remote Sensing challenge received low ratings in terms of laws and regulations, as compared to infrastructure and capability of resources. This is due to the lack of availability of a GIS major in local universities offering bachelor's degrees. However, this challenge is more mature in the oil sector. For Unmanned Aerial Vehicle (UAV) management, the participants did not consider this challenge as important as other challenges because it is dependent on Big Data and IoT. Some cities are using Local Area Networks (LANs) and Wide Area Networks (WANs) to connect traffic lights in order to control traffic conjunctions instead of using UAVs, indicating that a successful smart city could be achieved without this challenge.

Digital Platforms Management received partial infrastructure availability, but laws and regulations need to be developed. The participants argued that the Financial Technology (Fintech) Adaptation has medium infrastructure, capability, and laws. The concept of Fintech has received a great deal of attention from local banks, led by the Central Bank. For Crowd Density Management in Kuwait, there has been a significant investment in deploying systems to support traffic control. However, there are some factors regarding laws and regulations, where the responsibility is dispersed among many government entities.

Wireless Sensors Management received medium ratings in terms of infrastructure, as Kuwait has invested in Microwave networks and Satellite communications. However, capabilities and laws were rated as low. Currently, a new initiative has been introduced to install Digital Electricity Meters in all areas of Kuwait based on 4G technology. This process is promising, but faces many risks in the area of laws and capability. The participants rated Next Generation Internet Adaptation as low, as the transformation of IPv4 to IPv6 has not yet been executed, which could lead to security issues.

Technology optimization in Kuwait received low ratings, as there is a significant investment in government spending in Information and Communication Technology (ICT), but the return on investment is minimal compared to the private sector. The participants agreed that the Fog Computing challenge had a full agreement from them that the local level for adopting Cloud computing is not utilized to an acceptable level.

At the end of the session, the participants agreed that before initiating smart city projects, the country needs to complete transformation initiatives and projects towards digital transformation, before eventually reaching a smart city.

5. CONCLUSION

Smart cities are striving to boost efficiency, reduce the time needed to complete tasks, cut costs, and promote sustainability in society. However, there are many obstacles in establishing new smart cities or transforming existing cities into smart cities. This study reviewed more than 100 papers and presented 17 different challenges in the technology dimension of smart cities project to evaluate Kuwait's readiness for these challenges. Six experts in ICT evaluated each challenge as Low, Medium, or High based on these factors (i) regulations, (ii) resource availability, and (iii) infrastructure readiness.

The research results indicated that the top challenges in Kuwait are Blockchain, AI, and Cybersecurity. None of the challenges were rated as High in readiness, with most rated as Low. Further, the experts noted that some of these challenges are not used in traditional ICT projects implemented by local government agencies, and some are recent trends such as Fog Computing, Big Data, and Blockchain.

The experts agreed that the current level of readiness in the local government will not lead to a successful smart city project. This could be due to the absence of a clear national strategy with well-defined goals, action plans, and KPIs backed by top-level government officials. A national strategy could enhance resource capabilities through education, training, and knowledge transfer and also improve infrastructure and regulations. However, reaching an appropriate level of readiness requires a national-scale ecosystem with clear policies for adopting these new trends. Full digital transformation is a crucial factor for a successful smart city project as an interim stage. Moreover, for a successful smart city project, full government transformation with proper management and sponsorship at the national level across various stakeholders and dozens of projects must occur simultaneously.

REFERENCES:

[1] Mondschein, Jared, et al. "Smart Cities as Large Technological Systems: Overcoming Organizational Challenges in Smart Cities through Collective Action." Sustainable Cities and Society, vol. 67, Apr. 2021, p. 102730. DOI.org (Crossref), https://doi.org/10.1016/j.scs.2021.102730.

[2] Singh, Tarana, et al. "A Decade Review on Smart Cities: Paradigms, Challenges and Opportunities." IEEE Access, vol. 10, 2022, pp. 68319–64. DOI.org (Crossref), https://doi.org/10.1109/ACCESS.2022.3184710.

[3] Ismagilova, Elvira, et al. "Smart Cities: Advances in Research—An Information Systems Perspective." International Journal of Information Management, vol. 47, Aug. 2019, pp. 88–100. DOI.org (Crossref), https://doi.org/10.1016/j.ijinfomgt.2019.01.004.

[4] Visvizi, Anna, and Miltiadis D. Lytras. "Rescaling and Refocusing Smart Cities Research: From Mega Cities to Smart Villages." Journal of Science and Technology Policy Management, vol. 9, no. 2, July 2018, pp. 134–45. DOI.org (Crossref), https://doi.org/10.1108/JSTPM-02-2018-0020.

[5] Winkowska, Justyna, et al. "Smart City Concept in the Light of the Literature Review." Engineering Management in Production and Services, vol. 11, no. 2, July 2019, pp. 70–86. DOI.org (Crossref), https://doi.org/10.2478/emj-2019-0012.

[6] Silva, Bhagya Nathali, et al. "Towards Sustainable Smart Cities: A Review of Trends, Architectures, Components, and Open Challenges in Smart Cities." Sustainable Cities and Society, vol. 38, Apr. 2018, pp. 697–713. DOI.org (Crossref), https://doi.org/10.1016/j.scs.2018.01.053.

[7] Lai, Chun Sing, et al. "A Review of Technical Standards for Smart Cities." Clean Technologies, vol. 2, no. 3, Aug. 2020, pp. 290–310. DOI.org (Crossref), https://doi.org/10.3390/cleantechnol2030019.

[8] Orlowski, Aleksander. "Smart Cities Concept - Readiness of City Halls as a Measure of Reaching a Smart City Perception." Cybernetics and Systems, vol. 52, no. 5, July 2021, pp. 313–27. DOI.org (Crossref), https://doi.org/10.1080/01969722.2020.1871224.

[9] Kim, Hakpyeong, et al. "A Systematic Review of the Smart Energy Conservation System: From Smart Homes to Sustainable Smart Cities." Renewable and Sustainable Energy Reviews, vol. 140, Apr. 2021, p. 110755. DOI.org (Crossref), https://doi.org/10.1016/j.rser.2021.110755

[10] Thormundsson, Bergur. "Smart City Initiatives Global Spending 2018-2023." Statista, 17 Mar. 2022, http://www.statista.com/statistics/884092/worldwide-spending-smart-city-initiatives.

[11] Sengupta, Ushnish, and Ulysses Sengupta. "Why Government Supported Smart City Initiatives Fail: Examining Community Risk and Benefit Agreements as a Missing Link to Accountability for Equity-seeking Groups." Frontiers in Sustainable Cities, vol. 4, Frontiers Media, Aug. 2022, https://doi.org/10.3389/frsc.2022.960400.

[12] www.ETGovernment.com. "Trichy Smart City Projects Fail to Take off Even after 4 Years - Et Government." ETGovernment.com, 11 Oct. 2021, https://government.economictimes.indiatimes.com/news/smart-infra/trichy-smart-city-projects-fail-to-take-off-even-after-4-years/86934687.

[13] Maranis, Chris. "Vision 2035 and Kuwait's Banks: A Match Made in Heaven." Vision 2035 and Kuwait's Banks: a Match Made in Heaven, EXUS Software Limited, 25 Nov. 2022, http://www.exus.co.uk/blog/vision-2035-the-bold-plan-to-transform-kuwait-and-what-that-means-for-banks-1.

[14] Xie, Junfeng, et al. "A Survey of Blockchain Technology Applied to Smart Cities: Research Issues and Challenges." IEEE Communications Surveys & Tutorials, vol. 21, no. 3, 2019, pp. 2794–830. DOI.org (Crossref), https://doi.org/10.1109/COMST.2019.2899617.

[15] Alshehab, Abdullah, and Thalaya Alfozan. "Focus Group Study: Budget Effectiveness Impact on Information System Development Projects in Kuwait." International Journal of Business Information Systems, vol. 39, no. 3, 2022, p. 365. DOI.org (Crossref), https://doi.org/10.1504/IJBIS.2022.122359.

[16] Annan-Noonoo, Patrick, et al. "A Review of Dominant Issues, Multi-Dimensions, and Future Research Directions for Smart Cities." Advances in Theory and Practice of Emerging Markets, 2022, pp. 281–310., https://doi.org/10.1007/978-3-030-77987-0_13.

[17] Ullah, Zaib, et al. "Applications of Artificial Intelligence and Machine Learning in Smart

Cities." Computer Communications, vol. 154, Mar. 2020, pp. 313–23. DOI.org (Crossref), https://doi.org/10.1016/j.comcom.2020.02.069.

[18] Yigitcanlar, Tan, et al. "Towards Post-Anthropocentric Cities: Reconceptualizing Smart Cities to Evade Urban Ecocide." Journal of Urban Technology, vol. 26, no. 2, Apr. 2019, pp. 147–52. DOI.org (Crossref), https://doi.org/10.1080/10630732.2018.1524249.

[19] De Guimarães, Julio Cesar Ferro, et al. "Governance and Quality of Life in Smart Cities: Towards Sustainable Development Goals." Journal of Cleaner Production, vol. 253, Apr. 2020, p. 119926. DOI.org (Crossref), https://doi.org/10.1016/j.jclepro.2019.119926.

[20] Eldrandaly, Khalid A., et al. "PTZ-Surveillance Coverage Based on Artificial Intelligence for Smart Cities." International Journal of Information Management, vol. 49, Dec. 2019, pp. 520–32. DOI.org (Crossref), https://doi.org/10.1016/j.ijinfomgt.2019.04.017.

[21] Zhang, Yongchang, et al. "Big Data and Artificial Intelligence Based Early Risk Warning System of Fire Hazard for Smart Cities." Sustainable Energy Technologies and Assessments, vol. 45, June 2021, p. 100986. DOI.org (Crossref), https://doi.org/10.1016/j.seta.2020.100986

[22] Kanase-Patil, Amarsingh B., et al. "A Review of Artificial Intelligence-Based Optimization Techniques for the Sizing of Integrated Renewable Energy Systems in Smart Cities." Environmental Technology Reviews, vol. 9, no. 1, Jan. 2020, pp. 111–36. DOI.org (Crossref), https://doi.org/10.1080/21622515.2020.1836035.

[23] Iatrellis, Omiros, et al. "Cloud Computing and Semantic Web Technologies for Ubiquitous Management of Smart Cities-Related Competences." Education and Information Technologies, vol. 26, no. 2, Mar. 2021, pp. 2143–64. DOI.org (Crossref), https://doi.org/10.1007/s10639-020-10351-9.

[24] Guo, Xiao, et al. "Review on the Application of Artificial Intelligence in Smart Homes." Smart Cities, vol. 2, no. 3, Aug. 2019, pp. 402–20. DOI.org (Crossref), https://doi.org/10.3390/smartcities2030025.

[25] Alsamhi, Saeed H., et al. "Survey on Collaborative Smart Drones and Internet of Things for Improving Smartness of Smart Cities." IEEE Access, vol. 7, 2019, pp. 128125–52. DOI.org (Crossref), https://doi.org/10.1109/ACCESS.2019.2934998.

[26] Samih, Haitham. "Smart cities and internet of things." Journal of Information Technology Case and Application Research 21.1 (2019): 3-12.

[27] Allam, Zaheer, and Zaynah A. Dhunny. "On Big Data, Artificial Intelligence and Smart Cities." Cities, vol. 89, June 2019, pp. 80–91. DOI.org (Crossref), https://doi.org/10.1016/j.cities.2019.01.032.

[28] Voda, Ana Iolanda, and Laura Diana Radu. "Artificial intelligence and the future of smart cities." BRAIN. Broad Research in Artificial Intelligence and Neuroscience 9.2 (2018): 110-127.

[29] Rjab, Amal Ben, and Sehl Mellouli. "Smart Cities in the Era of Artificial Intelligence and Internet of Things: Promises and Challenges." Smart Cities and Smart Governance, 2021, pp. 259–288., https://doi.org/10.1007/978-3-030-61033-3_12.

[30] Bisoyi, Bhubaneswari, et al. "Urban Resilience and Inclusion of Smart Cities in the Transformation Process for Sustainable Development: Critical Deflections on the Smart City of Bhubaneswar in India." Advances in Power Systems and Energy Management, 2021, pp. 149–160., https://doi.org/10.1007/978-981-15-7504-4_16.

[31] Cui, Lei, et al. "Security and Privacy in Smart Cities: Challenges and Opportunities." IEEE Access, vol. 6, 2018, pp. 46134–46145., https://doi.org/10.1109/access.2018.2853985.

[32] Hammi, Badis, et al. "IoT Technologiesfor Smart Cities." IET Networks, vol. 7, no. 1, Jan. 2018, pp. 1–13. DOI.org (Crossref), https://doi.org/10.1049/iet-net.2017.0163.

[33] Talari, Saber, et al. "A Review of Smart Cities Based on the Internet of Things Concept." Energies, vol. 10, no. 4, Mar. 2017, p. 421. DOI.org (Crossref), https://doi.org/10.3390/en10040421.

[34] Mehmood, Yasir, et al. "Internet-of-Things-Based Smart Cities: Recent Advances and Challenges." IEEE Communications Magazine, vol. 55, no. 9, 2017, pp. 16–24. DOI.org (Crossref), https://doi.org/10.1109/MCOM.2017.1600514.

[35] Saifuzzaman, Mohd., et al. "IoT Based Street Lighting and Traffic Management System." 2017 IEEE Region 10 Humanitarian Technology Conference (R10-HTC), IEEE, 2017, pp. 121–24. DOI.org (Crossref),

https://doi.org/10.1109/R10-HTC.2017.8288921.

[36] Sikder, Amit Kumar, et al. "IoT-Enabled Smart Lighting Systems for Smart Cities." 2018 IEEE 8th Annual Computing and Communication Workshop and Conference (CCWC), IEEE, 2018, pp. 639–45. DOI.org (Crossref), https://doi.org/10.1109/CCWC.2018.8301744.

[37] Kitchin, Rob, and Martin Dodge. "The (In)Security of Smart Cities: Vulnerabilities, Risks, Mitigation, and Prevention." Journal of Urban Technology, vol. 26, no. 2, Apr. 2019, pp. 47–65. DOI.org (Crossref), https://doi.org/10.1080/10630732.2017.1408002.

[38] Qian, Yi, et al. "The Internet of Things for Smart Cities: Technologies and Applications." IEEE Network, vol. 33, no. 2, Mar. 2019, pp. 4–5. DOI.org (Crossref), https://doi.org/10.1109/MNET.2019.8675165.

[39] Singh, Priyanka, and Markus Helfert. "Smart Cities and Associated Risks: Technical v/s Non-Technical Perspective:" Proceedings of the 3rd International Conference on Computer-Human Interaction Research and Applications, SCITEPRESS - Science and Technology Publications, 2019, pp. 221–28. DOI.org (Crossref), https://doi.org/10.5220/0008494402210228.

[40] Sufiyan, Mohd, et al. "Evaluating Food Supply Chain Performance Using Hybrid Fuzzy MCDM Technique." Sustainable Production and Consumption, vol. 20, Oct. 2019, pp. 40–57. DOI.org (Crossref), https://doi.org/10.1016/j.spc.2019.03.004.

[41] Botello, Juan Velandia, et al. "BlockSIEM: Protecting Smart City Services through a Blockchain-Based and Distributed SIEM." Sensors, vol. 20, no. 16, Aug. 2020, p. 4636. DOI.org (Crossref), https://doi.org/10.3390/s20164636.

[42] Ande, Ruth, et al. "Internet of Things: Evolution and Technologies from a Security Perspective." Sustainable Cities and Society, vol. 54, Mar. 2020, p. 101728. DOI.org (Crossref), https://doi.org/10.1016/j.scs.2019.101728.

[43] D'Amico, Gaspare, et al. "Understanding Sensor Cities: Insights from Technology Giant Company Driven Smart Urbanism Practices." Sensors, vol. 20, no. 16, Aug. 2020, p. 4391. DOI.org (Crossref), https://doi.org/10.3390/s20164391.

[44] Toh, Chai K., et al. "Advances in Smart Roads for Future Smart Cities." Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences, vol. 476, no. 2233, Jan. 2020, p. 20190439. DOI.org (Crossref), https://doi.org/10.1098/rspa.2019.0439.

[45] Mohamed, Nader, et al. "Data-Driven Security for Smart City Systems: Carving a Trail." IEEE Access, vol. 8, 2020, pp. 147211–30. DOI.org (Crossref), https://doi.org/10.1109/ACCESS.2020.3015510.

[46] Tung, Ngo Thanh, et al. "Development and performance analysis of intelligent street lighting for smart cities using LoRa Wan." Engineering and Technology 2.3 (2020): 1.

[47] Ullah, Fahim, et al. "Risk Management in Sustainable Smart Cities Governance: A TOE Framework." Technological Forecasting and Social Change, vol. 167, June 2021, p. 120743. DOI.org (Crossref), https://doi.org/10.1016/j.techfore.2021.120743.

[48] Riasat, S., and M. A. Shah. "SECURING SMART CITIES: AN ANALYSIS ON USING BLOCKCHAIN FOR DIGITAL ECONOMIES." Competitive Advantage in the Digital Economy (CADE 2021), Institution of Engineering and Technology, 2021, pp. 143–48. DOI.org (Crossref), https://doi.org/10.1049/icp.2021.2417.

[49] Panori, Anastasia, et al. "Smart Systems of Innovation for Smart Places: Challenges in Deploying Digital Platforms for Co-Creation and Data-Intelligence." Land Use Policy, vol. 111, Dec. 2021, p. 104631. DOI.org (Crossref), https://doi.org/10.1016/j.landusepol.2020.104631.

[50] Khan, Mohd Imran, et al. "Using Integrated Weighted IRP-Fuzzy TISM Approach towards Evaluation of Initiatives to Harmonise Halal Standards." Benchmarking: An International Journal, vol. 26, no. 2, Feb. 2019, pp. 434–51. DOI.org (Crossref), https://doi.org/10.1108/BIJ-04-2018-0086.

[51] Rajan, Rishabh, et al. "Technology Management for Innovation in Organizations: An Argumentation-Based Modified TISM Approach." Benchmarking: An International Journal, vol. 28, no. 6, June 2021, pp. 1959–86. DOI.org (Crossref), https://doi.org/10.1108/BIJ-01-2020-0019.

[52] Löfgren, Karl, and C. William R. Webster. "The Value of Big Data in Government: The Case of 'Smart Cities.'" Big Data & Society, vol. 7, no. 1, Jan. 2020, p. 205395172091277. DOI.org

(Crossref), https://doi.org/10.1177/2053951720912775.

[53] Priyanka, E. B., and S. Thangavel. "Influence of Internet of Things (IOT) in Association of Data Mining towards the Development Smart Cities-A Review Analysis." Journal of Engineering Science and Technology Review, vol. 13, no. 4, 2020, pp. 1–21., https://doi.org/10.25103/jestr.134.01.

[54] Fatimah, Yun Arifatul, et al. "Industry 4.0 Based Sustainable Circular Economy Approach for Smart Waste Management System to Achieve Sustainable Development Goals: A Case Study of Indonesia." Journal of Cleaner Production, vol. 269, Oct. 2020, p. 122263. DOI.org (Crossref), https://doi.org/10.1016/j.jclepro.2020.122263.

[55] Khan, Shahbaz, et al. "Enablers to Implement Circular Initiatives in the Supply Chain: A Grey DEMATEL Method." Global Business Review, June 2020, p. 097215092092948. DOI.org (Crossref), https://doi.org/10.1177/0972150920929484.

[56] Atitallah, Safa Ben, et al. "Leveraging Deep Learning and IoT Big Data Analytics to Support the Smart Cities Development: Review and Future Directions." Computer Science Review, vol. 38, Nov. 2020, p. 100303. DOI.org (Crossref), https://doi.org/10.1016/j.cosrev.2020.100303.

[57] Keshvardoost, Sina, et al. "Issues and challenges of smart cities governance: a systematic review." CIB, 2019.

[58] Sovacool, Benjamin K., and Dylan D. Furszyfer Del Rio. "Corrigendum to 'Smart Home Technologies in Europe: A Critical Review of Concepts, Benefits, Risks and Policies' [Renew Sustain Energy Rev 120 (2020) 109663]." Renewable and Sustainable Energy Reviews, vol. 148, Sept. 2021, p. 111277. DOI.org (Crossref), https://doi.org/10.1016/j.rser.2021.111277

[59] Hamid, Bushra, et al. "Cyber Security Issues and Challenges for Smart Cities: A Survey." 2019 13th International Conference on Mathematics, Actuarial Science, Computer Science and Statistics (MACS), IEEE, 2019, pp. 1–7. DOI.org (Crossref), https://doi.org/10.1109/MACS48846.2019.9024768.

[60] Ismagilova, Elvira, et al. "Security, Privacy and Risks Within Smart Cities: Literature Review and Development of a Smart City Interaction Framework." Information Systems Frontiers, vol. 24, no. 2, Apr. 2022, pp. 393–414. DOI.org (Crossref), https://doi.org/10.1007/s10796-020-10044-1.

[61] Lee, In. "Internet of Things (IoT) Cybersecurity: Literature Review and IoT Cyber Risk Management." Future Internet, vol. 12, no. 9, Sept. 2020, p. 157. DOI.org (Crossref), https://doi.org/10.3390/fi12090157.

[62] Radu, Laura-Diana. "Disruptive Technologies in Smart Cities: A Survey on Current Trends and Challenges." Smart Cities, vol. 3, no. 3, Sept. 2020, pp. 1022–38. DOI.org (Crossref), https://doi.org/10.3390/smartcities3030051.

[63] Caviglione, Luca, and Mauro Coccoli. "A holistic model for security of learning applications in smart cities." Journal of E-Learning and Knowledge Society 16.1 (2020): 01-10.

[64] Vorakulpipat, Chalee, et al. "Security and Privacy in Smart Cities." Security and Communication Networks, vol. 2021, Aug. 2021, pp. 1–2. DOI.org (Crossref), https://doi.org/10.1155/2021/9830547.

[65] Aloqaily, Moayad, et al. "An Intrusion Detection System for Connected Vehicles in Smart Cities." Ad Hoc Networks, vol. 90, July 2019, p. 101842. DOI.org (Crossref), https://doi.org/10.1016/j.adhoc.2019.02.001.

[66] Al Ridhawi, Ismaeel, et al. "Providing Secure and Reliable Communication for next Generation Networks in Smart Cities." Sustainable Cities and Society, vol. 56, May 2020, p. 102080. DOI.org (Crossref), https://doi.org/10.1016/j.scs.2020.102080.

[67] Meliho, M., Khattabi, A. and Mhammdi, N. (2020) "Spatial assessment of soil erosion risk by integrating remote sensing and GIS techniques: A case of tensift watershed in Morocco," Environmental Earth Sciences, 79(10). Available at: https://doi.org/10.1007/s12665-020-08955-y.

[68 Sharma, Manu, et al. "Internet of Things (IoT) Adoption Barriers of Smart Cities' Waste Management: An Indian Context." Journal of Cleaner Production, vol. 270, Oct. 2020, p. 122047. DOI.org (Crossref), https://doi.org/10.1016/j.jclepro.2020.122047.

[69] Bitelli, Gabriele, and Emanuele Mandanici. "2nd Edition of Instrumenting Smart City Applications with Big Sensing and Earth Observatory Data: Tools, Methods and Techniques." Remote Sensing, vol. 13, no. 7, Mar. 2021, p. 1310. DOI.org (Crossref), https://doi.org/10.3390/rs13071310.

[70] Kumar, A. et al. (2020) "Monitoring of land use/land cover changes by the application of GIS for disposal of solid waste: A case study of proposed smart cities in Bihar," Lecture Notes in Civil Engineering, pp. 253–262. Available at: https://doi.org/10.1007/978-981-15-6887-9_28.

[71] Mualla, Yazan, et al. "Between the Megalopolis and the Deep Blue Sky: Challenges of Transport with UAVs in Future Smart Cities." HAL (Le Centre Pour La Communication Scientifique Directe), Le Centre pour la Communication Scientifique Directe, May 2019.

[72] Hu, Xinting, et al. "Risk Assessment Model for UAV Cost-Effective Path Planning in Urban Environments." IEEE Access, vol. 8, 2020, pp. 150162–73, https://doi.org/10.1109/access.2020.3016118.

[73] Cardullo, Paolo, and Rob Kitchin. Smart Urbanism and Smart Citizenship: The Neoliberal Logic of 'Citizen-Focused' Smart Cities in Europe. Center for Open Science, 9 Mar. 2018, http://dx.doi.org/10.31235/osf.io/xugb5. Accessed 2 Mar. 2023.

[74] Sánchez-Corcuera, Ruben, et al. "Smart Cities Survey: Technologies, Application Domains and Challenges for the Cities of the Future." International Journal of Distributed Sensor Networks, vol. 15, no. 6, June 2019, p. 155014771985398, https://doi.org/10.1177/1550147719853984.

[75] Hamilton, Steve, and Ximon Zhu. "Funding and Financing Smart Cities." Journal of Government Financial Management, vol. 66, no. 1, Apr. 2017, p. 26.

[76] Lakhno, Valerii, et al. "Model of managing of the procedure of mutual financial investing in information technologies and smart city systems." International Journal of Civil Engineering and Technology 9.8 (2018): 1802-1812.

[77] Das, Diganta. "In Pursuit of Being Smart? A Critical Analysis of India's Smart Cities Endeavor." Urban Geography, vol. 41, no. 1, July 2019, pp. 55–78, https://doi.org/10.1080/02723638.2019.1646049.

[78] Kumar, Adarsh, et al. "A Novel Heuristic Simulation-optimization Method for Critical Infrastructure in Smart Transportation Systems." International Journal of Communication Systems, vol. 33, no. 11, Wiley-Blackwell, Mar. 2020, p. e4397, https://doi.org/10.1002/dac.4397.

[79] Wang, Mengmeng, Tao Zhou, and Di Wang. "Tracking the evolution processes of smart cities in China by assessing performance and efficiency." Technology in Society 63 (2020): 101353, https://doi.org/10.1016/j.techsoc.2020.101353.

[80] Ylipulli, Johanna, and Aale Luusua. "Smart cities with a Nordic twist? Public sector digitalization in Finnish data-rich cities." Telematics and Informatics 55 (2020): 101457, https://doi.org/10.1016/j.tele.2020.101457

[81] Chen, Dongliang, et al. "Cyber Security in Smart Cities: A Review of Deep Learning-based Applications and Case Studies." Sustainable Cities and Society, vol. 66, Elsevier BV, Mar. 2021, p. 102655, https://doi.org/10.1016/j.scs.2020.102655.

[82] Avdeeva, Elena, et al. "Human Resource Development in the Implementation of the Concept of 'Smart Cities.'" E3S Web of Conferences, EDP Sciences, Dec. 2019, https://doi.org/10.1051/e3sconf/201911002139.

[83] Golubchikov, Oleg, and Mary Thornbush. "Artificial Intelligence and Robotics in Smart City Strategies and Planned Smart Development." Smart Cities, vol. 3, no. 4, Oct. 2020, pp. 1133–44, https://doi.org/10.3390/smartcities3040056.

[84] Prasad, Deepti, and Tooran Alizadeh. "What Makes Indian Cities Smart? A Policy Analysis of Smart Cities Mission." Telematics and Informatics, vol. 55, Dec. 2020, p. 101466, https://doi.org/10.1016/j.tele.2020.101466

[85] Yigitcanlar, Tan, et al. "Contributions and Risks of Artificial Intelligence (AI) in Building Smarter Cities: Insights from a Systematic Review of the Literature." Energies, vol. 13, no. 6, Mar. 2020, p. 1473, https://doi.org/10.3390/en13061473.

[86] Serban, Andreea Claudia, and Miltiadis D. Lytras. "Artificial Intelligence for Smart Renewable Energy Sector in Europe—Smart Energy Infrastructures for Next Generation Smart Cities." IEEE Access, vol. 8, 2020, pp. 77364–77, https://doi.org/10.1109/access.2020.2990123.

[87] Mustafa, Syed Ziaul, and Arpan Kumar Kar. "Evaluating Multi-Dimensional Risk for Digital Services in Smart Cities." Digital Nations – Smart Cities, Innovation, and

Sustainability, Springer International Publishing, 2017, pp. 23–32, http://dx.doi.org/10.1007/978-3-319-68557-1_3. Accessed 2 Mar. 2023.

[88] Swami, Ashish Chandra, and Ritu Bhargava. "Digital security for smart cities in India: Challenges and opportunities." IOSR Journal of Engineering 9.1 (2019): 63-71.

[89] Fernandes, Bruno F., et al. "Crowd Sensing for Urban Security in Smart Cities." Journal of Universal Computer Science, vol. 24, Verlag der Technischen Universität Graz, Jan. 2018, pp. 302–21.

[90] Ezzat, Mostafa Ahmed, et al. "Horizontal Review on Video Surveillance for Smart Cities: Edge Devices, Applications, Datasets, and Future Trends." Sensors, vol. 21, no. 9, May 2021, p. 3222, https://doi.org/10.3390/s21093222.

[91] Cecaj, Alket, et al. "Sensing and Forecasting Crowd Distribution in Smart Cities: Potentials and Approaches." IoT, vol. 2, no. 1, Jan. 2021, pp. 33–49, https://doi.org/10.3390/iot2010003.

[92] Paiva, Sara, et al. "Enabling Technologies for Urban Smart Mobility: Recent Trends, Opportunities and Challenges." Sensors, vol. 21, no. 6, Mar. 2021, p. 2143, https://doi.org/10.3390/s21062143.

[93] Alharbi, N., and B. Soh. "Roles and Challenges of Network Sensors in Smart Cities." IOP Conference Series: Earth and Environmental Science, vol. 322, no. 1, Aug. 2019, p. 012002, https://doi.org/10.1088/1755-1315/322/1/012002.

[94] Chang, Victor, et al. "Research Investigations on the Use or Non-Use of Hearing Aids in the Smart Cities." Technological Forecasting and Social Change, vol. 153, Apr. 2020, p. 119231, https://doi.org/10.1016/j.techfore.2018.03.002.

[95] Gomathi, P., et al. "Concurrent Service Access and Management Framework for User-Centric Future Internet of Things in Smart Cities." Complex & Intelligent Systems, June 2020, https://doi.org/10.1007/s40747-020-00160-5.

[96] Potdar, Vidyasagar, et al. "Risks and Challenges of Adopting Electric Vehicles in Smart Cities." Smart Cities, Springer International Publishing, 2018, pp. 207–40, http://dx.doi.org/10.1007/978-3-319-76669-0_9. Accessed 2 Mar. 2023.

[97] Appio, Francesco Paolo, et al. "Understanding Smart Cities: Innovation Ecosystems, Technological Advancements, and Societal Challenges." Technological Forecasting and Social Change, vol. 142, May 2019, pp. 1–14, https://doi.org/10.1016/j.techfore.2018.12.018.

[98] Haouari, Fatima, et al. "Fog Computing Potentials, Applications, and Challenges." 2018 International Conference on Computer and Applications (ICCA), IEEE, 2018, http://dx.doi.org/10.1109/comapp.2018.8460182. Accessed 2 Mar. 2023.

[99] Zhang, PeiYun, et al. "Security and Trust Issues in Fog Computing: A Survey." Future Generation Computer Systems, vol. 88, Nov. 2018, pp. 16–27, https://doi.org/10.1016/j.future.2018.05.008.

[100] Abdelaziz, Ahmed, et al. "A Machine Learning Model for Predicting of Chronic Kidney Disease Based Internet of Things and Cloud Computing in Smart Cities." Security in Smart Cities: Models, Applications, and Challenges, Springer International Publishing, 2018, pp. 93–114, http://dx.doi.org/10.1007/978-3-030-01560-2_5. Accessed 2 Mar. 2023.

[101] Dogo, Eustace M., et al. "Taking Cloud Computing to the Extreme Edge: A Review of Mist Computing for Smart Cities and Industry 4.0 in Africa." Edge Computing, Springer International Publishing, 2018, pp. 107–32, http://dx.doi.org/10.1007/978-3-319-99061-3_7. Accessed 2 Mar. 2023.

[102] Ahad, Mohd Abdul, et al. "Enabling Technologies and Sustainable Smart Cities." Sustainable Cities and Society, vol. 61, Oct. 2020, p. 102301, https://doi.org/10.1016/j.scs.2020.102301.

[103] Saarika, P. S., et al. "Smart Transportation System Using IoT." 2017 International Conference On Smart Technologies For Smart Nation (SmartTechCon), IEEE, 2017, http://dx.doi.org/10.1109/smarttechcon.2017.8358540. Accessed 2 Mar. 2023.

[104] Dodge, Martin, and Rob Kitchin. "The Challenges of Cybersecurity for Smart Cities." Creating Smart Cities, Routledge, 2018, pp. 205–16, http://dx.doi.org/10.4324/9781351182409-16. Accessed 2 Mar. 2023.

[105] Plageras, Andreas P., et al. "Efficient IoT-Based Sensor BIG Data Collection–Processing and Analysis in Smart Buildings." Future Generation Computer Systems, vol. 82, May 2018, pp. 349–57, https://doi.org/10.1016/j.future.2017.09.082.

[106] Pereira, Gabriela Viale, et al. "Smart Governance in the Context of Smart Cities: A Literature Review." Information Polity, vol. 23, no. 2, June 2018, pp. 143–62, https://doi.org/10.3233/ip-170067.

[107] Jia, Mengda, et al. "Adopting Internet of Things for the Development of Smart Buildings: A Review of Enabling Technologies and Applications." Automation in Construction, vol. 101, May 2019, pp. 111–26, https://doi.org/10.1016/j.autcon.2019.01.023.

[108] Qolomany, Basheer, et al. "Leveraging Machine Learning and Big Data for Smart Buildings: A Comprehensive Survey." IEEE Access, vol. 7, 2019, pp. 90316–56, https://doi.org/10.1109/access.2019.2926642.

[109] Mohandas, Prabu, et al. "Artificial Neural Network Based Smart and Energy Efficient Street Lighting System: A Case Study for Residential Area in Hosur." Sustainable Cities and Society, vol. 48, July 2019, p. 101499, https://doi.org/10.1016/j.scs.2019.101499.

[110] Zhang, Xiangyu, et al. "An IoT-Based Thermal Model Learning Framework for Smart Buildings." IEEE Internet of Things Journal, vol. 7, no. 1, Jan. 2020, pp. 518–27, https://doi.org/10.1109/jiot.2019.2951106.

[111] Panteli, Christiana, et al. "Building Information Modelling Applications in Smart Buildings: From Design to Commissioning and beyond A Critical Review." Journal of Cleaner Production, vol. 265, Aug. 2020, p. 121766, https://doi.org/10.1016/j.jclepro.2020.121766.

[112] Chen, Yujiao, et al. "Transfer Learning with Deep Neural Networks for Model Predictive Control of HVAC and Natural Ventilation in Smart Buildings." Journal of Cleaner Production, vol. 254, May 2020, p. 119866, https://doi.org/10.1016/j.jclepro.2019.119866.

[113] Casado-Vara, Roberto, et al. "IoT Network Slicing on Virtual Layers of Homogeneous Data for Improved Algorithm Operation in Smart Buildings." Future Generation Computer Systems, vol. 102, Jan. 2020, pp. 965–77, https://doi.org/10.1016/j.future.2019.09.042.

[114] Hakak, Saqib, et al. "Securing Smart Cities through Blockchain Technology: Architecture, Requirements, and Challenges." IEEE Network, vol. 34, no. 1, Jan. 2020, pp. 8–14, https://doi.org/10.1109/mnet.001.1900178

[115] Froufe, Mariangela, et al. "Smart Buildings: Systems and Drivers." Buildings, vol. 10, no. 9, Sept. 2020, p. 153, https://doi.org/10.3390/buildings10090153.

[116] Van Cutsem, Olivier, et al. "Cooperative Energy Management of a Community of Smart-Buildings: A Blockchain Approach." International Journal of Electrical Power & Energy Systems, vol. 117, May 2020, p. 105643, https://doi.org/10.1016/j.ijepes.2019.105643.

[117] Liu, Yaqing, et al. "Daily Activity Feature Selection in Smart Homes Based on Pearson Correlation Coefficient." Neural Processing Letters, vol. 51, no. 2, Jan. 2020, pp. 1771–87, https://doi.org/10.1007/s11063-019-10185-8.

[118] Porkodi, S., and Kesavaraja Duraipandy. "Privacy and Security Smart Cities Issues in Green." Handbook of Green Engineering Technologies for Sustainable Smart Cities, CRC Press, 2021, pp. 299–318, http://dx.doi.org/10.1201/9781003093787-17. Accessed 2 Mar. 2023.

[119] Pratama, Arif Budy, and Satria Aji Imawan. "A Scale for Measuring Perceived Bureaucratic Readiness for Smart Cities in Indonesia." Public Administration and Policy, vol. 22, no. 1, July 2019, pp. 25–39, https://doi.org/10.1108/pap-01-2019-0001.

[120] Kurniawan, Bobi, et al. "Framework for Developing Smart City Models in Indonesian Cities (Based On Garuda Smart City Framework)." 2022 International Conference on ICT for Smart Society (ICISS), IEEE, 2022, http://dx.doi.org/10.1109/iciss55894.2022.9915073. Accessed 2 Mar. 2023.

[121] "Kuwait." The Arab Gulf States and Reform in the Middle East, Palgrave Macmillan, http://dx.doi.org/10.1057/9781137467836.0011. Accessed 2 Mar. 2023.

ISSN: 1992-8645 www.jatit.org E-ISSN: 1817-3195

Table 2 Participants Readiness Measurements

NO	Readiness Measurement	PAR1	PAR2	PAR3	PAR4	PAR5	PAR6	Agreements
C1	Infrastructure Readiness	L	M	L	L	M	L	Partial Agreement
	Capability of Resources Readiness	L	L	L	L	L	M	Partial Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
C2	Infrastructure Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Capability of Resources Readiness	L	L	L	M	M	M	Partial Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
C3	Infrastructure Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Capability of Resources Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
C4	Infrastructure Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Capability of Resources Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Laws & Regulations Readiness	M	L	L	L	M	L	Partial Agreement
C5	Infrastructure Readiness	**M**	**M**	**M**	**M**	**M**	**M**	**Full Agreement**
	Capability of Resources Readiness	M	L	L	L	M	M	Partial Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
C6	Infrastructure Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
	Capability of Resources Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
C7	Infrastructure Readiness	M	L	M	L	M	L	Partial Agreement

	Capability of Resources Readiness	M	L	M	L	L	M	Partial Agreement
	Laws & Regulations Readiness	M	L	M	L	L	L	Partial Agreement
C8	Infrastructure Readiness	M	M	M	L	M	L	Partial Agreement
	Capability of Resources Readiness	M	M	M	M	M	M	Full Agreement
	Laws & Regulations Readiness	M	M	M	M	M	L	Partial Agreement
C9	Infrastructure Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Capability of Resources Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
C10	Infrastructure Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Capability of Resources Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	Full Agreement
C11	Infrastructure Readiness	L	M	L	L	M	M	Partial Agreement
	Capability of Resources Readiness	L	L	L	M	L	M	Partial Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
C12	Infrastructure Readiness	M	L	L	L	M	L	Partial Agreement
	Capability of Resources Readiness	M	L	L	L	M	L	Partial Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
C13	Infrastructure Readiness	M	M	L	L	M	L	Partial Agreement
	Capability of Resources Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
C14	Infrastructure Readiness	L	L	M	M	L	M	Partial Agreement

	Capability of Resources Readiness	L	L	L	M	L	M	Partial Agreement
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
C15	Infrastructure Readiness	M	M	M	L	M	L	Partial Agreement
	Capability of Resources Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
C16	Infrastructure Readiness	L	M	M	L	L	L	Partial Agreement
	Capability of Resources Readiness	L	L	L	L	L	L	**Full Agreement**
	Laws & Regulations Readiness	L	L	L	L	L	L	**Full Agreement**
C17	Infrastructure Readiness	L	M	L	L	M	L	Partial Agreement
	Capability of Resources Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**
	Laws & Regulations Readiness	**L**	**L**	**L**	**L**	**L**	**L**	**Full Agreement**