Data Science and Smart Cities

By

Maab Fatima

Submitted for assessment in

UC1PBL053 – Problem Based Learning

at

Noroff University College

Table of Contents

1. Overview of search results

Search Engine Used	Keywords and Phrases	Hyperlink to Results	Reasons for inclusion in top results
SCIENCE DIRECT	"SMART" CITY AND "DATA SCIENCE	Data Architecture and Big Data Analytics in Smart Cities - ScienceDirect	GIVES ME AN OVERVIEW OF THE SMART CITIES FROM THE BEGINNING. HELPS ME IN WRITING THE LITERATURE PART.
SCIENCE DIRECT	SMART CITY @ARCHITECTURES@	Smart City Transition Pillars With Layered Applications Architecture - ScienceDirect	THIS SEARCH LEADS ME IN WRITING MY CHALLENGES THAT CAN BECOME A HURDLE IN THE DEVELOPMENT OF SMART CITIES
SCIENCE DIRECT	"IOT" ARCHITECTURE FOR SMART CITIES	IoT in smart cities: A contemporary survey - ScienceDirect	THIS SEARCH LEADS ME TO SHAPE MY DISCUSSION IN AN ACADEMIC WAY
SCIENCE DIRECT	"DATA SCIENCE" IN SMART CITIES	Smart City Data Science: Towards data-driven smart cities with open research issues - ScienceDirect	GIVES ME A GLANCE OF SMART CITIES RELATED TO DATA STRUCTURE, HELPS ME IN WRITING SOME PART OF MY LITERATURE.
SCIENCE DIRECT	SMART CITIES OF THE FUTURE	Developing future human-centered smart cities: Critical analysis of smart city security, Data management, and Ethical challenges - ScienceDirect	DESCRIBE SOME CHALLENGES IN RELATION OF ETHICAL DATA, IT ALSO ANALYSIS SOME CRITICAL CHALLENGES IN THE MANAGEMENT OF SMART CITIES

2. Annotated Bibliography Entries

2.1. Reference 1

Reference	Khan, M. A., & Salah, K. (2018). IoT security: Review, blockchain solutions, and open challenges. *Future Generation Computer Systems*, *82*, 395–411. https://doi.org/10.1016/j.future.2017.11.022
Summary	"Since smart cities became the basic need of urban areas, Internet of Things (IoT) will be served as its application. The author focuses on decision making process which results in the development of different services provided to the smart city citizens."(Khan & Salah, 2018) "This paper also explain IoT framework architecture based on machine learning and deep learning. The authors research circles around smart city services and their prioritization according to the need. At the end, the author discussed some open research issues which could be confronted in the future."(Khan & Salah, 2018)
# Citations	2063
Journal Quality	Scimagojr **Q1** (Computer Networks and Communications) H -Index **134** Sjr 2021 **2.23**
Author	**Khaled Salah** (Scopus: H-Index – 41, Citations 7455, https://orcid.org/0000-0002-2310-2558) (Google scholar: H-Index – 54, Citations 11821) **Minhaj Ahmad Khan** (Scopus: H-Index 6, Citations 1656, ORCID) (Google Scholar: H-Index – 5, Citations 531)
Other	

2.2. Reference 2

Reference	Sarker, I. H. (2022). Smart City Data Science: Towards data-driven smart cities with open research issues. *Internet of Things*, *19*, 100528. https://doi.org/10.1016/j.iot.2022.100528
Summary	"Since smart cities became the basic need of urban areas, Internet of Things (IoT) will be served as its application. The author focuses on decision making process which results in the development of different services provided to the smart city citizens."(Sarker, 2022) "This paper also explain IoT framework architecture based on machine learning and deep learning. The authors research circles around smart city services and their

	prioritization according to the need. At the end, the author discussed some open research issues which could be confronted in the future."(Sarker, 2022)
# Citations	15
Journal Quality	Scimagojr H-Index **27** **Q1** (Artificial Intelligence) Sjr 2021 **1.61**
Author	**Iqbal H. Sarker** (Scopus: H-Index 22, Citations 1631, ORCID)
Other	

2.3. Reference 3

Reference	Rejeb, A., Rejeb, K., Simske, S., Treiblmaier, H., & Zailani, S. (2022). The big picture on the internet of things and the smart city: A review of what we know and what we need to know. *Internet of Things, 19,* 100565. https://doi.org/10.1016/j.iot.2022.100565
Summary	"According to this research paper, Internet of Things (IoT) are the interconnected devices which take part in the development of intelligent cities. This paper describes the fundamental basics of IoTs and their architectures. The author explains why the need of IoT devices are worthy in the innovation of smart cities. He proved his arguments by sharing the quotes of famous scholars and researchers who are known as the best in the field of IoT."(Rejeb et al., 2022) "In his literature, he discussed briefly about the present developments in smart cities and gave suggestions of how they could be made better in the future."(Rejeb et al., 2022)
# Citations	10
Journal Quality	Scimagojr H-Index **27** **Q1** (Artificial Intelligence) Sjr 2021 **1.61**
Author	**Abderahman Rejeb** (Scopus: H-Index 12, Citations 482, ORCID) **Karim Rejeb** (Scopus: H-Index 10, Citations 246, ORCID) **Steve Simske** (Scopus: H-Index 35, Citations 4892, ORCID) **Horst Treiblmaier**

	(Scopus: H-Index 39, Citations 5866, ORCID) **Suhaiza Zailani** (Scopus: H-Index 20, Citations 1795, ORCID)
Other	

2.4. Reference 4

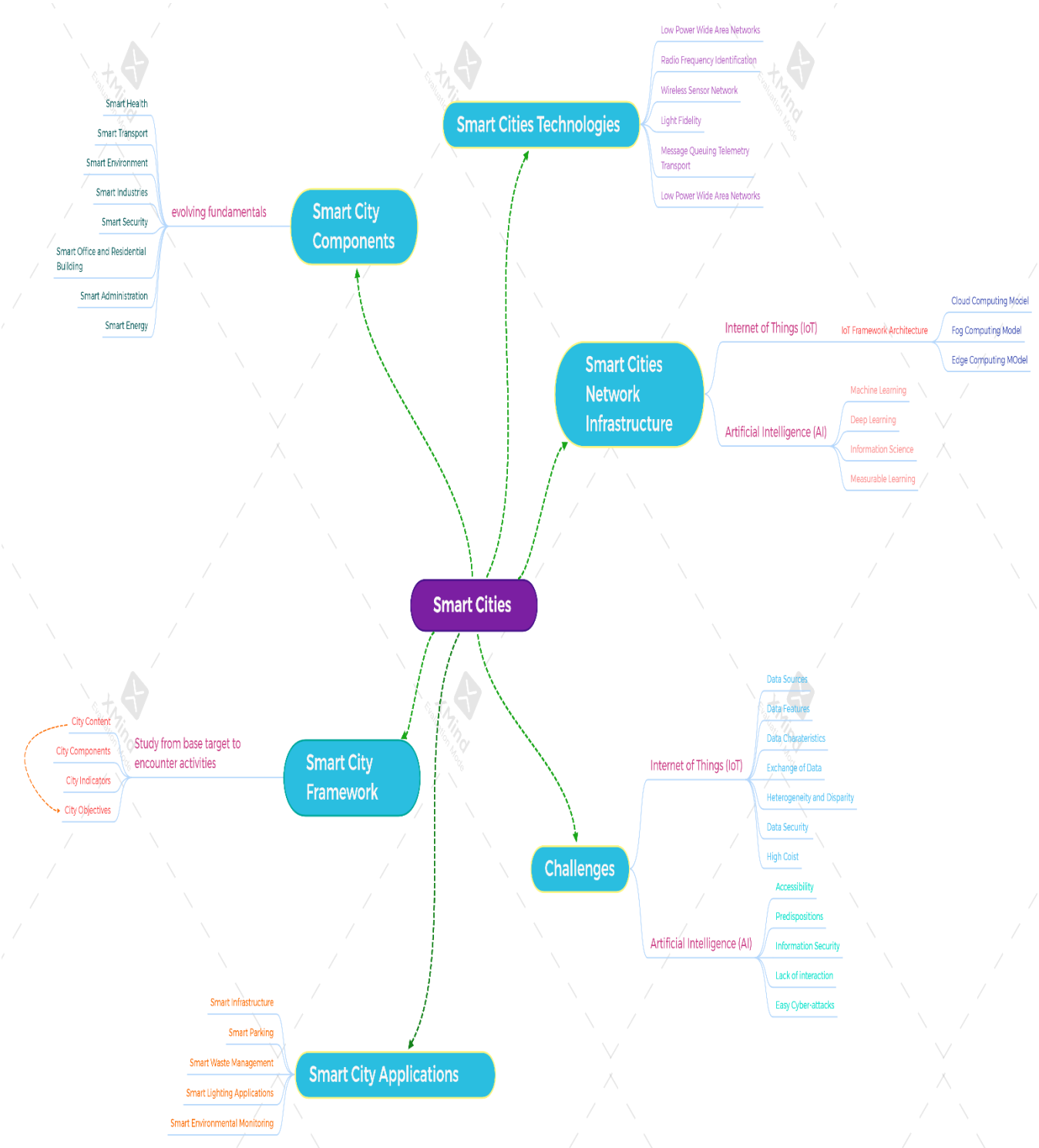
Reference	Peralta Abadía, J. J., Walther, C., Osman, A., & Smarsly, K. (2022). A systematic survey of Internet of Things frameworks for smart city applications. *Sustainable Cities and Society*, *83*, 103949. https://doi.org/10.1016/j.scs.2022.103949
Summary	"In this research paper, we came to know about the different definitions of smart cities and their key elements according to the definition. The author also explains smart city domains according to different models. We also came to know about the Internet of Things (IoT) which is considered as an application of smart cities."(Peralta Abadía et al., 2022) "The author describes about Internet of Things (IoT) and its framework architecture which consist of different layers. This paper also showed us the survey results among IoT framework as taking part in the development of smart cities."(Peralta Abadía et al., 2022)
# Citations	3
Journal Quality	Scimagojr H-Index **82** **Q1** (Civil and Structural Engineering) Sjr 2021 2.02
Author	**José Joaquín Peralta Abadía** (Scopus: H-Index 2, Citations 5, ORCID) **Christian Walther** (Scopus: H-Index 2, Citations 5, ORCID) **Ammar Osman** (Scopus: H-Index 1, Citations 2, ORCID) **Kay Smarsly** (Scopus: H-Index 15, Citations 614, ORCID)
Other	

2.5. Reference 5

Reference	Sánchez-Corcuera, R., Nuñez-Marcos, A., Sesma-Solance, J., Bilbao-Jayo, A., Mulero, R., Zulaika, U., Azkune, G., & Almeida, A. (2019). Smart cities survey: Technologies, application domains and challenges for the cities of the future. *International Journal of Distributed Sensor Networks*, *15*(6), 1550147719853984. https://doi.org/10.1177/1550147719853984
Summary	"In this research paper, the author introduces the technologies that plays a major role in our lives. He explained smart cities, smart cities domain with respect of different definitions and the architecture that lies behind the success of smart cities. IoT has popular among most of them, so he explains Internet of Things (IoT) framework architectures." (Sánchez-Corcuera et al., 2019) "The author also lightens up some smart cities' applications in different domains which take part in the basic infrastructure. At the end, he discussed some known smart cities in the world."(Sánchez-Corcuera et al., 2019)
# Citations	145
Journal Quality	Scimagojr **Q2** (Computer Networks and Communication) H-Index **58** SJR 2021 **0.5**
Author	**Aitor Almeida** (Google Scholar: H-Index 20, Citations 1261) **Gorka Azkune** (Google Scholar: H-Index 11, Citations 763) **Ruben Sánchez-Corcuera** (Google Scholar: H-Index 3, Citations 170) **Adrián Nuñez-Marcos** (Google Scholar: H-Index 3, Citations 353) **Jesus Sesma-Solance** (Google Scholar: H-Index 2, Citations 155) **Aritz Bilbao-Jayo** (Google Scholar: H-Index 8, Citations 275) **Rubén Mulero** (Google Scholar: H-Index 8, Citations 373)

	Unai Zulaika (Google Scholar: H-Index 4, Citations 175)
Other	

3. Topic Overview Mind Map



4. Chapter Plan and High-level Structure

Essay Outline

4.1. Introduction:

Define smart cities-Internet of Things (IoT)-Progression of technology

4.2. Literature Review:

Emergence of Smart Cities-Smart Cities Framework and Components

4.3. Network Infrastructure:

Internet of Things (IoT)-Artificial Intelligence (AI)

4.4. Discussion:

Schematic analysis in terms of technologies and applications

4.5. Challenges:

Facing through IoTs and AIs models

4.6. Conclusion:

Summarize every topic

4.7. References:

List of my Sources

5. Chapter Section

5.1. Introduction

"Since the world population increases day by day, about 55% of the populace lives in an urban region, and it is anticipated that the number will increment up to 66% by 2030. As the city develops, unused issues emerge, and the assets are rare. Therefore, functioning on the transformation of the city has become a preference for all of us."(Camero & Alba, 2019)

"A smart city is an innovative cutting-edge urban range that employs different types of electronic strategies and sensors to gather information."('Smart City', 2022) "These cities are consisting of different components such as agriculture, homes, industrial, energy, transport, etc."(Rp et al., 2021) "Moreover, these are designed in a manner to meet with the needs of people living in urban areas, which is exemplarily dealt with as an appliance of Internet of Things (IoT)"(Sarker, 2022). "Internet of Things consists of several interconnected objects through the internet. It has different types of applications, such as smart cities, smart connected automobiles, and smart homes."('Internet of Things', 2022) "In fact, the applications based on IoT network has become a crucial part of our daily lives. With the growing demand for these applications, they have become vulnerable to challenges. Since these applications communicate among smart objects through the internet where there is less human interaction, so they are wide open to cyber-attacks."(Tariq et al., 2021) In this chapter, we will be covering topics such as smart cities and their components. The chapter delivers the smart city framework and implementations of smart city technologies and applications in the real world. The chapter will also explain the primary goals of the Internet of Things (IoT) and Artificial Intelligence (AI) in the development of smart cities. In the end, you will be meeting with the discussion about some challenges and their solutions.

5.2. Literature Review

"The perception of a smart city showed up in 1992," (Ouafiq et al., 2022). "Smart city exploration achieved strength in the 2000s when they contemplated a coming over urban approach through data science to boost the element of life in urban areas. Later in 2011, the first smart city expo world congress was held, where the barricades were broken, and the smart city literature showed an augmented growth by having 200,000 publications per year."(Richter et al., 2022)

"Furthermore, a fine definition of smart cities stills require not only academically but also in empirical projects. Indeed, a literature survey shows that:

The smart city can be defined as a data project which focuses on city developments and made innovations in the manner of making human life luxurious."(Dameri, 2013) According to (Secinaro et al., 2022), "smart cities emanate from the data city notion and grasp five amplitudes: smart recession, smart automobility, smart habitat, smart living, and smart administration."

5.2.1. Smart City Framework:

"A smart city system may be a basic choice technique that empowers both the civil and confidential divisions to arrange and execute smart cities activities successfully. Most developing cities execute the same basic structural plan that is shown below (Figure 1). The framework begins with the city target as its base, in contrary to encounter the activities."(Falconer & Mitchell, 2012)

"**Figure 1**: Smart City Framework.

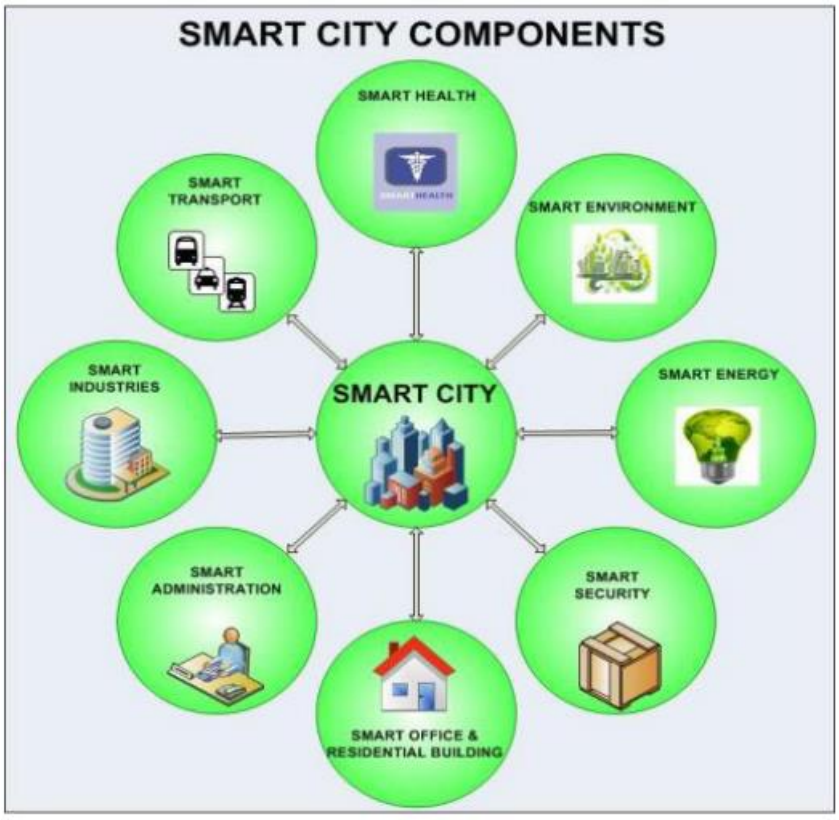
(Source:"(Falconer & Mitchell, 2012))

5.2.2.Smart City Components:

"The fundamentals for making a smart city in evolving are shown below:

- A clever administration framework with straightforward data trade between inhabitants, the city, metropolitan administrations, and crisis administrations.
- A shrewd economy empowers an effective stream of items, administrations, and information at the city level and between cities.
- Intelligent portability is an interconnected, secure, and proficient framework for the administration of transport, coordination, stopping parcels, and open transport.
- The smart environment is an imaginative asset administration framework such as gadgets.
- Smart inhabitants have gotten to instruction and preparation through cutting-edge media transmission and data innovations. In expansion, the backup of inhabitants in terms of asset imagination of human potential empowers the dynamic interest of inhabitants within the life of the city.
- A brilliant way of life, permitting to move forward the quality of life, to create superior wellbeing administrations and foundations, but moreover broaden and differentiate the culture and benefit advertised."(Ouafiq et al., 2022)

"**Figure 2**: Smart City Components



(Source:"(Gaur et al., 2015))

5.3. Smart Cities Network Infrastructure:

"A smart city ordinarily employments ICT (information and communication technology) to expand financial development, life improvement, and fortify government frameworks. City information gathered from assorted sources such as sensors, interconnected gadgets, or outside sources, is being mined to administer fitter services to society and enhance decision-making developments."(Sarker, 2022) "Network Infrastructure is defined as an important key element of smart cities and its common application is the Internet of Things (IoT) which is widely known as a network of internet-connected devices."(Peralta Abadía et al., 2022)

5.3.1. Internet of Things (IoT):

"Information and communication technology (ICT) advances a modern kind of communication environment like the Internet of Things (IoT)"(Wazid et al., 2020), "which has seen fast development due to the broad appropriation of advanced equipment and computer program stages, more prominent accessibility of communications systems, and the advancement of information examination devices. The Internet of Things (IoT) constitutes a center component which can be joined within the framework and forms of a smart city to attain its vision"(Rejeb et al., 2022).

5.3.1.1. IoT Framework Architecture:

"Since of the huge number of heterogeneous gadgets the Internet of Things coordinating, adaptable, layered IoT system models are fundamental to associate the physical and advanced universes."(Peralta Abadía et al., 2022) "There are different proposed models for smart cities architecture depending on the requirements according to the situation in cities. The architecture described in this chapter is the most common model consisting of layers in an account of securing, preparing, and making utilization of the information. These layers are shown below:"(Sánchez-Corcuera et al., 2019)

- "Cloud computing Model:

  Cloud computing could be a demonstration for empowering omnipresent, helpful, on-demand organize get to a shared pool of configurable computing assets that can be quickly provisioned and discharged with negligible administration exertion or benefits supplier interaction."(Sánchez-Corcuera et al., 2019)

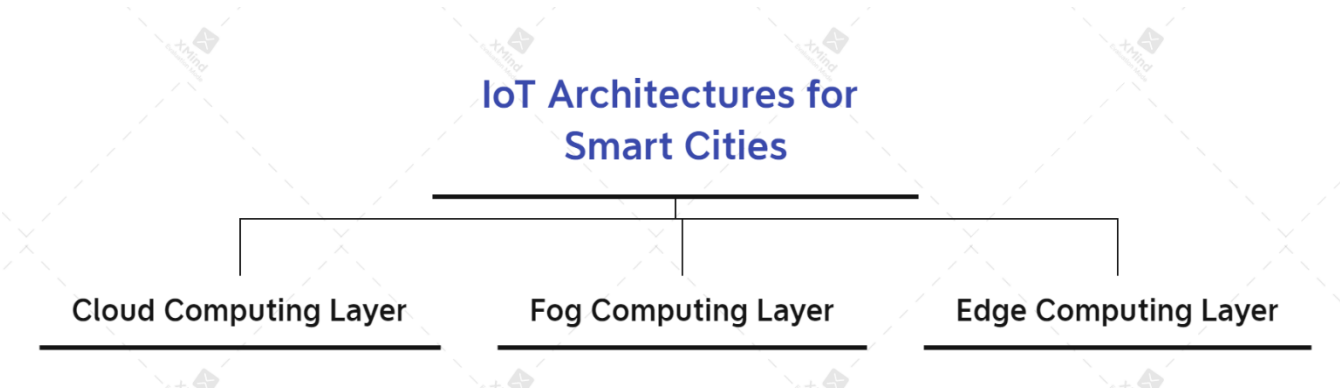
- "Fog Computing Model:

  This design is utilized for applications where moo idleness is required, topographically scattered foundations, or applications where the information obtained isn't common sense to send to the cloud and hold up for its preparation."(Sánchez-Corcuera et al., 2019)

- "Edge Computing Model:

  Edge computing may be a worldview that takes after the articulation that in case the information is created at the edge of the arrange it ought to moreover be more productive to handle that data at the edge of it. This can be a comparable approach to mist computing but with the distinction, that haze centers more on the foundation and edge on the side of the things. It is critical to note that the edge isn't continuously the littlest sensor in a arrange but the bridge between the nearby arrange and the cloud."(Sánchez-Corcuera et al., 2019)

Figure 3: IoT Architectures for Smart Cities



5.3.2. Artificial Intelligence:

"A digital city application requests a joint exertion of individuals from diverse disciplines, such as designing, engineering, urban planning, and financial matters, to arrange, plan, actualize, and send a keen arrangement for a basic errand. Artificial Intelligence (AI) procedures have moreover been demonstrated exceptionally viable to pick up bits of knowledge from information collected through distinctive IoT sensors to oversee and utilize the assets more proficiently. In this chapter, the term AI broadly utilizes as an umbrella term for counting methods and calculations able to memorize information (i.e., information science, measurable learning, machine learning, deep learning). A few key smart city applications where AI has been demonstrated exceptionally viable incorporate healthcare, transportation, instruction, environment, farming, defense, and open administrations."(Ahmad et al., 2022)

5.4. Discussion

5.4.1. Schematic Analysis:

"A smart city employs IoT innovations to accumulate data from required zones and communicate with the citizens, which moves forward the welfare of a country's individuals and government administrations. Ordinary digital cities are presently being supplanted distantly by different innovations, counting the IoT and other such rising advances. With the help of tables, I have explained the technologies using IoT applications and the current applications which incorporate these technologies in developing a smart city. Table 1 describes the technologies, and Table 2 explains the smart city infrastructure."(Rp et al., 2021)

Table 1: "Smart City Technologies (Source:" (Rp et al., 2021))

"**Technology**	**Main components used**	**Purpose**
LPWANs (Low Power Wide Area Networks)	-	Combine different Sensors in one Network
RFID (Radio Frequency Identification)	Tags and Readers	Transmitting and Accepting Data
WSNs (Wireless Sensor Networks)	-	Identify different Natural Variables
Li-Fi (Light Fidelity)	LEDs	High Speed Remote Internet Communication

MQTT (Message Queuing Telemetry Transport)	-	Translate the Message between Gadgets, Servers, and Applications."(Rp et al., 2021)

Table 2: "Smart City Applications (Source:"(Rp et al., 2021))

"Area of Focus	**Application**	**Device used**
Smart Infrastructure	effective and economic framework	-
Smart Parking	identifies the entry and flight of the vehicles and stopping area proximity sensors	ultrasonic sensors and separate estimation sensors
Smart Waste Management	control of discuss contamination, heaping up of rubbish of in lanes etc.	Level identifying sensors
Smart Lighting Applications	vitality conservation	lighting sensors, nearness sensors and photodiodes
Smart Environmental Monitoring	observing the components of significance	humidity sensor, water sensor and temperature sensors"(Rp et al., 2021)

5.5. Challenges:

"Huge information applications in digital cities have numerous imperative challenges which ought to be explored. For example, (1) Data Sources, this challenge should be investigated in the way that the information plot and collected sources must allude from the bequest frameworks and modern ones in numerous plans. (2) Data Features, the information gathered in different shapes should be organized most thoroughly with the help of data formats (e.g., sound, video, pictures, etc.) for easy utilization."(Embarak, 2021) "(3) Data Characteristics, this is the challenge where the digital city application ought to adapt with information Volume, Speed, Inconstancy, Instability, Esteem, Assortment, Legitimacy, and Veracity. (4) Exchange of Data, the issue between different substances such as metropolitan office and service supplier, they do not want to share their property data. To get rid of this issue, approaches in clever cities must discover ways to anticipate or decrease obstruction to smooth information trade between them."(Embarak, 2021) "(5) Heterogeneity and disparity, the nonappearance of a structure results in unwavering quality, heterogeneity,

and inconsistency issues which becomes a cause of having different providers with distinctive sources and participation. This problem can be resolved by arranging the gathered information from distinctive file sources in standard designs and saving them in unmistakable databases. (6) Data Security and Privacy, Assurance-established information requires immense security and components to avoid unauthorized approaches and malevolent assaults."(Embarak, 2021) (7) "High Cost, although the development of intelligent cities requires a huge amount of money, through proper planning and with the correct usage of gadgets, the risk can be minimized."(Rp et al., 2021)

"Since Artificial Intelligence (AI) methods point to prepare and distinguish a design in information gathered by different sensors and give valuable experiences on how to optimize basic administrations, it also meets with some dangers and challenges such as accessibility, predispositions, and security of information, to effectively send AI in opposite smart city applications. For occurrence, assailants can dispatch distinctive sorts of ill-disposed assaults on AI models to influence their prescient proficiencies. Another key challenge is the lack of intractability which makes it harder for humans to deal with it. The solutions to minimize these challenges are explainability and ethics."(Ahmad et al., 2022)

6. Conclusion

"Smart cities can be characterized as those that successfully coordinated physical, advanced, and human frameworks in urban environments to provide maintainable, affluent, and comprehensive results for their citizens."(Ouafiq et al., 2022) This chapter summarizes approximately the different advanced coordinates in creating smart cities. The current applications of intelligent cities utilizing IoT advances have been discussed. Digital cities framework has been shown to understand the developing process carried out by the Internet of Things which consists of layers. "In this chapter, we discussed the challenges confronted in the development of IoT infrastructure for smart cities and suggested possible solutions for minimizing the risk."(Khan & Salah, 2018) "We have checked on the key challenges within the effective arrangement of AI in smart city applications."(Ahmad et al., 2022) "This chapter showed us that the emergence of the smart city is inescapable for resolving the issues of urban areas. Nonetheless, designs based on innovations to form a smart city from raw will be a distant better alternative for developing an unused city."(Javed et al., 2022)

7. References:

- Ahmad, K., Maabreh, M., Ghaly, M., Khan, K., Qadir, J., & Al-Fuqaha, A. (2022). Developing future human-centered smart cities: Critical analysis of smart city security, Data management, and Ethical challenges. *Computer Science Review*, *43*, 100452. https://doi.org/10.1016/j.cosrev.2021.100452
- Camero, A., & Alba, E. (2019). Smart City and information technology: A review. *Cities*, *93*, 84–94. https://doi.org/10.1016/j.cities.2019.04.014
- Dameri, R. (2013). Searching for Smart City definition: A comprehensive proposal. *International Journal of Computers & Technology*, *11*, 2544. https://doi.org/10.24297/ijct.v11i5.1142
- Embarak, O. (2021). Smart City Transition Pillars With Layered Applications Architecture. *Procedia Computer Science*, *191*, 57–64. https://doi.org/10.1016/j.procs.2021.07.011
- Falconer, G., & Mitchell, S. (2012). *A Systematic Process for Enabling Smart+Connected Communities*. 11.
- Gaur, A., Scotney, B., Parr, G., & McClean, S. (2015). Smart City Architecture and its Applications Based on IoT. *Procedia Computer Science*, *52*, 1089–1094. https://doi.org/10.1016/j.procs.2015.05.122
- Internet of things. (2022). In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=Internet_of_things&oldid=1123185157
- Javed, A. R., Shahzad, F., Rehman, S. ur, Zikria, Y. B., Razzak, I., Jalil, Z., & Xu, G. (2022). Future smart cities: Requirements, emerging technologies, applications, challenges, and future aspects. *Cities*, *129*, 103794. https://doi.org/10.1016/j.cities.2022.103794
- Khan, M. A., & Salah, K. (2018). IoT security: Review, blockchain solutions, and open challenges. *Future Generation Computer Systems*, *82*, 395–411. https://doi.org/10.1016/j.future.2017.11.022
- Ouafiq, E. M., Raif, M., Chehri, A., & Saadane, R. (2022). Data Architecture and Big Data Analytics in Smart Cities. *Procedia Computer Science*, *207*, 4123–4131. https://doi.org/10.1016/j.procs.2022.09.475
- Peralta Abadía, J. J., Walther, C., Osman, A., & Smarsly, K. (2022). A systematic survey of Internet of Things frameworks for smart city applications. *Sustainable Cities and Society*, *83*, 103949. https://doi.org/10.1016/j.scs.2022.103949

- Rejeb, A., Rejeb, K., Simske, S., Treiblmaier, H., & Zailani, S. (2022). The big picture on the internet of things and the smart city: A review of what we know and what we need to know. *Internet of Things*, *19*, 100565. https://doi.org/10.1016/j.iot.2022.100565
- Richter, M. A., Hagenmaier, M., Bandte, O., Parida, V., & Wincent, J. (2022). Smart cities, urban mobility and autonomous vehicles: How different cities needs different sustainable investment strategies. *Technological Forecasting and Social Change*, *184*, 121857. https://doi.org/10.1016/j.techfore.2022.121857
- Rp, J., K, R., A, A., & K, L. N. (2021). IoT in smart cities: A contemporary survey. *Global Transitions Proceedings*, *2*(2), 187–193. https://doi.org/10.1016/j.gltp.2021.08.069
- Sánchez-Corcuera, R., Nuñez-Marcos, A., Sesma-Solance, J., Bilbao-Jayo, A., Mulero, R., Zulaika, U., Azkune, G., & Almeida, A. (2019). Smart cities survey: Technologies, application domains and challenges for the cities of the future. *International Journal of Distributed Sensor Networks*, *15*(6), 1550147719853984. https://doi.org/10.1177/1550147719853984
- Sarker, I. H. (2022). Smart City Data Science: Towards data-driven smart cities with open research issues. *Internet of Things*, *19*, 100528. https://doi.org/10.1016/j.iot.2022.100528
- Secinaro, S., Brescia, V., Lanzalonga, F., & Santoro, G. (2022). Smart city reporting: A bibliometric and structured literature review analysis to identify technological opportunities and challenges for sustainable development. *Journal of Business Research*, *149*, 296–313. https://doi.org/10.1016/j.jbusres.2022.05.032
- Smart city. (2022). In *Wikipedia*. https://en.wikipedia.org/w/index.php?title=Smart_city&oldid=1122802302
- Tariq, N., Khan, F. A., & Asim, M. (2021). Security Challenges and Requirements for Smart Internet of Things Applications: A Comprehensive Analysis. *Procedia Computer Science*, *191*, 425–430. https://doi.org/10.1016/j.procs.2021.07.053
- Wazid, M., Das, A. K., Bhat K, V., & Vasilakos, A. V. (2020). LAM-CIoT: Lightweight authentication mechanism in cloud-based IoT environment. *Journal of Network and Computer Applications*, *150*, 102496. https://doi.org/10.1016/j.jnca.2019.102496