Role of Artificial Intelligence in Smart Cities for Information Gathering and Dissemination (A Review)

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Abstract

The rise in urban population and technological innovation has resulted in climatic, technological, and economic changes that can severely impact the value of life in cities. In reaction to the changes, the idea of smart cities has been developed, which refers to the novel application of information communication technology to minimize the severe impacts on the cities and their occupants. Artificial Intelligence is among the technologies being adopted to develop smart cities. Research shows that Artificial Intelligence (AI) is improving rapidly, and it plays a substantial role in helping intelligent city-wide systems in various domains. Thus, it is vital to decide the modern research advances to realize the role played by Artificial Intelligence in smart cities for intelligence gathering and dissemination. Also, there is a need to analyze the relationship between Artificial Intelligence and smart cities scientifically. To identify this relationship, this research paper will focus on the role of Artificial Intelligence, its applications, and the challenges associated with concepts and technologies identified as Artificial Intelligence in smart cities. Therefore, this research paper attempts to give insights into Artificial Intelligence's role in smart cities for intelligence gathering and dissemination.

Keywords: Urbanization, Smart City, AI, Risks and Legal Framework, Privacy and Remedies, DPR

1. Introduction

Cities are compound entities but are exposed to the necessities; they comprise individuals and communities associated with roads, spaces, and buildings in various contexts and settings. Cities are identified as smart cities with different sensors gathering data to obtain insight and employ the data to manage the objects that communities and human beings interact with efficiently (Nam and Pardo, 2011, p. 282). When items are identified as assets, asset management will be the primary benefit-appropriate management results in improved performance, reduced management cost, satisfied asset users, and improved sustainability. Smart cities are using Artificial Intelligence to gather intelligence in proactive management and job prioritization. In gathering intelligence, Artificial Intelligence allows collecting geospatial features to be employed in maps and GIS software in an automated manner. This research focuses on the role of artificial intelligence in smart cities for intelligence gathering and dissemination.

2. Research Background

The high rate of urbanization is associated with numerous challenges, such as the scramble for limited resources to meet the increasing human needs. The United Nations Department of Economics and Social Affairs report shows that more than 55 percent of the global population lives in urban centers. The percentage is expected to increase up to 68 percent by 2050 (d'Amour et al., 2017, p. 8939). Thus, the challenges associated with urbanization will continue to rise unless proper strategies are employed to address the challenges. Urbanization will increase due to the population increase in major cities and the rapid expansion of regional cities. In return, the rise in urbanization will result to pressure for a sustainable environment, where the population will need more and improved infrastructure on the little space available (Anser et al., 2020). Moreover, urbanization will result in a more affordable and better quality of life for city residents.

Smart cities are among the solutions established to address the rising challenges associated with urbanization. McKinsey conducted research that shows smart city technology will improve specific quality indicators of life by about 10-30 percent (Vuppalapati, 2019). Moreover, the study indicates that there will be a significant reduction in crime, reduced health weights, minimal commuting, and minimal carbon emissions.

Thus, a smart city is defined as a municipal region that depends on information and communication technologies to establish economic development, improve quality of life, and support governance systems (Kim et al., 2017).

For instance, municipal governance can link its transport and energy grid structures, establish sensor-equipped structures with efficient energy, and create communications that improve monitoring and accessibility to an emergency, healthcare, and various public services.

McKinsey's report identifies three stages that interlock to create an intelligent city function. The first stage is the technological foundation that comprises smartphones and devices equipped with sensors generating data and linking to high-speed communication systems (Viale et al., 2017, p. 526). The second stage is computers which process the information to create logical solutions for specific issues. The final layer is the overall public related to the identified technologies (Datta and Sharma, 2017, p.1). All the employment of smart city technologies relies on individuals regularly applying them and giving data to produce predictions.

Artificial Intelligence has played a significant part in the development of smart cities. For any city to work as a smart city, smart city technologies need a process of enormous volumes of data or Big Data. Big Data has explained the three "Vs." as high velocity, high volume, and high variety information composition (Al-Salim et al., 2017, p. 458). This implies that enormous data is generated rapidly via algorithms and the implementation of various data origins, such as varying data sets. There is a close relationship between Big Data and Artificial Intelligence. Artificial Intelligence is identified as the different approaches for employing non-human structures to study from experience and take after human intelligence conduct (Miller, 2019, p. 1). Artificial Intelligence can examine vast amounts of Big Data competently to establish forecasting and cost-effective remedies to drive innovative city technologies.

The nature in which Big Data and Artificial Intelligence work depends on if Artificial Intelligence is supervised or unsupervised. In supervising studying, datasets and figures are developed to train Artificial Intelligence connections to determine specific issues in the gathered raw data (Allam and Dhunny, 2019, p. 80). Artificial Intelligence will later carry out automated procedures and strategies while discovering new opportunities and probabilities that may offer improved results than the existing solutions. Berry et al. (2019) state that in unsupervised learning, non-identified and non-grouped datasets are employed to teach and ask queries of artificial intelligence systems, which the identified latent features and concealed configurations in the data.

Intelligence gathering in Artificial Intelligence is vital in the strategic planning of smart cities. Hassabis (2017) identifies Artificial Intelligence as a science of making machines smart,

where machines are taught to act and reason like human beings. Thus, artificial intelligence gathers intelligence by observing current trends in forecasting. Artificial intelligence can disseminate intelligence using the predictive model where the machines study and improve from their past predictions (Ben and Mellouli, 2019, p. 259). Moreover, intelligence dissemination can also be conducted through a prescriptive approach where the machine forecasts according to the available data and recommends the subsequent actions.

Use Cases of Artificial Intelligence in Smart Cities

Artificial intelligence is used in public transit in smart cities to improve transportation. Cities with numerous transport infrastructures and structures benefit from the implementations that will enhance the users' experience. In public transit, artificial intelligence gathers intelligence using real-time where buses, trains, and vehicles get real-time information via mobile applications (Voda and Radu, 2018, p. 118). The real-time information helps the users communicate about delays, breakdowns, and less congested paths to save time and make informed decisions. Such strategies encourage other users to modify their choices or travel paths to minimize future public transit congestions. Gathering and analyzing public transit application data helps smart cities to make informed decisions when changing public routes and their schedules (Navarathna and Malagi, 2018, p. 44). Thus, the users can effectively allocate more accurate infrastructure resources. Places such as Dubai have finished several innovative city projects. One of the projects is observing the condition of bus drivers, which has resulted in a 65 percent reduction in road accidents due to tiredness and fatigue.

Artificial intelligence is also used in public safety in smart cities. The networks and cameras installed to monitor public transport are being used to improve public safety by saving more lives and reducing the crime rate (Nambiar et al., 2018, p. 243). In smart cities, artificial intelligence gathers intelligence from traffic lights and congestion information, which the emergency services disseminate to arrive at their destinations faster and safer (Ciaburro and Iannace, 2020, p. 23). Moreover, smart cities can collect information on accidents or identify other factors to quantify, to establish predictive and protective strategies for the future.

Jung et al. (2013) state that automation systems are constructed using artificial intelligence in smart cities to collect and disseminate intelligence. In smart cities, sensors are installed in strategic structures to gather data on energy usage and forecast consumer behavior. The information will then be transferred to the relevant individuals, such as bodies controlling energy,

to make informed decisions based on consumer behavior. For instance, wholesalers and retailers use the intelligence from the data gathered by the sensors to identify peak seasons when their customers need more goods and services. Moreover, the data can help businesspeople to identify the most strategic locations to establish their business, where the public gravitates. Via the application of artificial intelligence, the data produced helps generate reliable predictions and trail daily, weekly, monthly, and seasonal variations (Baig et al., 2017, p. 3). Thus, the collected intelligence is disseminated to make consistent predictions.

According to Geisler (2013), Power grids are another field where artificial intelligence plays a vital part in smart cities for intelligence gathering and dissemination. Artificial intelligence and smart cities can ensure the safety of power grids and grow performance organizations. Smart grid, which includes power systems, such as production plants implanted with computer technology, can make smart meter appraisals of vast amounts of data to examine and forecast need replies and weigh clustering. Forecasting approaches can be developed on the smart grids to predict the price and demand for energy for an identified regular interval (Xiong et al., 2012, p. 2908). According to some research, the prediction models can exceed the existing models because they are more accurate in price and load prediction.

Legal Frameworks for Implementing Artificial Intelligence

According to Joshi et al. (2016), individuals dealing with the establishment of future smart cities technologies leveraging artificial intelligence structures, and national and local administrative firms generating the technologies for their regions, should assess how to circumnavigate the existing legal and regulatory principles guiding the establishment and implementation of artificial intelligence systems. The European Union identifies the primary advantage of establishing the artificial intelligence sector (Sajjad et al., 2020, p. 108). In February 2020, the union provided a white paper concerning artificial intelligence, European excellence, and the trust model. Artificial intelligence offered two chances and the likely need for a future regulatory guideline.

Cath et al. (2018) state that when identifying the capacity for artificial intelligence and public-private associations, in 2019, the government of the United Kingdom was the initial administration to examine the new group of artificial intelligence procurement principles established by the World Economic Forum. Even if the United Kingdom is the first government,

it is rapidly becoming increasingly vital for every state administration to have robust frameworks developed for the products being generated to be helpful to the citizens.

The implementation of artificial intelligence brings some legitimate concerns, such as data privacy dangers. The data administered by the systems comprises private data of employees and suppliers, such as facial identification and biometric structures for observing and security reasons. In the European Union, the General Data Protection Regulation is used together with local privacy regulations in every jurisdiction, for example, the Data Protection Act 2018 in the United Kingdom (Cornock, 2018 p. A1). Otherwise, they may comprise the inherent risks of creating and using an artificial intelligence system. According to research, there are no unique European Union-wide laws that govern artificial intelligence (England, 2013). Nevertheless, the European Commission developed the High-Level Expert Group on Artificial Intelligence and established its Ethics Guidelines for Trustworthy Artificial Intelligence in April 2019. The established guidelines state that artificial intelligence structures should be legal, strong, and ethical to fulfill the seven vital requirements to be perceived as trustworthy. Fig 1 represents the life cycle of a sustainable smart city empowered by technologies.
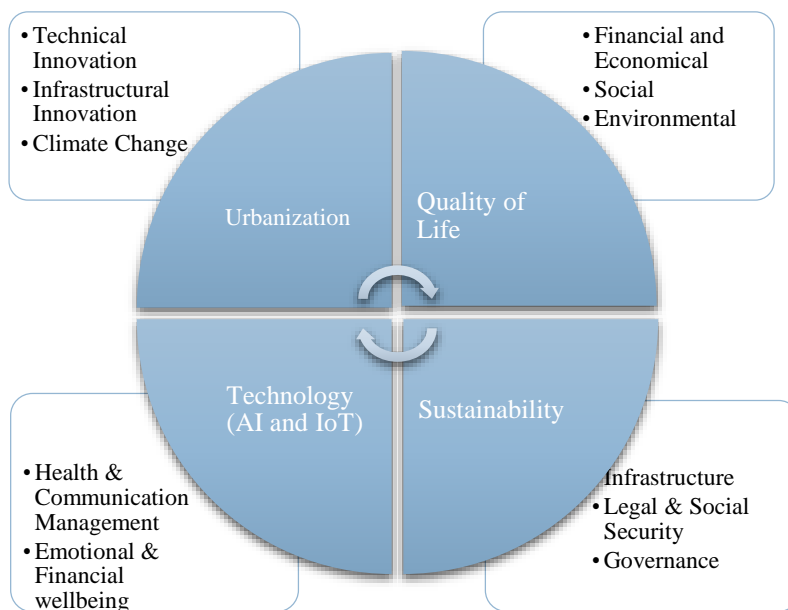
Fig 1: Life cycle of sustainable smart cities

Additionally, the tasks have been executed on developing mechanisms to employ the Ethics Guidelines for Trustworthy Artificial Intelligence. A recently published report by the artificial intelligence sector and academics offers suggestions on how to advance the auditing of assertions concerning items promoted by the artificial intelligence industry (Thiebes et al., 2020, p. 1).

In 2020, the Information Commissioner's Office released guidance for firms that want to implement artificial intelligence systems. The guidance included directions for describing the decisions taken with artificial intelligence and guideline for auditing artificial intelligence (Buruk et al., 2020, p. 387). The principles are considered by the Information Commissioner's Office in implementing enforcement strategies where private data is dealt with, for example, the introduction of fines under the General Data Protection Regulation.

Risks in Executing Artificial Intelligence

There are both technical and non-technical risks associated with the implementation of AI in smart cities (Al Sharif & Pokharel, 2021). In smart cities, artificial intelligence can process private data such as issuing and observing the application of power in a residential area. Personal data can also be processed by overseeing the locomotion and providing applicable adverts founded on geo-location to prospective customers within the urban residence (Scherer, 2015, p. 353).
Artificial intelligence in smart cities may comprise facial identification to trail and observe individuals motioning around a public area for protection and personalization (Verghese et al., 2018, p. 19). There are several extra challenges around privacy and data protection when artificial intelligence handles private data. The fig 2 below details about a model for risk acescent and resolution tool in smart cities.

Smart City Dimensions

Risk Type
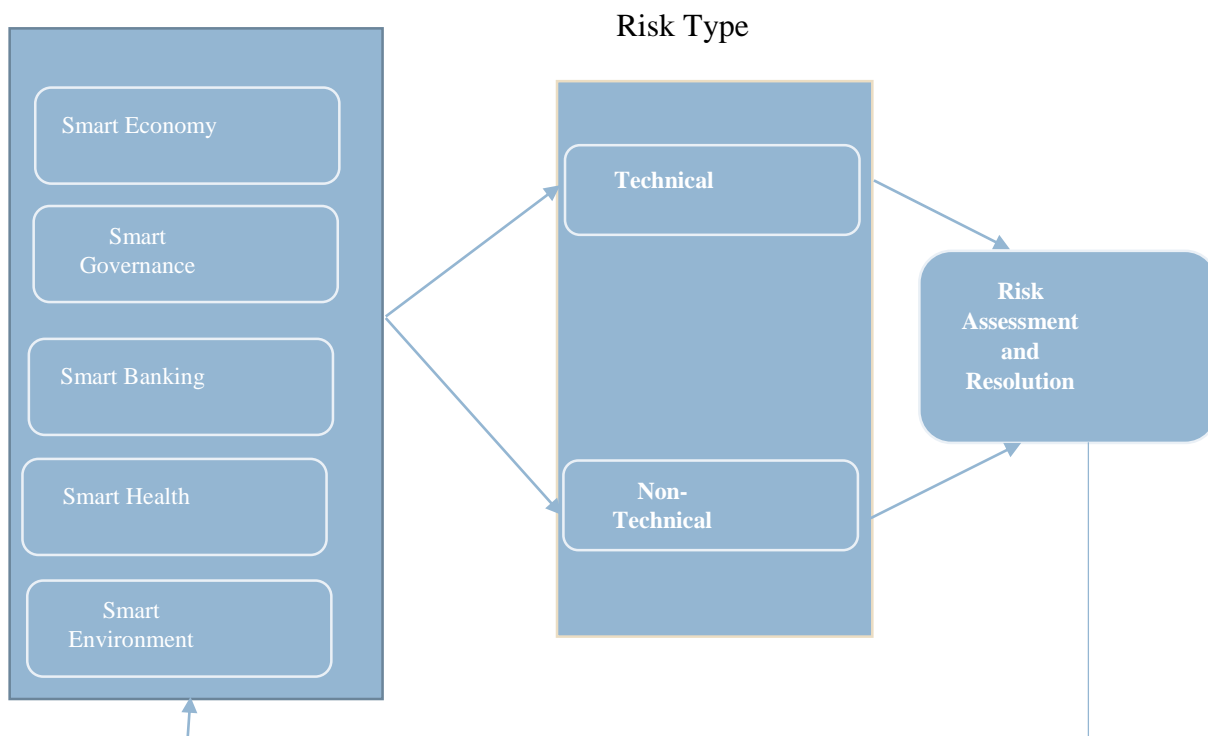
Fig 2: Risk acescent and resolution tool in smart cities

Yu (2020) identifies that there are other challenges concerning the equality and consistency of the algorithm. For instance, when facial identification technology is implemented for policing and public protection, it is expected that data groups for training the technology have an adequately broad range of various demographics symbolized within it. Thus, the facial recognition technology would accurately recognize individuals of various ethnic and racial origins instead of a specific ethnic group. The buyers of such technologies should attempt to identify how the technology developers adopted measures to ensure that the artificial intelligence evaded developing or cementing unequal bias during system development. For example, if the algorithm were developed with the data group, it would naturally process such individuals from the different metropolis, and if the procedures were established to examine possible bias (Villasenor and Foggo, 2020, p. 295). There should be control measures to ensure that the implementation users can identify any likely inequality. Such biases include discrimination, bias, or poor system performance.

Fulfilling transparency needs is a significant issue in smart cities. Specifically, it is crucial to communicate competently with the residents of a specific state, motioning around a smart city while relating with artificial systems (Malgieri and Comande, 2017). The transparency that needs to be stated in Articles 13 and 14 of the General Data Protection Regulation can be burdensome and are not essentially logical in an urban environment, even with the vast symbols (Hoofnagle et al., 2019, p. 65). Thus, it is highly recommended to establish signage that can comprise the application of regularly identified signs and QR codes, permitting people to get complete information available on the internet.

Another challenge is that of developing suitable human oversight measures. For the individuals involved in purchasing artificial intelligence systems, it is vital to consider the necessary stage of human regulation for the specific smart city infrastructure (Srivastava et al., 2017p. 130). Particular approaches should be embraced. However, the issue is the volume and velocity of data going via the Big Data structures and when human oversight can genuinely be generated. It is essential to have a strategy in place to enhance the system's suitability in every situation. A crucial point in the progressive implementation of sensor-equipped Internet of Things and different smart city technologies is if a smart traffic light or smart meter has been automatically prepared with a link to the free internet (Patel and

Doshi, 2019, p. 692). Such measures will bring out the risk outline of the system. If that is the case, the overall cybersecurity appropriate procedure will be more relevant. For example, if the technology can be installed with firewalls or antivirus software, password sanitation, and accessibility of security updating.

Remedies for Implementing Artificial Intelligence

While there are numerous risks associated with implementing new technologies such as artificial intelligence, the benefits imply that the creator and buyer of smart city technologies will require comprehending how to address the risks. Managing the risks will result in improved application and understanding of the intelligence gathered. When private data is involved in the artificial intelligence systems, administrations such as local and national governments and various system purchasers, identified as data controllers, should follow the overreaching responsibility guideline under the General Data Protection Regulation (Yigitcanlar et al., 2020, p. 1473). Thus, there will be practical data governance and executing security by intention and default when employing instruments to develop data or run artificial intelligence algorithms according to Article 5 of the General Data Protection Regulation (DPR rules).

Smart Cities and Overcoming the Privacy and AI Hurdles

There are vital factors that should be considered to overcome smart cities' privacy and artificial intelligence hurdles. The first factor is the Data Protection Impact Assessment. The application of new technologies and the improved data group processing using artificial intelligence can activate the need to carry out a Data Protection Impact Assessment (Brauni et al., 2018, p. 499). While relating, integrating, or matching data from numerous sources, the relevant bodies identify Data Protection Impact Assessments as a vital factor to consider. Application of innovative technology or generating biometric or generic information when combined with another activate from the guidelines on Data Protection Impact Assessments such as systematic monitoring also makes an organization in smart cities conduct an assessment. An improved Data Protection Impact Assessment is highly recommended to examine specific features of artificial intelligence such as firmness, efficiency, transparency, bias minimization, and liability. On the other hand, in massive region projects,

It is suggested that a Fundamental Rights Impact Assessment and Equality Impact Assessment dealing with practical stakeholders such as the public individuals who are likely to be impacted by the project should be conducted in advance.

Privacy and artificial intelligence hurdles can also be overcome by ensuring transparency. To deal with the need in GDPR for legal, equal, and transparent dispensation and transparency apprehensions in the Ethics Guidelines for Trustworthy Artificial Intelligence, the institutions wanting to deploy artificial intelligence in smart city technologies should follow transparency responsibilities keenly (Yanisky-Ravid and Hallisey, 2019 p. 428). Thus, organizations may need to create a layered model such as symbols and marks around the urban region. To attain an enhanced transparency level, transparency can also be enhanced by revising existing administrative privacy notices. The clarity should be centered on a lawful basis for processing, such as public interest.

Effective adoption and implementation of internal policies help organizations in smart cities demonstrate their accountability with the GDPR. There is a need to establish rules and responsibilities regarding the description of artificial intelligence facilitated decisions to people (Kumar, 2015, p.1). Privacy should be enhanced by default or design in smart cities during the implementation of artificial intelligence to ensure that institutions are sailing towards good data administration. Artificial intelligence execution techniques include data minimization approaches to guarantee that only the relevant data is gathered, processed, and maintained by the system for intelligence according to the identified purpose. Another technique is purpose limitation measures like separating data groups to guarantee the datasets are applied in their intended purpose. The final technique of implementing artificial intelligence is security methods such as pseudonymization or anonymization of probable information and the execution of access controls, encryption, and audit logs.

Completely automated decision-making helps the organizations in smart cities to overcome the hurdles. Suppose the artificial intelligence generates private data and is implemented for the application in automated decision-making comprising profiling without any substantial human participation in the decision-making process. In that case, it may lead to a legal or similarly significant impact on the person (Gassmann et al., 2019).

Such impacts include ranking emergency services requests in a smart city founded on data associated with residents making emergency pleas, which will be consequential according to article 22 of GDPR. The organizations in intelligent towns should have the correct legal basis to implement completely automated decision-making. Moreover, the organizations should ensure appropriate guidelines, such as the right to appeal against the decision of an individual decision-maker.

What makes Smart Cities Smart?

Smart cities have unique features that differentiate them from other cities. Smart cities use artificial intelligence-powered technology to achieve is goals and make them stand out among other cities (Jucevicius et al., 2014, p. 146). Some of the components that make smart cities smart are innovative traffic supervision, smart parking, smart waste management, smart policing, smart lighting, and smart authority. Artificial intelligence works closely with the Internet of Things to develop smart traffic remedies to improve the smart city's efficiency and speed of movement.

Smart parking is another feature that distinguishes smart cities from other cities. Due to the increased population, it is becoming difficult for individuals to find a parking lot because most people own cars. However, artificial intelligence helps smart cities install sensors that help individuals identify if there is a free parking slot around them (Grodi et al., 2016, p. 1). Thus, individuals in smart cities save time and minimize congestion and pollution within the city. Smart cities have smart waste management systems where waste is regularly collected and disposed of at the appropriate place. Proper waste management raises the urban population's need to embrace modern waste management methods (Rohit et al., 2018, p. 1). Artificial intelligence helps recycle some wastes while effectively disposing of the wastes that cannot be reused by providing a sustainable waste management system. For instance, Barcelona has a waste management system that has installed sensors on waste bins which informs the relevant authorities that it is time to collect the waste when the containers are almost filled.

Innovative policing in smart cities helps minimize the increasing crime rates in the modern world. Law enforcement agencies use evidence-based data-directed measures, which are economical, efficient, and practical, to capture crime. Singapore is among the smart cities using smart policing,

Where cameras and sensors are installed in numerous places to identify individuals engaging in illegal activities such as smoking in public (Yuen, 2018, p. 349). Street lighting is vital in smart cities, although they are uneconomical because they consume more energies. Thus, smart cities are shifting to using smart lighting, which is more economical (Coldren et al., 2013, p. 275). With proper lighting, individuals in smart cities can effectively run their businesses even at night to meet their expectations. Smart governance makes smart cities a conducive place for their inhabitants. Smart cities' artificial intelligence improves the decision-making process by working closely with the relevant stakeholders, such as the administration and the citizens.

Smart cities should have high livability to provide conducive living conditions for the residents. Moreover, the city will have minimal pollution, low congestion, and easily accessible services. Smart city infrastructure and artificial intelligence technology, which share the same goal of improving the living conditions in intelligent cities, work closely to achieve this goal. Thus, the cities become more competitive and sustainable. Artificial intelligence is implemented in the cities to widen the streets to reduce congestion (Marsal-Llacuna et al., 2015, p. 611). Artificial intelligence enables computers and machines to move, listen, see, and think like humans. Moreover, the technology allows efficient monitoring of smart cities to ensure they function as expected. Most urban planners are using artificial intelligence because it is a high-quality technology.

Workability is another feature associated with smart cities. With the help of artificial intelligence, smart cities are providing improved infrastructures to enable their residents to be internationally competitive in the job market (Zealand, 2018, p. 80). For example, Vienna's administration is using WienBot artificial intelligence to provide customized digital services to its citizens to improve the workability of the smart city. Smart cities should be sustainable even for future generations. Although most environmentalists and other counterarguments maintain that urbanization is not good, numerous benefits are ripped from urbanization. Such benefits include better educational opportunities, improved healthcare, and better infrastructure and services. The current initiatives are being implemented in smart cities while accounting for their future implications by ensuring they are sustainable. Artificial intelligence provides intelligent insights to urban planners to help them allocate resources more efficiently, using the available resource effectively.

Research conducted by McKinsey Global Institute found that the use of artificial intelligence in smart cities will help to minimize emissions by 15 percent, reduce water consumption by 30 percent, and reduce the average commuting time by 20 percent, to make the cities more sustainable (Batagan, 2011 p. 80).

Moreover, the individual in intelligent cities have equal access to quality learning opportunities in different learning settings. Learning settings embraced in smart cities include schools, families, workplaces, and public places. This is achievable because artificial intelligence supports all aspects of life, such as learning.

Challenges and Benefits of Artificial Intelligence in Smart Cities

Currently, most cities are changing their usual way of operation by implementing artificial intelligence. The cities change their method of operation, delivery, and maintaining social amenities. Nevertheless, the implementation of artificial intelligence n smart cities is challenged by deploying a technology that does not work competently or fails to align with other services in the smart city (Qureshi et al., 2020, p. 1). Thus, before implementing artificial intelligence, it is vital to consider if the technology will effectively work in the city it is being implemented. Additionally, it is essential to note that artificial intelligence is not a stand-alone technology because it collaborates with other technologies to be effective. Thus, for the urban regions to benefit from the advantages offered by smart cities, they should identify the technologies that complement artificial intelligence.

3. Recommendations and Conclusion

This research paper indicates that smart cities need to embrace artificial intelligence technology to improve their performance. Apart from embracing artificial intelligence, smart cities should adopt strategies to accommodate the technology within the numerous functions to develop a municipality. Such measures will ensure that the concept of smart cities is recognized and adopted in most parts of the world.

Conclusively, the development of intelligent cities is promising to improve the standard way of life in urban centers within the public sector and the private sector. However, developing smart cities needs careful consideration of the technology to enhance their sustainability. Artificial intelligence plays a vital role in smart cities by ensuring improved security, smart policing, proper waste management, efficient energy use, and smart parking.

AI collects intelligence in data using installed cameras and IoT-enabled sensors. The intellect is then disseminated to the relevant bodies to make informed decisions. Although urbanization is viewed as wrong by some environmentalists, AI in urbanization makes it more beneficial.

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