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Digital Twins: Current problems in Smart City and Recommendations for future technology

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Abstract - *Digital twins are virtual replicas of physical devices that data scientists and IT pros can use to run simulations before actual devices are built and deployed. They are also changing how technologies such as IoT, AI and analytics are optimized. This technology can identify a problem or error before its occurrence while working with the machines or systems and it has the potential to predict the outcome for the future. Therefore in this paper, we focus on digital twin technologies to overcome the problems associated with current implementation technologies, and we will give recommendations based on the loopholes to be utilized in future technologies.*

Key Words: **Smart city, Digital Twins, IoT, AI, Robotics, Big Data.**

1. INTRODUCTION

1.1. Introduction of technologies

Digital twins can be a physical asset, process, people, place, system and device used for a various purpose[1].It collects data to represent real-time information. Information is further shared between partners andconnecting device[1]. The digital twin is constantly trained based on new and historical data. The new technology named digital twins can create virtual models of objects, processes and large systems[1]. Scientists believe that the digital twin of a human will also appear soon. It may sound daunting, but digital twin technology examples are already in practice in manufacturing and some other sectors[1]. A digital twin is a virtual model of a real product, process or service that can monitor, analyze and improve its performance[3]. The model is created using computer-aided engineering and is integrated with the IoT, artificial intelligence, robotics and Big Data[3]. A virtual prototype of an object is “live” and dynamic, meaning that it is updated every time its physical twin changes [3]. It is also able to learn, absorbing the knowledge from people, machines and the environment it exists in. IoT technology is making it easier for buildings with legacy infrastructure to save energy and improve their sustainability[3]. Smart building energy management systems, for instance, use IoT devices to connect disparate, nonstandard heating, cooling, lighting, and fire-safety systems to a central management application[3]. A Smart City will have Digital Twin applications in many areas including but not limited to transportation, logistics, energy and power, communications, and healthcare[2]. The primary goal of Digital Twin application in smart cities will be to improve the efficiency of systems and subsequently sustainability of such systems[2]. For instance, concerning the transportation and logistics perspective, the focus will be on improving the performance in terms of enhancing energy consumption and reducing harmful emissions e.g. carbon footprint reduction[2].

1.2. Digital Twin Applications

The next subsection of this review focus on the areas discussed above - IoT, Big Data, AI, Robotics and Digital Twins, firstly, looking at the potential applications of each topic, the review will look at some of the current challenges. This section identifies some of the potential applications for this technology[4]. For the moment the term and concept of a Digital Twin are growing across academia, and the advancements in IoT and AI are enabling this growth to increase[4]. At this stage, the main areas are Smart City, Manufacturing, healthcare is discussed below:

1.2.1. Smart City

The use and the potential for Digital Twins to be dramatically effective within a smart city is increasing year on year because of the fast developments in connectivity through IoT[4].With an increasing number of smart cities developed, the more connected communities are, with this comes more Digital Twins use[4]. Not only this, the more data we gather from IoT sensors embedded into our core services within a city, but it will also make an easier way for researcher aimed at the creation of advanced AI algorithms[4]. As we know, the benefit of a smart city is the elements of advanced connectivity[4]. This greater connectivity affects some of the core services within a city that would normally be unused natural data. Example, The traffic management systems, traffic cameras that are just recording, these could be used to create traffic management models to reduce traffic congestion and overall export within a road network[4].

- Buildings
- Roads
- Logistics
- Public Services
- Power Grid
- People

The ability for these services and infrastructures to have sensors and to be monitored with IoT devices is of great value for all kinds of future proofing[4]. It can be used to help in the planning and development of current smart

cities and help with the ongoing developments of other smart cities. As well as the benefits of planning, there are also benefits within the energy-saving world. This data gives an excellent insight into how our utilities are being distributed and used. Advancement for the smart city is the potential to utilise Digital Twin technology[4]. It can facilitate growth by being able to create a living testbed with a virtual twin to one test scenarios, two it allows for the Digital Twin to learn from its environment analysing changes in data collected. The data collected can be used for data analytics and monitoring. The scope for Digital Twins is becoming more viable as the development of smart cities increases connectivity and the amount of us able data[4].

1.2.2. Manufacturing

The next identified application and most popular setting for Digital Twin is within a manufacturing setting[4]. The biggest reason for this is that manufacturers are always looking for a way in which their products can be easily tracked and monitored in such a way to save time and money, a key driver and motivation for any manufacturer hence why Digital Twins look to be making the most significant impact within this setting. Likewise, with the development of a smart city, connectivity is one of the biggest drivers for manufacturing to utilise Digital Twins[4].

The Digital Twin has the potentiality to give real-time status on machines performance as well as production line feedback[4]. It can predict the issues sooner. Greater connectivity ensures machine performance. AI algorithms and the Digital Twin has the potentiality for greater accuracy as the machine can hold a large amount of data, required for performance and prediction analysis[4]. The Digital Twin is creating a virtual environment to test products as well as a system that acts on real-time data, within a manufacturing setting this has the potential to be a hugely valuable asset[4].

Another application of Digital Twins is in the automotive industry, most notably demonstrated by Tesla[4].The ability to have a Digital Twin of an engine or car part can be valuable in terms of using the twin for simulation and data analytics [4]. AI improves the accuracy of testing as it can perform data analytics on live vehicle data to predict the current and future performance of components[4].

The technology cannot only be applied in the development of smart city buildings or structures but also as an ongoing real-time prediction and monitoring tool[4]. The use of the Digital Twin and data analytics will potentially provide greater accuracy when predicting and maintaining buildings and structures with any changes made virtually then applied physically[4]. The Digital Twin gives construction teams greater accuracy when carrying out simulations as the algorithms can be applied in-time within the Digital Twin before the physical building[4].

A common goal seen so far across the field of Digital Twins is this idea of real-time simulation as opposed to low detailed static blueprint models[4]. The use of these models serve a purpose, but they are not using real- time parameters which limits the predictability and learnability. The Digital Twin can be learning and monitoring simultaneously, as well as applying machine and deep learning algorithms[4].

1.2.3. Healthcare

Similarly, with the smart city and manufacturing concept for Digital Twin applications. The growth and development enabling technology are having on healthcare is unprecedented as the once impossible is becoming possible[4]. On an IoT front the devices are cheaper and easier to implement, hence the rise in connectivity. The increased connectivity is only growing the potential application of Digital Twins use within the healthcare sector. One future application being a Digital Twin of a human, giving a real-time analysis of the body[4]. A more realistic current application is a Digital Twin used for simulating the effects of certain drugs. Another application sees the use of a Digital Twin for planning and performing surgical procedures[4].
Likewise with other applications within a healthcare setting the use of a Digital Twin gives researchers, doctors, hospitals or healthcare providers the ability to simulate environments specific to their needs whether it be real-time or looking to future developments and uses[4]. As well as this, the Digital Twin can be used simultaneously with AI algorithms to make smarter predictions and decisions[4]. Just as many applications within healthcare do not directly include the patient but are beneficial for the ongoing care and treatment. Digital Twin for healthcare is in its infancy, but the potential is vast from using it for bed management to large scale wards and hospital management[4].

Having the ability to simulate and act in real-time is even more paramount within healthcare as it can be the difference between life or death[4]. The Digital Twin could also assist with predictive maintenance and ongoing repair of medical equipment. The Digital Twin within the medical environment has the potential along with AI to make life-saving decisions based on real-time and historical data[4].

Some applications of a Digital Twin are identified here, showing some of the cross overs in the intended use demonstrating how predictive maintenance is adaptable from manufacturing plant machines to healthcare patient care[4]. It also shows some of the applications where they do not cross over, and Digital Twin use is specific to its intended use[4]. The advancements in AI, IoT and Industry 4.0 have facilitated the growth in Digital Twin applications[4].

2. INTRODUCTION TO TECHNOLOGIES

2.1. AI

"Artificial intelligence (AI), the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings[5]."Artificial Intelligence is a branch of Science which deals with helping, machines find solutions to complex problems in a more human-like fashion. This generally involves borrowing characteristics from human intelligence and applying them as algorithms in a computer- friendly way[5]. A more or less flexible or efficient approach can be taken depending on the requirements established, which influences how artificial intelligent behaviour appears[5].AI research development, and systems design, as well as programs and policies to help ensure that these systems broadly benefit individuals and society[5]. One of the most promising applications of AI has been its rigorous use on the Internet such as in search engines. Although the efficacies of AI are significant, as with any application they are limited in both capability and functionality[6].In an organization in which human intelligence is tied to a particular person or a group of people, AI applications can provide permanency that prevents the knowledge from being lost when the individual or the group members retire or are no longer available to the organization[6]. The life of the knowledge encapsulated in an AI framework could be as long as the relevance of the problems and decision scenarios remain unchanged. AI also enables the development of a learning capability which can be utilized to further prolong the life and relevance of the application[6]. Learning from real-world success and failure is an enabling feature of AI tools known as "reinforcement learning" and is advantageous in that it increases the reliability of the tools with their increased use in applications[6]. The broad application of any tool only occurs when its reliability has been established, and AI has already proven to be quite reliable in many different applications because of its ability to simulate human intelligence in a reasoning process[6]. Like many automatics, AI supports cost minimization as it enables reduction of the need for personnel time[6]. An agency can reduce significant staff time by adopting appropriate AI applications in the decision-making process, thus reducing operational costs[6].

2.2. IoT

Due to the rapid growth of the population density in urban cities, infrastructure and services are required to provide the necessities of the city residents. On this basis, there is a significant increase for digital devices, e.g. sensors, actuators, and smartphones that drive to huge business potentials for the IoT, since all devices can interconnect and communicate with each other on the Internet [7]. The IoT prototype is subject to smart and self-configuring objects that are connected to each other through a global network infrastructure. IoT is mostly considered as real objects, broadly scattered, with low storage capability and processing capacity, with the target of improving reliability, performance and security of the smart city and its infrastructures [7]. With this knowledge, in this article, a review of the IoT based smart city is carried out[7].Smart cities have become smarter than before thanks to the recent developments of digital technologies[7]. A smart city is equipped with different electronic elements employed by several applications, like street cameras for observation systems, sensors for transportation systems, etc[7]. In addition, this can spread the usage of individual mobile devices. Therefore, by considering the heterogeneous environment, different terms, such as features of objects, contributors, motivations and security rules should be investigated[7]. Reference introduced some of the main aspects of a smart city in 2020[7].The objective of IoT is Anything, Anyone, Anytime, Anyplace, Any service and any network[8].

2.3. Big Data

The word "Big Data" has become a buzzword[9]. It is being used by almost everyone including academicians and industry experts[9]. There are various definitions available in the literature. With the digitization of most of the processes, the emergence of different social network platforms, blogs, deployment of different kind of sensors, adoption of hand-held digital devices, wearable devices and explosion in the usage of the Internet, a huge amount of data are being generated continuously [9]. No one can deny that the Internet has changed the way businesses operate, the functioning of the government, education and lifestyle of people around the world[9]. Today, this trend is in a transformative stage, where the rate of data generation is very high and the type of data being generated surpasses the capability of existing data storage techniques[9]. It cannot be denied that these data carry a lot more information than ever before due to the emergence and adoption of the Internet[9].

2.4. Robotics

In the last decade, the robotics industry has created millions of additional jobs led by consumer electronics and the electric vehicle industry, and by 2020, robotics will be a $100 billion worth industry, as big as the tourism industry[11]. For example, the reformation of robot market has grown 10 times between 2010 and 2016, thanks to advancements in restore/therapy robots, active artificial body part, strict external covering for the body, and wearable robotics[11]. In short, the very next decade robotics will become vital components in several applications and robots paired with AI will be able to perform complex actions that are capable of learning from humans, driving the intelligent automation phenomenon[11].The impact of robotics on employment goes far deeper than just job creation[10]. Robotics, are

focus on technologies that demand an extensive understanding of every associated parameter[10].The impact of robotics on employment opportunities have always been a topic of much speculation. When it comes to organising and manipulating data, processing complex mathematical problems, and executing tasks in the blink of an eye, robotics are the most preferred choice[10]. As a result, robotics has penetrated almost every industry, from construction, transport, and manufacturing to business intelligence, education, and healthcare[10]. It is, therefore, not surprising that many silicon valley figures, including Facebook CEO Mark Zuckerberg, believe that not only can robotics support and enhance existing jobs, but it can also create new roles[10]. A report generated by Gartner suggests that by 2020, robotics would generate an estimated 2.3 million jobs[10]. This figure was calculated by taking into account the 1.8 million jobs made simpler by automation. However, like any other technology, when it comes to domain skills, robotics also require dedicated training courses[10].

3. PAPER SELECTION

To select the relevant paper, based on our area of interest, we followed a paper selection process. We first formulated keywords. These keywords are based on the main terms in our area of interest. We use two types of keywords:
1) General keywords
2) Domain-specific keywords

The general keywords are those keywords which are used in a universal context, i.e. technologies, present technology, technology in the industry, advantage, disadvantage of current technology. The domain-specific keywords consist of all those keywords which are specific to our area of interest(domain-specific) i.e. Smart city, Digital Twins, IoT, AI, Robotics, Big Data. To further search the papers based on our keywords, we have used two digital libraries:
1) Google Scholar
2) IEEE Explore

By following this paper we got a lot of papers. To further select the final set of papers we read the abstract of all papers and based on the information given in the abstract we selected our set of paper .only those paper were selected whose abstract show some relevant to our work.

4. LITERATURE REVIEW

To summarize existing finding in this field of study, special focus has been placed on technology like IoT, Big data, Robotics, Artificial Intelligence and its loopholes are to be compared. Loopholes of below technologies are to be overcome using Digital Twins Technology.

Robotics, design, construction, and use of machines (robots) to perform tasks done traditionally by human beings[12]. Robots are widely used in such industries as automobile manufacture to perform simple repetitive tasks, and in industries where work must be performed in environments hazardous to humans[12]. Many aspects of robotics involve Artificial Intelligent; robots may be equipped with the equivalent of human senses such as vision, touch, and the ability to sense temperature. Some are even capable of simple decision making, and current robotics research is geared toward devising robots with a degree of self-sufficiency that will permit mobility and decision-making in an unstructured environment[12]. Today's industrial robots do not resemble human beings; a robot in human form is called an android[12].

The integration of robotics aims to improve city operations, such as using drones for postal services, some call it the Fourth Industrial Revolution. We are in the starting age of automation technology, powered by software robots and artificial intelligence (AI)[13]. Today robotics are everywhere from agriculture to space, collaborating and collectively working hand in hand with human workers[13]. It's estimated that 1.3 million industrial robots will arrive in factories by 2018, and the international market value for robotics is now $32 billion[13]. According to a recent survey the industrial robots that are working on assembly lines, which are capable of putting together everything from a television circuit board to a Volkswagen[13]. Following are the limitations of Robotics:

- Robotics technology is very expensive because all people cant afford domestic robots. Robots have limited capability.
- Robots can eliminate many jobs, being replaced by industrial robots.
- Robots can be dangerous.
- Robots can displace human labour.
- They generate an important technological backwardness(slowness).
- They can be hacked by someone to change particular tasks.
- As robots are considered as software, it requires constant updates (maintenance).
- Performing system of the robot requires a lot of time and money.
- Create machines that are self-sufficient and can displace the human race.
- Man feels less important when a machine or system "overcomes" it.

This is the discussion about big data technology, the South Korean city of Songdo is an appropriate example of how big data has changed it[14]. Songdo is located just 40 miles from Seoul and 7 miles from the Incheon International Airport. Songdo has 1500 acres of land reclaimed from the city and 40% of its area is earmarked as open area[14]. Although we hear a lot about smart cities these days, the vision of building Songdo into a completely connected city started getting implemented way back in 2000 with a projected cost of $35 billion. Now, in 2015, Songdo is at the threshold of realizing that vision[14]. Cisco has been

working on the project and it is making sure that every inch of the city is wired with fibre optic broadband. So, Songdo, the smart city, is going to massively impact the lives of its 65,000 residents and the 300,000 who will commute daily to Songdo[14]. Given below are some ways this smart city is going to behave[14]. Some of the limitations are overcome in Big Data: following are the limitations of Big Data:

- Traditional storage can cost a lot of money to store big data.
- Lots of big data is unstructured.
- Big data analysis violates the principles of privacy.
- It can be used for manipulation of customer records.
- It may increase social stratification.
- Big data analysis is not useful in the short run. It needs to be analyzed for a longer duration to leverage its benefits.
- Big data analysis results are misleading sometimes.
- Speedy updates in big data can mismatch real figures.

Now Artificial intelligence technology is discussed according to the data published by the UN, the world population will reach up to a limit of 9.7 billion by the end of 2050[15]. It is deduced that almost 70% of that population will be an urban population with many cities accommodating over 10m inhabitants[15]. As the number grows, we'll have to encounter challenges regarding making a provision for resources and energy to all of the inhabitants and at the same time, avoiding environment deterioration[15]. Another critical challenge is administration and management to prevent sanitation issues, mitigate traffic
congestion, thwart crime, etc[15]. But many of these problems can be tamed by the use of AI-enabled IoT[15]. Using technological advancement to facilitate the new experience for inhabitants can make their day-to-day living more comfortable and secure. This has given rise to the concept of smart cities[15]. A smart city is a city that makes use of information and technologies to enhance the quality and performance of urban services (like energy and transportation), thereby reduces the consumption of resources, prevents wastage, and overall costs[15]. Smart cities not only possess ICT but also employ technology in a way that positively impacts the inhabitants[15].some of the limitations are overcome in AI: following are the limitations of AI:

- Rapid advances in AI could lead to massive structural unemployment.
- Unpredictable and unseen impacts of new features.
- An expert system or rule-based approach is not optimal for all problems, and considerable knowledge is required to apply in any of the systems.
- Ease of rule creation and rule modification can be double-edged. A system can be sabotaged by a non-knowledgeable user who can easily add worthless rules or rules that conflict with existing ones.
- Reasons for the failure of many systems include the absence of (or neglect to employ diligently) facilities for system audit, detection of possible conflict, and rule lifecycle management (e.g. version control, or thorough testing before deployment). The problems to be addressed here are as much technological as organizational.

The Internet-of-Things (IoT) is a revolutionary communication paradigm which aims to bring forth an invisible and innovative framework to connect a large number of digital devices with the Internet[16]. Thus, it intends to make the Internet more immersive and universal [16]. The emerging IoT market is continuously gaining momentum as operators, vendors, manufacturers, and enterprises begin to recognize the opportunities it offers[16]. According to the latest, Interactive Data Corporation(IDC) forecast the worldwide IoT market will reach to 1.7 trillion in 2020 up from 655.8 billion United State Dollar(USD) in 2014 with a compound annual growth rate of 16.9%. The devices alone are expected to represent 31.8% of the total worldwide IoT market in 2020.This greater percentage of the revenue in 2020 is expected by building IoT platforms, application software, and service-related offerings[16]. A smart city is a complex ecosystem characterized by the intensive use of ICT, aiming at making the cities more attractive, more sustainable and a unique place for innovation and entrepreneurship [16]. The major stakeholders include application developers, service providers, citizens, government and public service providers, research community, and platform developers[16]. Furthermore, the smart city acycle consists of numerous ICT technologies, development platforms, maintenance and sustainability, Apps for evolving citizens, and technical, social as well as economic key performance indicators (KPIs)[16]. Consequently, IoT systems will play a fundamental role in the deployment of large scale heterogeneous infrastructures. Following are the limitations of iot:

- Compatibility: As of now, there is no standard for tagging and monitoring with sensors. A uniform concept like the USB or Bluetooth is required which should not be that difficult to do.
- Complexity: There are several opportunities for failure with complex systems. For example, both you and your spouse may receive messages that the milk is over and both of you may end up buying the same. That leaves you with double the quantity required. Or there is a software bug causing the printer to order ink multiple times when it requires a single cartridge.
- Privacy/Security: Privacy is a big issue with IoT. All the data must be encrypted so that data about your financial status or how much milk you consume isn't common knowledge at the workplace or with your friends.
- Safety: There is a chance that the software can be hacked and your personal information misused. The possibilities are endless. Your prescription

being changed or your account details being hacked could put you at risk. Hence, all the safety risks become the consumer's responsibility.

Table 4.1: Table showing related work of IOT, Big data, AI, Robotics

Paper Title	Authors	Descriptions	Results	Drawbacks/Limitation
1)"Robotics: The Pros, the Cons and the Results"	Perficient Author	-This paper focuses on the advantages and disadvantages of Robotics and Prevent the Solution.	-In this paper author has discussed the opportunities with robotics are immense and as and when robotics technology will come it will be dangerous for humans.	• Resources • Unemployment concerns. • Up-front • investment. • Rigidity. • Predefined programming.
2)"Big Data: Challenges, Opportunities ,and Realities"	Abhay Kumar Bhadani, Dhanya Jothimani	-This paper focuses on presenting an overview of big data analytics, its application, advantages, and limitations. Few research issues and future directions are presented in this chapter.	-In this paper, the author has discussed an overview of big data, processed involved in big data analytics and discussed various tools and techniques to process big data.	• Scalability and Storage Issues. • Timeliness of Analysis. • Privacy and Security. • Not always better data. • Data errors.
3)"AI Advantages and disadvantages" "Advantages and Limitations of Artificial Intelligence"	Hafiza Elbadi Ahmed Mashrur Chowdhury Adel W.Sadek	-This paper focuses on Artificial Intelligent Technologies provide more life facilities for human beings, increase the productivity and accuracy in industrial filed but also the Artificial Intelligent Technologies effect in human's life in term of work.	-In this paper, the author has discussed that AI Technologies ease human's life and by coming future Artificial Intelligent Technologies can provide a more competitive advantage.	• Rapid advances in AI could lead to. • Unemployment. • Unpredictable and unseen impacts of new features. • An expert system approach is not optimal for all problems. • Particular knowledge is required to apply in any of the systems.
4)"Survey on IOT based	Gokulnath, C,Marietta.	-This paper focuses on the word IoT trends as a field of	-In this paper, the author has discussed	• Compatibility

Smart City" *"Iot-based Smart Cities: a Survey"*	J,Deepa.R, Senthil Prabhu .R, Praveen Kumar Reddy. M, Kavitha B.R *H. Arasteh, V. Hosseinnezhad,V. Loia, A. Tommasetti, O. Troisi,M. Shafie-khah, P. Siano*	research in various engineering disciplines. -IoT includes various elements like communication technologies, communication protocols, identification technologies, sensing, computation, services and semantics. -In the smart city application, several heterogeneous devices need to be connected through the internet for communication. -In the smart city application, we will have huge data to be collected from various applications and database which needs to be classified and analyzed. -The research areas in IoT for the smart city include authorization, authentication, secured communication, congestion control, and knowledge engineering. -The recent implementation of various IoT applications and their research issues in the smart city application.	Smart City has improved the quality of urban life with the future enabled internet services. -Smart cities are enabled by the information and communication technologies which play a vital role in providing various services. -The challenges existing in the traditional smart city environment needs to make the city smarter.	• Complexity. • Privacy. • Security. • Safety.

In Literature survey, table 4.1 represents the related work of IoT, Big Data, AI, Robotics including articles and research papers selected according to our research strategy. The frequency of published papers regarding smart cities and digital twins has been analysed.

5. COMPARISON BETWEEN TECHNOLOGIES

Table 5.1: Table showing a comparison of Cost and Time and Advantages and Limitation of IoT, Big data, AI, Robotic

Technology	Cost	Time	Advantages	Limitations
Robotics [17]Advantages [17,18]Limitation	High	High	• Operating In Unsafe Surroundings. • Improvement In Quality • Increase In Production • Duty During Adverse Hours (24*7). • Safety And Health Of Workers(based on Hazardous Environment).	• Training. • Expenses. • Maintenance. • Safety. • Unemployment. • High Risk.
BigData [19]Advantages. [20]Limitation	High	High	• Cost reduction. • Faster, better decision making. • Good and new products and services. • Fraud Detection.	• Scalability and Storage Issues • Timeliness of Analysis • Representation of Heterogeneous Data • Privacy and Security • Not always better data
AI [21]Advantages, [21]Limitation	High	High	• Reduction in Human Error. • Takes risks instead of Humans. • Available 24×7. • Helping in Repetitive Jobs. • Digital Assistance. • Faster Decisions. • Daily Applications. • New Inventions.	• High Costs of Creation. • Making Humans Lazy. • Unemployment. • No Emotions. • Lacking Out of Box Thinking.

IOT [22]Advantages. [22]Limitation	Low	Low	• Communicate between M2M. • Connection without human interference. • More information helps making better decisions. • Reduces the monitoring time. • Accurate and faster in the smallest amount of time. • Minimum utilization of energy.	• Compatibility • Complexity • Privacy/Security • Safety

Table 5.1 represents a comparison between Cost and Time and Advantages and Limitation of IoT, Big Data, AI, Robotics. This table shows one to one comparison in the context of cost and time and advantages and limitations.

Table 5.2: Table showing comparison of Features of IoT, Big Data, AI, Robotics

Feature	*IoT*	*Big Data*	*AI*	*Robotics*
Security [22,23,24,25,26,30,31]	Strong	Strong	Strong	Weak
Privacy [22,23,24,25,26,30,31]	Strong	Weak	Weak	Strong
Trust [22,23,24,25,26,30,31]	More	More	More	Less
Risk Management [22,23,24,25,26,30,31]	High	High	High	High
Cost [22,23,24,25,26,30,31]	Low	High	High	High
Time consumption [22,23,24,25,26]	Low	High	High	High
Communication [22,23,24,25,26,30,31]	Strong	Weak	Strong	Strong
Connectivity [22,23,24,25,26,30,31]	More	More	More	More

Table 5.2 represent comparison based on features of IoT, Big data, AI, Robotics. Here in this table some of the common features of the technologies are discussed like Security, Privacy, Trust, Risk management, Time consumption, Communication, and Connectivity. From the above 3 comparison table, we can conclude that IoT technology is the best technology using digital twins in the implementation of smart cities. Because when the comparison based on cost and time at that time compared to all technologies IoT requires less time and low cost. Moreover, IoT also provides strong security, strong privacy, trustworthy, communication is very strong, and yes several devices can also be connected.

6. RESULTS

To realize the concept of a smart city, IoT technologies are one of the most essential elements in carrying forward detailed plans of a smart city. Smart city with Digital Twin is taken into consideration. Regarding the various aspects of IoT technologies, the following points should be addressed. Comprehensive demonstration sites for the testing of IoT technologies within a smart city infrastructure should be established various other technology are taken into consideration, technology like IoT, Big data, Robotics, Artificial Intelligence. This will allow the participants within a smart city infrastructure to evaluate and verify the efficiency, economic feasibility, and influencing effects of developing the above technologies and suggested technical services. Based on the results of the current study, it is meaningful to present both necessary and priority issues regarding the aspects of technologies for the successful establishment of smart city infrastructure and its related services. Although the current study evaluated the importance of Digital Twins technologies about the concept of a smart city, in-depth discussions and debates among experts and engineers in fields related to smart cities and other technologies should be continuously conducted for the provisioning of specific plans of action. Moreover, extensive professional panels of experts in diverse research fields including urban development, information and communication technologies, transportation, and environmental policies should be organized.

CONCLUSION AND FUTURE WORK

In this paper, we explore a few recent technologies that are a powerful solution in the form of “Digital Twins: Current problems in Smart City and Recommendations for future technology”. The objective of this paper is to summarize the powerful technology that is used in a digital twin. With the above comparison and variations of technology i.e. IoT, AI, Robotics, Big Data. IoT, AI, Robotics, Big Data have powerful features and anyone they are very difficult to pick. In future, by referring to this work we will work on systematic literature review and further comparison of technology in detail by focusing on the implementation part.

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