Technoarete Transactions on Internet of Things and Cloud Computing Research
Vol-2, Issue-3, September 2022
e-ISSN: 2583 - 0805

Application of IOT Based Networks for Smart City Development

Krishnamohan B. H.[1*], Muzammil Parvez M[2]

[1] Bharathidasan University, India
[2] Dept of ECE, KL University, India
Corresponding Author Email: [1] mohanbk28@gmail.com

Abstract

Internet of things has become an integral part of the development of cities especially the smart cities. Its importance as well as the application has been discussed here in this research in five distinct section and those are introductory, methodology, results, discussion and conclusion part. In the introductory part a background about the research topic has been provided which is the application of IoT based technology for the development. In the past decade the smart city project has been increased significantly and country like China had the highest number of smart cities which is over 100. The next part is the material and methodology part here it has been discussed various types of methodologies that has been used here for performing this research has been discussed. Qualitative research type has been chosen for performing this research and data has been on the basis of the secondary data collection. Data analysis method that has been used here is thematic data analysis with preparing themes based on the research topic. The next section has discussed about the results section where a detailed rationale regarding the research topic has been provided. Findings has been discussed in the discussion part and ended with conclusion part.

Keywords

Internet of Things, Smart City, Technology.

INTRODUCTION

IoT ***technology*** or the ***internet of things*** is the special type of ***technology*** that has been often used in the modern times for the purpose of the communication network. In other words it can be said that the ***internet of things*** are those physical objects which have sensors, special types of software and processing ability which basically used to exchange the data with other devices through the internet [1]. The term ***Internet of things*** was coined by the computer scientist Kevin Ashton in the year 1999. The main purpose behind its invention was to exchange data from one system to the other through the internet. Data can be transferred without the interaction as well but using the ***technology*** of IoT has certain benefits and those benefits have been given. It basically helps to reduce the cost involved in transferring the data. Using the ***internet of things*** in data transfer becomes easier and it is done with the help of ***technology*** with high efficiency and productivity. Increasing the opportunity of the business becomes important and hence when it comes to the ***internet of things*** it provides more and more business opportunities. Final benefit of using the ***technology*** of the ***internet of things*** is to improve the experience of the customers.

Smart city is a broad term but it has a significant meaning when it is compared to the capital city or the financial city. A ***smart city*** is a modern urban area which basically uses different types of electronic methods and sensors for the collection of data. It is not as advanced as the capital city or the financial city but it is a technological advanced city and they are either planned or modernized using different techniques. Some of the popular smart cities are like Singapore, Helsinki, Zurich, Oslo and New York. China is the country which has the highest number of smart cities and that is 100 plus [2]. In a ***smart city*** the things which are required are: good technological infrastructure, environmental initiatives, proper city planning and highly skilled youth population who are employable. In this the most significant thing that is required in a ***smart city*** is a good technological infrastructure and hence for that purpose the ***technology*** of ***internet of things*** is crucial. The high data transfer through the internet helps to increase the business opportunity and attracts the foreign investments [3]. Getting high customers is yet another thing which a company wants to improve and with the help of the IoT it can be very much possible. Countries like China, Singapore, and Taiwan have been using this ***technology*** to make the best possible infrastructure for the ***smart city*** and Singapore is seen as the best city for ***Smart city*** from all over the world. The location of the ***smart city*** is also very impartial and it is always preferable to choose the location which is under the special economic zones.

MATERIALS AND METHODS

Research methodology is important for any of the research and in this section those methodologies that have been taken for performing this research have been discussed. It has been broadly categorized into four categories: the research design, research type, data collection & analysis and finally the exclusion & inclusion of this research. The research design that has been taken here is qualitative research design. The research type that has been used here is the secondary

Technoarete Transactions on Internet of Things and Cloud Computing Research
Vol-2, Issue-3, September 2022
e-ISSN: 2583 - 0805

research type that is mainly done with the help of theoretical literature. The data collected for this research is based on the basis of the secondary data collection method. After collection of the data it had been further analyzed with the help of thematic data analysis. Qualitative research type is the type of research design which includes the research which includes the theories, concepts and the qualitative data has already been prepared already by other research and those data are interpreted [4]. Secondary data includes similar things like as it includes the data from the journals, articles, and websites. It also includes some of the quantitative and statistical data just for the purpose of interpretation not the actual calculation. After the successful collection of data it is important that the data should be analyzed with the proper data analysis method and hence the thematic data analysis method has been chosen.

In thematic analysis a data is analyzed with the help of the preparation of themes and those are based on research topics and here the research topic is based on the application of the ***technology*** of the ***internet of things*** in making smart cities. It will include the data of the concepts of ***internet of things*** and smart cities along with the recent trends that have been going across the world [5]. For that purpose the secondary data will be adequate and along with the secondary research type. Hence, for this research the primary data has been excluded along with the primary research type. Primary research type has been excluded along with the quantitative data from the surveys and interview has been excluded and vice versa has been included. In collection of data from the websites as well as the sources it has been taken is that the authentic data should be used along with the recent data.

RESULTS

Importance of internet of things based technologies in modern cities

Data has become the most significant asset of the 21st century as with the help of data a company can draw its marketing strategy and the government can draw schemes for the welfare of the people. Data storage and its fast transfer are important and for that the ***technology*** of the ***internet of things*** can be remarkable. Artificial intelligence and machine learning has been increasingly developed along with the ***technology*** of the internet of things.

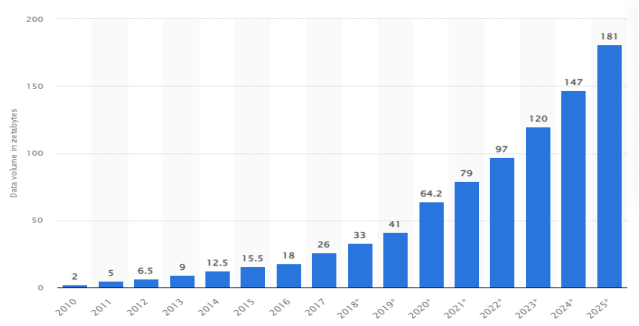

Figure 1: Amount of data consumed and created every year from the year 2010 to the year 2025

The figure 1 it had discussed about the data consumed as well as data that has been created annually globally. According to the graph that has been provided in the year the overall data that was created as well as created globally was only 2 zeta bytes [6]. Since the year 2010 the data consumption as well as its creation shot up and in the year 2020 after one decade it had ceased to 64.2 zeta bytes [6]. The growth is significant as it is around 3100% increase of the data globally. Currently the global data consumption has reached up to 120 zeta bytes and it has been projected that it will rise further in the year 2025 by 181 zeta bytes [6]. The data is enormous and its transfer is also needed with the best possible ***technology*** and for that purpose the ***internet of things*** can be a useful tool. Today most of the smart cities are filled with high quality digital infrastructure with the fastest internet connectivity.

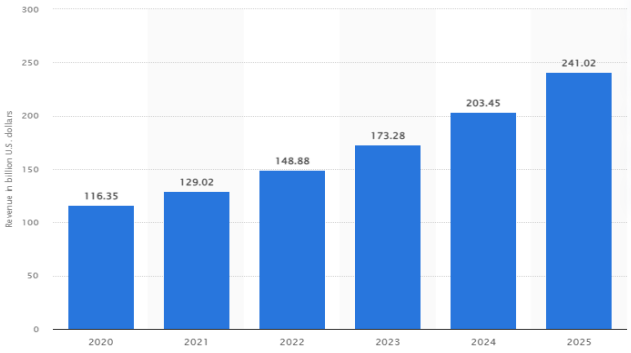

Figure 2: Smart cities revenue from the year 2020 to the year 2025

Counties are investing a huge amount in the development of the smart cities and as the revenue have been increased from the year 2020 to the year 2023 and in future it has been expected that it will rise further in future. According to the figure, in the year 2020 116.35 billion US dollars and in the year 2023 it is around 173.28 billion dollars [7]. According to statista in the year 2025 it had been expected to reach the mark of 241.02 billion US dollars and it is pretty much evident that the most of the operation in smart cities are based on ***technology*** and tonnes of data [7]. Smart cities had been expected to rise further in future with the rise of the technological infrastructure. Some of the popular and most common uses of the ***internet of things*** are voice assistants, smart televisions and heating and cooling systems [8]. Data consumption is expected to raise further in future due to the introduction the 5g technology. These are some of the common uses of the ***technology*** but at the same time this ***technology*** can be used in the traffic management in a ***smart city***. Along with this it can also be used in effective environment monitoring smart buildings, helps the country to reach the carbon neutral targets in the nearest possible time. Lastly, the benefits have been with industrial, agricultural and commercial management. All of these will be discussed further in the next section.

e-ISSN: 2583 - 0805

Application of IoT in smart cities and its increasing demands

Addressing the significance of the ***technology*** of ***internet of things technology*** has been applied in various areas in smart cities like the smart buildings, energy efficiency & reduction of carbon emission. Its application in the industrial sector and commercial has made it an important tool of the 21st century in terms of management and its transfer to proper destination. The application of the ***technology internet of things*** in a ***smart city*** has been given below:-

Traffic management

A ***smart city*** has been known for its best and effective traffic management and for that gadgets as well as digital appliances are used. They are like cameras, traffic lights, parking and other sensors for the prevention of accidents [9]. With the ***technology*** of the ***internet of things*** all the data will be used and helps to manage the traffic from the control in the computers. There are many countries in the world that are technologically and economically advanced but the problems with traffic management have always appeared for them.

Industrial and commercial management

Internet of things has been used exclusively in the industrial as well as commercial sector to improve the security facilities and production control. In a manufacturing company like the industrial ***internet of things*** can be used to track any of the wear and tear in the process, as well as for effective movement of the worker [10]. As it is now quite clear that the work pressure is different therefore according to that the workforce will be managed. The data regarding the quality and control management is also important and the management of the industry would need to examine to draw their future strategy and this data transfer can be effectively transferred through the industrial IoT.

Supply chain management

Supply chain is the most significant part of the supply of goods and services especially in a ***smart city*** hence in a ***smart city*** all these developments can be boosted with the help of the internet of things. Supply chain data helps in many ways like increasing the actual output, improving the quality of the raw materials, decreasing the energy consumption and ensuring the profitability of the company [11]. The best example is the Shenzhen city of China which is one of the smart cities of China and is the largest manufacturing ***smart city***. Also sharing the real time data helps to better operate the overall operation. Due to its exclusive usage of IoT ***technology*** in the supply chain it has seen some of the optimistic developments and those are like the optimization of the route, tracking of the goods throughout the process, it helps a company in reduction of the fuel cost as well as the maintenance cost. Warehouse management has always been the biggest concern for the supply chain company hence they needed to manage the warehouse. Therefore, with the help of real time data sharing helps to locate the goods to the right places. Also getting the final review from the customer is one of the parts of the IoT ***technology*** implementation in supply chain management.

Smart buildings and smart homes

In making smart homes and smart buildings the ***technology*** can be remarkable as it helps a person to build homes in an energy efficient way with proper water management. In constructing a building or home it is important to make sure that the building should have temperature controlling facilities, it should have security with the devices like the mobile and computer if the building is dedicated to the commercial or information ***technology*** office [12]. With the help of the ***internet of things*** some of the developments in smart buildings can be possibly included like the proper lighting management with proper power consumption facilities. Along with these garden management, home safety protection, air as well as the water quality and smart switcher. By including all these technologies the smart homes and smart bulging can be built most effectively.

Smart grids

Smart grids are a totally new ***technology*** that has been used in digital and other advanced technologies for monitoring and managing the transport of electricity from the electricity generation source for meeting the demand. It could be understood with the help of an example as if US and Canada forms an official grid alliance then if due to any cause the electricity demand rises in Canada then it can take the help of the US electric companies to fulfil its demands. It is totally a new concept and currency. It is in its developmental stage and more research and development is needed to be done [13]. The ***technology*** of IoT can be seen as the most significant ***technology*** which can not only help to boost this infrastructure but also help to make the process fast and secure. Some of the practical uses of the ***Internet of things technology*** in smart grids are like real time data analytics & visualization, uses of the advanced algorithms, and overall process automation. Countries like Germany had made significant progress in this field and it had developed IoT infrastructure for the smart grid in Mannheim.

Issues regarding the IoT technology and best methods for its application in smart cities

Instead of all these positives there are some of the issues regarding the usage of the ***technology*** of ***Internet of things*** and all those issues has been given. *Lack of encryption*, it has been said that all the ***technology*** that has been used today is based on encryption as both the ends are connected with a certain type of algorithm [14]. For hackers it is important to break those algorithms and it has been often said the ***Internet of things*** uses less strong encryption as it uses the internet to send the data. Due to its access to the internet it became vulnerable to cyber attackers. The data can easily be altered as well as manipulated and therefore by breaking the algorithms. *Insufficient testing*, with the increase of the demand of the ***internet of things technology*** the company is

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focusing to produce more and more IoT based software without actually checking the security issues [15]. Companies' negligence has created a vulnerable infrastructure of the IoT ***technology*** which can be hacked easily. Therefore, it has become significant for the companies to make improvements in the security problems. Any of the devices and software becomes vulnerable if it is not treated well when it comes to the passwords. Weak passwords give an edge to the hacks to attack on the system and take the important data. The other risk or the challenge for using the IoT ***technology*** is the default passwords that are often offered by the software itself.

Apart from all these challenges the challenges of using the IoT ***technology*** is the high cost of the market as well as too much time consumption. The overall operation of the IoT ***technology*** appears lucrative and quite helpful but at the same time it is one of the expensive technologies and it takes much of the time in its effective operation. Due to the increase of the use of the ***internet of things technology*** has paved the way to make the system vulnerable to malware and those malware. In future, the possibility of the increase of the malware if high as the ***technology*** has been increasing. Finally the overall security problem has been and this is with the designing part and its implementation so the system can be made robust and reliable to secure the cryptographic algorithms. Minimizing such risks it is important to make the encryption more and more secure and it can only be achieved with the help of complex algorithms.

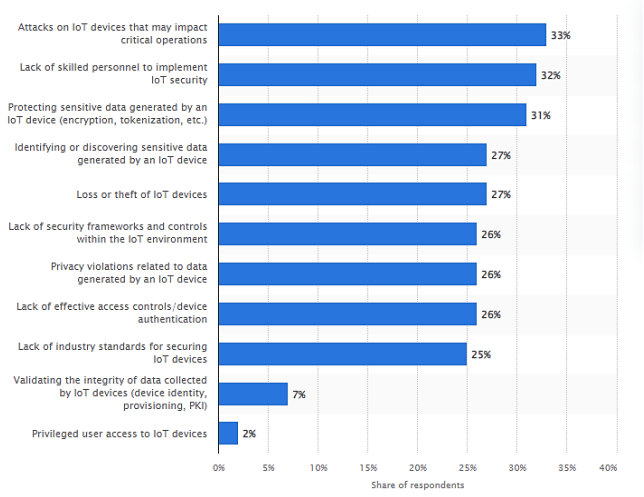

Figure 3: IoT security threats and concerns worldwide in the year 2019

Regarding the security threats and concerns that are often posed by the IoT in the year 2019 worldwide have been covered exclusively in the graph that has been provided above. According to the figure globally 33% of the respondents have reported that the security challenges have been posed by the IoT ***technology*** [16]. The most significant reason for the increase of this risk is the lack of the skill that has been posed by professionals regarding the ***technology*** of the IoT. Along with this the other important factor that needed to be considered here is the effective implementation of the data encryption. The best ways for minimizing the risk of the IoT ***technology*** is to make the process more and more compatible as well as better algorithms should be used. Algorithms which are difficult to break and to build such a complex network a company requires a professional which has the creativeness to build more complex algorithms. Skilled workforce is also required which have the adequate knowledge of the latest technologies like the IoT [17]. Innovation is also needed as the cost of the ***technology*** is high as compared to the ***technology*** that has been considered parallel. As the demand for the IoT has increased the company has been producing the products and services without actually caring about the security of the system. It has therefore become important for them to monitor and test all its products against all the odds.

DISCUSSION

Technology of the ***internet of things*** has been used in many areas like in the education, industries, commercial and the financial sector. In the development of cities, the role of data transfer has become significant and for that the various technologies have been explored. In exploration the IoT is seen as the most significant and easily implemented. Unlike the financial city and the capital city, a new kind of city has been developed by many of the counties and this type is a ***smart city***. A ***smart city*** is termed as the city which is technologically advanced and it has the best transportation system, its governance is of the best in the entire country and overall health care of the city is of world class level. The best examples are Singapore, Newyork and Amsterdam. In the development of a ***smart city*** many things are required like better skilled people, good infrastructure, transportation and good connectivity from one part of the city to the other. ***Technology*** of IoT can be used exclusively in many ways like in the supply chain management, building smart homes, building of the smart grids, better and effective transport management, and in the industrial and commercial sector.

The data consumption has risen in the last decade as in the year 2010 the over data creation as well as transfer globally was 2 zeta bytes. Due to the technological development since the year 2010 and people become more and more aware of creating data. Some of the popular data creating platforms are getting access to social media, working software like the Microsoft office and Google documents. After the year 2010 all the sectors whether it is manufacturing sector, public sector or the private corporation had included the computer in their offices and performed their daily operation through the internet. In this process the ***technology*** like Microsoft had played a critical role but still the data transfer was quite slow at that time and it needed to be fast. With help of internet data transfer becomes easier but still it is slow and it needs to foster the process. With the technological transformation it can be improved and there are many of the challenges and those challenges can only be resolved by the IoT ***technology***. In a smart way many of the industries operate, especially the

e-ISSN: 2583 - 0805

manufacturing there. Real time data tracking in the traffic, supply chain management and other implementation. The concept of the smart cities has gained its popularity and in the future it seems to rise further in future.

CONCLUSION

IoT ***technology*** has been becoming popular day by day worldwide and countries like Singapore, Hong Kong, US and UK have been benefited with this. Due to increase of the global data consumption and creation the data transfer has become common these especially though the internet. As of the year 2023 the annual data consumption and creation is expected to reach the mark of 120 zeta bytes and as of the year 2023 the revenue that is generated through the smart cities is expected to rise up to 173.28 billion US dollars. Considering both of these aspects, the role of ***Internet of things technology*** can be crucial in raising the revenue of the smart cities. The reason is quite clear as most of the operations in smart cities are done through digital mode and for that use of the internet has been increased. In the future the use of the internet seems to rise and the speed is also expected to rise further with the introduction of 5g ***technology***. Today most of the nations of the world have been thinking to improve grid ***technology*** and for that the IoT can be a game changer. The result part has covered all this and it can be and the data has been collected on a secondary basis and it is a qualitative research. After a brief discussion in the discussion part it can be figured out that for the rapid development of the smart cities the IoT ***technology*** is significant.

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