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Internet of Things (IoT) as an Emerging Technology in Global Management

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Abstract

We are aware that the latest emerging technology in management, that is making a big impact, is Internet of Things (IoT). The paper makes a brief discussion on the significance of the current status of usage, along with the possible future usage of the technology of Internet of Things (IoT). The paper further examines the technologies of edge computing, AI, and 5G, that are emerging with the technology of Internet of Things (IoT). The various applications of the emerging technology of Internet of Things (IoT) are researched in detail, as these might further augment the advantages of the technology of Internet of Things (IoT) in the market. The solutions as well as the concerns of privacy and security of the applications of the technology of Internet of Things in the different domains of management are explored to give us an idea of the future applications. We are aware that Internet of Things (IoT) comprises of devices, physical objects, vehicles and other items, that are embedded in software, sensors, as well as connectivity, to allow to enable the exchanging and collection of data with humans as well as with each other. The paper further makes an in-depth study of the transformations in the industries of smart cities, agriculture, healthcare and transportation by the augmenting of cost efficiency, as well as the experience of users. The range of the objects include consumer devices, like smart watches and smartphones, as well as equipment of industry, like pipelines and turbines. The innovative feature is the ability to analyze as well as collect huge quantities of data from different sources, that augment the processes of more informed decisions by individuals and businesses. The technology of Internet of Things (IoT) also demonstrates the potential for augmenting new revenue streams and developing new models of business. This is presently a critical technology both in the government and private sectors. However, the main challenge is security (due to cyber attacks) and interoperability of equipment (due to absence of standardization).

Keywords : 5G, AI (Artificial Intelligence), Internet of Things (IoT), Healthcare, and Smart Watches

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Objectives of Study

The main objectives of study are :

- a) Study of Internet of Things (IoT) applications
- b) Study of Privacy and Security Concerns of Internet of Things (IoT)
- c) Study of Future Growth of Internet of Things (IoT)

Methodology

The research is mainly based on secondary data. A detailed study was made of the initial application of Internet of Things (IoT), that was smart home technology. The success of this application led to huge investment of the industry in research and development of Internet of Things (IoT). The growth of Internet of Things (IoT) was expedited by the augmented accessibility of big data analytics and cloud computing. This led industries to make data-driven decisions and derive valuable insights due to the ability in analyzing and storing vast amounts of data. This further led to the advent of 5G networks, that further augmented new opportunities for Internet of Things (IoT) by providing more reliable and faster connectivity, that made the deployment of innovative applications possible. The technology of Internet of Things (IoT) introduces innovative ways for analysis, collection and utilizing data, that enable organizations to reduce costs by optimization of operations and satisfaction of customers.

It was further observed and studied that in healthcare industry, the devices of Internet of Things (IoT), like remote patient monitoring systems and wearable sensors, could be used to analyze the real-time health data, that assists the providers of healthcare to make personalized plans of treatment, and make remote monitoring of patients. The IoT-enabled devices reduce healthcare costs, detect falls and vital signs, track the adherence to medication and improve patient outcomes.

During studies, it was further noted that the technologies of Internet of Things (IoT) could augment efficiency and safety in the transportation industry as well. There could be sharing of data and infrastructure, with each other in connected vehicles, promoting real-time traffic optimization and monitoring. These systems assist in making predictions of maintenance needs and monitoring vehicle performance, with improvement of vehicle reliability and reduction of downtime.

The studies further revealed that the technologies of Internet of Things (IoT) reduce costs and optimize energy consumption in energy sector as well. The Internet of Things (IoT) enabled smart grid systems reduce energy consumption by monitoring energy usage, causing better

cooling and heating systems, managing energy usage, as well as having better waste management.

The studies in the manufacturing sector indicated that the technologies of Internet of Things (IoT) utilize the sensors for monitoring performance of machines, predicting the needs of maintenance, improving overall efficiency as well as quality control, and optimizing the processes of production. It also enables the addressing and identifying of issues, and further enables real-time monitoring with analysis of the data of production.

It is indicated in general, that the technologies of Internet of Things (IoT) have the ability of letting the industries make analysis, collection, and make utilization of data in innovative ways. The augmentation of innovation of the technologies of Internet of Things (IoT), let the industries meet the evolving needs of customers, as well as remain competitive.

Findings

The paper briefly discusses the diverse applications of Internet of Things (IoT) that spread across industries like agriculture, transportation, smart cities and healthcare. The benefits derived from the technology of Internet of Things (IoT) include the augmentation of productivity as well as efficiency, and enhancing of safety.

- a) The application of the technology of Internet of Things (IoT) helps reducing waste and augmenting efficiency, along with the optimization of yielding of crops. This allows the real-time monitoring of soil, weather conditions and crops, and also makes the farmers aware of valuable data, that helps in making informed decisions. The major application in agriculture is precision farming, involving the usage of mapping tools and sensors for garnering data on soil moisture and crop yield, along with other variables. The analyses of this data is made for reducing costs, optimizing usage of water and fertilizers, and increasing crop yields. This technology is also used for smart irrigation, that uses sensors for forecasting weather conditions, and measuring moisture content of soil, for optimizing the schedules of irrigation. It further helps to reduce costs and wastage of water, along with the augmentation of yields of crops. The technology of Internet of Things (IoT) is also utilized for monitoring livestock, by way of attaching smart sensors to livestock, that helps monitoring their behavior, location and health in real-time. This, in turn, assists the farmers to optimize feeding schedules, and recognize the potential health issues. This results in augmented efficiency and better animal health. Thus, we find that the technology of Internet of Things (IoT) has the capacity of modernizing the procedures of management of livestock as well as their crops. The

sensors and devices of Internet of Technology (IoT), make the collection and analyzing of the data, along with the reduction of wastage of water, and optimization of the yield of crops, that result in the augmentation of the total efficiency of agricultural supply chains.

- b) The application of the technology of Internet of Things (IoT) helps the transportation industry in augmenting the momentum. This technology in the transportation industry includes the integration of various platforms, devices and sensors, to facilitate real-time decision-making process, data sharing and communication. The utilization of this technology transformed the transportation services, resulting in reduction of costs, along with augmentation of safety and efficiency. The noteworthy application of Internet of Things (IoT) in transportation industry is supply chain and logistics. The devices and sensors monitor the location as well as the movement of goods in transit, that enable the transporters to track the location and the progress of their shipments in real-time, along with providing them with on-time delivery of goods, helping them to reduce delays, as well as, make better scheduling of deliveries and planning. The cities using devices and sensors, that are enabled by Internet of Things (IoT), could predict congestion, monitor traffic flow, as well as study traffic signals in real time. The usage of this technology, helps reduce air pollution, travel time and also reduce congestion. This scenario of Internet of Things (IoT) further helps monitoring the performance of the public vehicles, ensuring minimum breakdowns and efficient running. The solutions based on Internet of Things (IoT) not only reduces maintenance costs, but also the combination of sensors and predictive analytics, help recognizing issues before these escalate to major problems. Thus it is observed that this type of proactive approach helps reduce downtime and augments the overall efficiency of the system of transportation. The major application of Internet of Things (IoT) is the introduction of autonomous vehicles. The decision-making processes and communication of these vehicles are controlled by solutions of Internet of Things (IoT). The solutions of Internet of Things (IoT) use machine-learning algorithms and sensors, that make real-time decisions and analysis of the environment. The use of autonomous vehicles eliminates human errors, and thus reduces accidents on the road. Furthermore, the usage in this industry is not entirely land-based. The technology of Internet of Things (IoT) is also used in aviation, that enables real-time monitoring of engine performance, requirements of maintenance and consumption of fuel. It is thus ensured that there is minimization of

downtime in issues of maintenance, reduction in the consumption of fuel, and an overall efficiency in the running of aircrafts. It is thus found that Internet of Things (IoT) leads to augmented efficiency in the transportation industry along with augmented safety and reduction of costs, with the likelihood of further innovation and development.

- c) The application of the technology of Internet of Things (IoT) helps in the concept of smart cities, for enhancing the quality of life of the citizens, boosting sustainable development and revamping urban services. In cases of smart cities, data is leveraged from linked devices for augmenting public safety, and enhancing transportation as well as infrastructure. Internet of Things (IoT) is observed in diverse applications, like smart parking, smart waste management systems, smart lighting, as well as smart transportation. The sensors in street lighting could identify the existence of vehicles and passers-by, and accordingly, modify the lighting, for augmented safety and adjusted energy consumption. The sensors in garbage bins would recognize the level of the waste, and optimize the schedules of garbage collection, that would lead to the enhancement in utilization of resources, and reduction in the consumption of fuel. Internet of Things (IoT) is also used in several applications in smart cities, that include the monitoring of the environment, smart buildings as well as smart grids. Smart grids monitor the quality of power, make reduction of the outages and manage the distribution of energy. Smart buildings cause the reduction of costs by the garnering of data from the concerned sensors, like, humidity, occupancy and temperature, and also engage in optimization of consumption of energy. Internet of Things (IoT) in smart cities has the capability to transform the operation of the cities by augmenting the habitability, sustainability and efficiency. The manipulation of the data from the linked data devices, would enable the administrators to make data-driven decisions for encouraging innovation, augmenting the engagement of citizens, and upgrading the public services. However, there are quite a few challenges, as issues of interoperability, requirement of a robust infrastructure, and concerns of data security and privacy. In order to overcome the challenges and maximize the capability of Internet of Things (IoT) in smart cities, a holistic approach could be considered, that could include regulations, infrastructures and policies. The crucial factors for the success in the implementation of Internet of Things (IoT) in smart cities are the partnerships between the diverse stakeholders, that would include providers of technology, citizens as well as the local governments.

d) The application of the technology of Internet of Things (IoT) helps in the innovation and growth of the healthcare sector. The Internet of Things (IoT) enabled wearable, mobile applications, as well as medical devices are being used widely and these provide enhanced patient outcomes, as well as present the facilities of personalized treatment and remote monitoring. The technology of Internet of Things (IoT) has the capacity to transform the healthcare sector by converting the practices of traditional healthcare to proactive and patient-centric approaches. Internet of Things (IoT) further allows the providers of healthcare, to monitor in real-time the health conditions as well as vital signs, that enables early detection for timely intervention. These factors cause considerable reductions in the visits to emergency rooms, as well as readmission in hospitals, thus effecting a vast reduction in healthcare costs. Internet of Things (IoT) has also facilitated the growth of wearable devices, that could track several types of data of the patients, like oxygen saturation, blood pressure, heart rate, among others. It is thus observed that the frequency and accuracy of the monitoring of the health of patients have been upgraded by the usage of the smart devices, that resulted in the improvement of the plans of personalized treatment and diagnoses. Internet of Things (IoT) has further facilitated the growth of usage of telemedicine, that has enabled the providers for remote communication and monitoring, with reference to the patients. It is most helpful in remote and rural locations where there is limited access of healthcare. Telemedicine has made it possible for consultation with patients, who are physically unfit and have mobility problems. The Internet of Things (IoT) has helped the evolution of Electronic Health Records that assist in providing the access to a patient's medical history and help the outcomes of patients. The Electronic Health Records augmented the sharing of data among the providers of healthcare, that lead to better care of patients. The studies indicate a positive impact of Internet of Things (IoT) in the healthcare sector, that included deeper satisfaction of patients, reduction in the costs of healthcare and upgradation of satisfaction of patients. For the purpose of upgradation of patient care, the healthcare sector needs to promote the technology of Internet of Things (IoT).

The paper would now make the study of privacy and security concerns of Internet of Things (IoT). Since a large number of dissimilar devices are linked, a middleware is required for the support of the implementation. The challenge of interoperability mostly lies with the problems of authentication and the user's identity. Data of these two elements should never be tapped during the communication between devices. Another major challenge is the confidentiality of the data due to the continuous changes in the requirements of end-users and changes in terminologies. The challenges of identification technologies usually map one unique indicator to another entity, for elimination of ambiguity, and making the same to be retrievable as well as identifiable. In the architecture of Internet of Things (IoT), it becomes binding for the requesters and providers, making meaningful communication with each other, without considering the diverse nature. The challenges of communication technology include cost, accuracy of deployment, diverse nature, constraint-free mobility of objects, as well as the modalities of communication, that make continuous changes of the growth by transforming the existing network in a dynamic fashion, such that varying degrees of autonomy become permissible. Accurate design standards are to be made for correct signal processing and further identification of data, such that the requirements of all the possible applications could be supported, that are interrelated to Internet of Things (IoT). The threats in privacy and security of the Internet of Things (IoT) based healthcare systems include tampering attack, false data injection attack, attacks against block-chain based solutions, impersonation attack, stolen card attack, Privileged-Insider attack, Ephemeral Secret Leakage Attack, Sybil Attack and a few others. The main threats in precision agriculture include injection of malicious data for loss of signal from long distance deployment and harsh weather conditions, vulnerability of sensors to stealing and eavesdropping, as well as tampering of outdoor sensors that result in the failure of the facilities of agriculture and cause abnormal operations. The vulnerability of 5G results from threats like blocking network attacks, confidentiality, authenticity, integrity and nodal communication. For smart agriculture, there needs to be further improvement in privacy and security. For this purpose, the performance and security requirements need to include session key agreement, resilience to attacks, non-linkability, mutual authentication and device anonymity. It is proposed that the framework aids the reuse, that would include multiple bidders with an auctioneer, and an authority of cryptography. It is further proposed that for establishing the trust and the traceability for the agricultural supply-chain, a security solution is deployed, over the blockchain network. A distributed framework for key management, based on group based keys is proposed for the confirmation of end-to-end security. There is also a further

proposal for detection systems for intrusion, based on data mining and machine learning algorithms.

The paper would now make the study of the future growth of Internet of Things (IoT). The trend of growth would continue for the next ten years. Several factors attribute to the growth of Internet of Things (IoT). These include the easy availability of the low-cost sensors, sudden increase in the availability of wireless networks, and the augmentation in the adoption of smart devices. The practice of the utilization of Internet of Things (IoT) would be increasingly global, including both developing as well as developed countries, and businesses would augment their investment in the solutions of Internet of Things (IoT), for enhancing their efficiency and productivity. The increase in the utilization of smart devices is a major driver of the growth of Internet of Things (IoT). The likes of smart devices as smart watches and smart phones are integral parts of daily life, in similarity to the usage of internet. There would be an increase in the demand of smart devices, in similarity to the increased number of internet users, that drive the growth of Internet of Things (IoT). Furthermore, the abundance of low-cost sensors in the market, played a significant role to make the processes of collection of data, less in cost. The cost of sensors have decreased by more than 60% (sixty percent only) in the post-covid period, and this has made the sensors affordable for the industries, for incorporation of the same in the devices of Internet of Things (IoT). This has driven the growth of Internet of Things (IoT), due to the usage of an augmented number of devices of Internet of Things (IoT). The augmented demand for the adoption of the technologies of the Industry 4.0 and the surge in the demand for automation would be the main drivers of growth in the next few years. The assistance provided by Internet of Things (IoT) in the augmentation of the productivity, reduction of waste, and the optimization of the various processes of the industries, contribute to the growth of Internet of Things (IoT). With this result in mind, a greater number of industries would make investment in Internet of Things (IoT) for enhancing the qualities of the predictive maintenance processes, supply chain management and quality control. The growth of 5G wireless networks has offered faster speeds of data, higher connectivity of devices and lower latency. This has made it possible for a higher number of smart devices to be connected, and drive the growth of Internet of Things (IoT). The combination of 5G and Internet of Things (IoT) spread out the opportunities for the applications of Internet of Things (IoT), that include smart cities, remote healthcare and autonomous vehicles. There would be significant growth in the healthcare sector as well, as devices utilizing Internet of Things (IoT) are increasingly utilized for the remote monitoring of patients, that has acquired serious concern due to the

Covid-19 pandemic. It is gauged that there would be an increase of at least 100% (One hundred percent only) in the utilization of Internet of Things (IoT) in the health sector. Similarly, in the transportation sector, managing and tracking vehicles are becoming increasingly reliant on the smart devices of Internet of things (IoT), for the reduction of cost and augmented efficiency. The logistics as well as the transportation markets of Internet of Things (IoT) are also expected to grow by 100% (One hundred percent only) in the next few years. Therefore, the study observed that there would be significant growth of Internet of Things (IoT) in the next ten years, as the same would be driven by the augmented availability of the low cost sensors, leading to adoption of smart devices, along with the enhancement in the utilization of 5G wireless network. The demand for the devices of Internet of Things (IoT) continuously persists and increases, and the industries have more and more tendencies to have a competitive edge in the market by the incorporation of smart devices of Internet of Things (IoT) into their services and products.

Conclusion / Implication

It is concluded that the research paper has brought to light the applications as well as the emerging technologies of management of Internet of Things (IoT), discussing the future as well as present perspectives. This technology is growing with a fast speed and continues to make progress rapidly. The future benefits of this technology are immense in management, but the same are derived with significant risks and challenges. The Internet of Things (IoT) has the capability of transforming the industries, and making impacts on the society, that are both positive and negative.

Recommendation

It is recommended that future research needs to make a deeper exploration of the implications, both social and ethical, of the implications of the technology of Internet of things (IoT), especially in the areas related to security and privacy. Future research could further investigate the capability of the technology of Internet of Things (IoT) for the solution of global problems as sustainability and change of climate.

Limitations

The limitations of the research paper are brought to light from the scope of the topic, that is very limited, and several areas of Internet of Things (IoT) lay uncovered in depth due to constraints of time and space. Furthermore, the fast development of the technology of Internet of Things (IoT) indicate that certain discussions made in the paper could become obsolete rapidly.

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