|| Volume 6 || Issue 3 || March 2021 || ISSN (Online) 2456-0774
INTERNATIONAL JOURNAL OF ADVANCE SCIENTIFIC RESEARCH
AND ENGINEERING TRENDS

AN EMPIRICAL STUDY OF RECENT TRENDS IN IOT, CLOUD AND ITS INDUSTRIAL APPLICATIONS

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Abstract: - The Internet of Things is a paradigm in which industrial devices can be equipped with identifying, sensing, communication, and networking capabilities, allowing them to communicate with each other and other devices over the Internet to achieve results. The cloud is a key component of the Internet of Things, which offers useful application-specific resources in a variety of application domains. In recent years, a wide variety of industrial IoT applications have been created and implemented. Since it has grown rapidly in recent years, it is important to research this emerging technology in-depth and examine its applications in different sectors. This paper reviews the current literature for current trends in IoT, cloud, and IoT applications in different industries, and collects primary data from stakeholders to help the study to better understand the application of IoT and cloud in industries. The analysis of current trends in IoT and cloud, as well as their pertinence in various industries, is a major contribution of this paper.

Keywords: - *IoT, Empirical Study, CLOUD, Applications of IoT, Industrial Applications*

I INTRODUCTION

The German government first proposed the fourth industrial revolution (Industry 4.0) in 2013 (Li L. , 2018). It aims to build a smart manufacturing system in which emerging technologies are used to create cyber-physical systems (CPS) and human–equipment interfaces, resulting in manufacturing systems that are economically, environmentally, and socially sustainable (Schmidt, et al., 2018) (Bahrin, Kamarul, Othman, Azli, & Talib, 2016). Industry 4.0 promotes interoperability, automation, actionable insights, and information transparency by using big data analytics, the Internet of Things (IoT), cloud computing, additive manufacturing, virtual reality, robotic systems, and artificial intelligence.

The Internet of Things (IoT) is a vast global information system made up of a large number of heterogeneous, decentralized devices that can be sensed, identified as well as processed using interoperable and standardized communication protocols (Cirani, Picone, & Veltri, 2015). It enables detectors, sensors, as well actuators, and other devices in a smart environment to communicate seamlessly (Li, Xu, & Zhao, 2015). Healthcare, supply chain, logistics, transportation, mining, building automation, intelligent home, smart grids, smart city, energy management, and asset tracking are all examples of IoT applications (Fang, et al., 2014).

IoT

The Internet of Things (IoT) is an evolving technology that is supposed to change the role and position of many current industrial structures, such as transportation and manufacturing systems. As the Internet of Things is used to create intelligent transportation systems, for example, the transportation authority can be able to monitor each vehicle's current location, control its movement, and predict its future location as well as road traffic. The word Internet of Things (IoT) was first coined to refer to radio-frequency identification (RFID)-enabled interoperable connected objects (Clark, 2016). Researchers later connect IoT to other technologies including mobile devices, sensors, actuators, and GPS devices.

Cloud

The concept of cloud computing was first proposed in the 1950s when large-scale central computers were made available through personal terminals to businesses and universities. It was important to find ways to optimize revenues from such an investment, such as allowing multiple users to share access and Processor time from multiple terminals, reducing inert time, which became popular as timesharing in the network industry. Scientists and technologists tried to explore ways to provide maximum IT capacity to more users through timesharing as computers became more popular. This could be accomplished by employing algorithms to allow infrastructure and applications to operate more efficiently, prioritizing CPU access and, ultimately, providing better service to end-users. Cloud computing can be divided into three types of services, Platform as a service, Software as a Service, and Infrastructure as a Service (Papoutsidakis, Piromalis, Symeonaki, & Tseles, 2017).

How Cloud empowers IoT

Cloud and IoT have evolved at a fast and distinct speed. These worlds are different from one another, and their features are often complementary. Many researchers have proposed and are proposing their integration because of this complementarity (Alhakbani, Hassan, Hossain, & Alnuem, 2014) (Gomes, Righi, & Costa, , 2014).

Both cloud computing and the Internet of Things work to improve the efficiency of daily activities and are complementary. IoT generates a large amount of data, thus cloud computing allows this data to move. IoT companies can access huge amounts of Big Data by storing data in the cloud. IoT systems are based on the principles of mobility and widespread networking, like cloud computing is built on the principles of speed and scale. To get the most out of their combination, both cloud and IoT must form cloud-based IoT applications. The growth of the Internet of Things can be attributed to this partnership.

Many IoT-related innovations are now focused on plug-and-play hosting services. As a result, the cloud is a natural fit for IoT. Hosting providers don't have to rely on bulky equipment or maybe even hardware that can't handle the agility that IoT devices need. Most hosting companies can now give their customers a ready-to-use model due to the cloud, eliminating entry barriers.

When it comes to IoT, the cloud serves as a bridge in the form of a mediator or contact facilitator. Cloud communications enable several powerful APIs, such as Cloudflare, Cloud, and Dropstr, which make it easy to connect to smartphones. This makes it easier for computers to communicate with one another rather than only with humans, which is the IoT cloud's tenet. Cloud computing has the potential to drive the growth in IoT. Nevertheless, there are some disadvantages and obstacles to using cloud technology (He & Li, 2014). Not just because the cloud is inherently faulty, but because the combination of IoT and cloud will present some challenges to users. If you decide to pursue an IoT cloud solution, it is preferable to be aware of the potential obstacles (Chopra & Dhote, 2019) .

Industry wise applications

Manufacturing

Abdullah Mohammed said that Cloud manufacturing (CMfg) is a new manufacturing solution that allows for complete sharing of manufacturing tools that are encompassed as services and is enabled with cutting-edge technology and advanced concepts. Internet of Things (IoT) and Cloud computing are key supporting technologies in the cloud manufacturing sector, where common resources such as machines, workers, materials, logistics goods, and production jobs are turned into smart manufacturing objects (SMOs) that can sense and respond to one another in a cloud-based intelligent environment (Ren, et al., 2015).

To begin with, IoT devices, like RFID readers and tags, are routinely deployed in common manufacturing sites such as shop floors to identify various resources. They will then automatically sense each other to obtain real-time data (Wang, 2013) (Mourtzis, Vlachou , Xanthopoulos, Givehchi , & Wang, 2016). Second, a set of data models can organize the sensed and captured data, allowing it to be identified, processed, and for future uses such as production planning and scheduling it is formatted into a standardized scheme.

Healthcare

The Internet of Things (IoT) opens up new possibilities for improving healthcare (Domingo, 2012). All objects in healthcare systems (people, equipment, medicine, and so on) can be tracked and monitored at all times due to IoT's sensing, ubiquitous identification, and communication capabilities (Alemdar & Ersoy, 2010). All healthcare-related data (diagnosis, logistics, rehabilitation, medication, finance, management, and even everyday activity) can be obtained, handled, and shared efficiently due to the internet's global connectivity. Sensors, for example, will periodically collect a patient's heart rate and send it to the doctor. IoT-based healthcare systems can be mobile and customized by using personal computing devices (mobile phone, smartphone, laptop, etc.) and mobile internet connectivity (3G, WiFi, LTE, etc.) (Plaza , Marin, Martin, & Medrano, 2011). IoT-powered in-home healthcare (IHH) systems have accelerated due to the widespread availability of mobile internet services (Pang, Chen, Tian, Zheng, & Dubrov, 2013).

Transportation and Logistics

The Internet of Things (IoT) will become highly significant in the logistics and transportation industries (Atzori, Iera , & Morabito, 2010). Transportation and logistics companies will perform real-time monitoring of the movement of physical objects from an origin to a destination through the entire supply chain, including production, shipping, distribution, etc, as more physical objects are equipped with sensors, bar codes, RFID tags (Karakostas, 2013). Also, the Internet of Things is expected to deliver promising strategies for transforming transportation networks and automotive services (Zhou, Liu, & Wang, 2012).

IoT technologies can be used to improve vehicle sensing, networking, communication, and data processing capabilities as vehicles gain more efficient sensing, networking, communication, and data processing capabilities. IoT technologies, allow you to track each vehicle's current position, control its movement, and predict its future location. BMW's intelligent informatics system (iDrive system) recently used a variety of sensors and tags to deal with different situations,

including monitoring the vehicle's position and road conditions to provide driving directions (Qin, Long, Zhang, & Huang, 2013).

Supply Chain

Supply chains are becoming much more complicated in today's world. The implementation of IoT in Industry 4.0 would link the entire supply chain as a network. Demand forecasting, logistics, and capacity planning would not be an issue for highly adaptive networks.

Latest Trends in IoT & Cloud Technology

The IoT technology evolves constantly, and IoT trends therefore always evolve and change. Here are some industry wise emerging IoT trends that can be anticipated.

Future of IoT across the industries

The IoT has been evolving for a period already. After new metrics have been introduced for a postwar ISA age, Internet-of-Things technologies reengineer companies and modify them in an optimal manner. Almost all the existing industries – health, insurance, intelligent building, production, transport & logistics, retail and more – are affected by these technologies.

The changes required depends very much on the devices, on the dimensions of the target market and especially on the industry. Although some current general IoT trends are very apparent in all industries, the predictions in the industry must not be overlooked.

IoT trends in healthcare

The IoT is very well fit for the needs of the healthcare industry. The most promising areas of IoT technology usage are:

- Remote patient monitoring with built-in sensors to track patients' conditions.
- Optimization of everyday hospital operations through customer service facilitation and medical equipment management.
- Disease monitoring and prevention, enabled by mobile apps paired with IoT devices.

IoT trends in manufacturing

Heavy industries, such as manufacturing, deal with complex systems and process management in and outside factories. Thing's platforms in the industrial Internet can not only reveal, but also reduce inefficiencies in the workflow. These are the key improvements introduced by IoT production platforms:

- Inventory management
- Production maintenance
- IoT trends in transportation
- Industrial big data analytics

In the transport & logistics industry, the rate of IoT adoption is already high and continues to accelerate. Transport companies are investing in new technologies, reducing shipping or transport costs and increasing their operating efficiency. The latest IoT trends transforming the transportation of people and goods are:

- Predictive diagnostics and vehicle maintenance based on automotive IoT
- Complete transportation telematics with vehicle-to-vehicle communication
- Real-time cargo monitoring

In some ways, this industry-specific Internet of Things of future trends is specific to the universal trends of IoT applications that we will deal with below. The top ten trends in IoT to be explored are as follows:

- Artificial Intelligence
- 5G Networks Across the Industries
- Blockchain for IoT Security
- Distributed Cloud
- Sensor Innovation
- Augmented Reality (AR) and IoT
- New Wireless Networking Technologies for IoT
- Distributed Cloud
- Advancements in Edge Computing
- Human Augmentation
- Global Connectivity
- Better Data Analytics

On the basis of this list, IoT trends for human growth, increasing security concerns, practical blockchain, artificial intelligent services, increased IoT expenditure for businesses, 5G networks, and the edge of the market would be discussed in some more detail (Vilmate, 2019).

II MATERIAL AND METHOD

For this analysis, a qualitative approach was chosen as the research tool. Empirical work is carried out with the collection of data using a survey instrument as part of the research process. A survey analysis study is one in which a group of people or items is examined by gathering and analysing data from a small number of people or items that are considered representative of the entire group. To put it another way, only a small portion of the population is analysed, and the results are intended to be applied to the entire population (Nworgu 1991:68).

Induction is the process of qualitative research that collects data on a particular topic and then develops concepts and theories based on that data. In comparison to a quantitative approach, which is more structured, broader in scope, and numerically focused, a qualitative approach was considered more applicable to conduct this research because it allowed for more depth and meaning to be gained based on an individual's perceptions of unemployment as well as their beliefs and feelings.

Sampling and selection

It's doubtful that the researcher would be able to gather data from all cases to address the objective. As a result, selecting a sample is necessary. The population refers to the entire set of cases from which the researcher's sample is drawn. Researchers use sampling techniques to reduce the number of cases as they do not have the time or resources to analyse the entire population **Invalid source specified.**.

Data collection and analysis

A questionnaire is a highly adaptable tool that can be used to collect almost any form of data. A questionnaire was developed for this research to examine recent trends in IoT and Cloud, as well as their implementation in various industries. Before the questionnaire was distributed, the respondents were told of the aims and objectives of the research. The questionnaire was given to the respondents through an online platform.

The responses were then coded, analysed, and interpreted using a content analysis method.

III RESULT AND DISCUSSION

Six male and four females responded to the survey. Most of them (80%) were on top engineering positions in their organisation. As big as 90% of the respondents said they are using the latest IoT and Cloud technologies in their organisation and one of them is likely to use them in the future. 50% were representing IT sector, which is strongly connected to both the chosen research technologies, IoT and Cloud. Two of them (20%) were representing Automobile Industry. One (10%) is working in Industrial Automation sector, one (10%) in the supply chain industry and one (10%) in manufacturing sector, as shown in the table below.

Table 1-1 Respondents and their sectors

Sr, No.	Respondent Name	Sector
1	Ashwin Kshirasagar	Industrial Automation
2	Madhuvanti Nitant Joshi	Information technology
3	Malayaj Hartalkar	Information technology
4	Nitin Amraotkar	Information technology
5	Richa Bhide.	Supply Chain
6	Supriya Ghospurkar	Information technology
7	Atul Joshi	Manufacturing
8	Makarand Kulkarni	Automobile
9	Siddhant Rokade	Information technology
10	Saurabh Renavikar	Automobile

In an attempt to better understand the application areas of IoT and Cloud in their organisation we asked them about the specifics and their responses are given in table 1.2 below. 60% organisations use IoT and Cloud for Application Development, 30% use them for Monitoring processes, 20% for System Management, Data Management and Research, 10% use them for Device Management, Tools for analysis, and Visualization,

Table 1-2 Industrial Application areas of IoT and Cloud

Applications of IoT and Cloud	Responses	Percentage
Application development	6	60
Device management	1	10
System management	2	20
Data management	2	20
Tools for analysis	1	10
Monitoring processes	3	30
Visualization	1	10
Research	2	20
Other(Please specify)	8	80

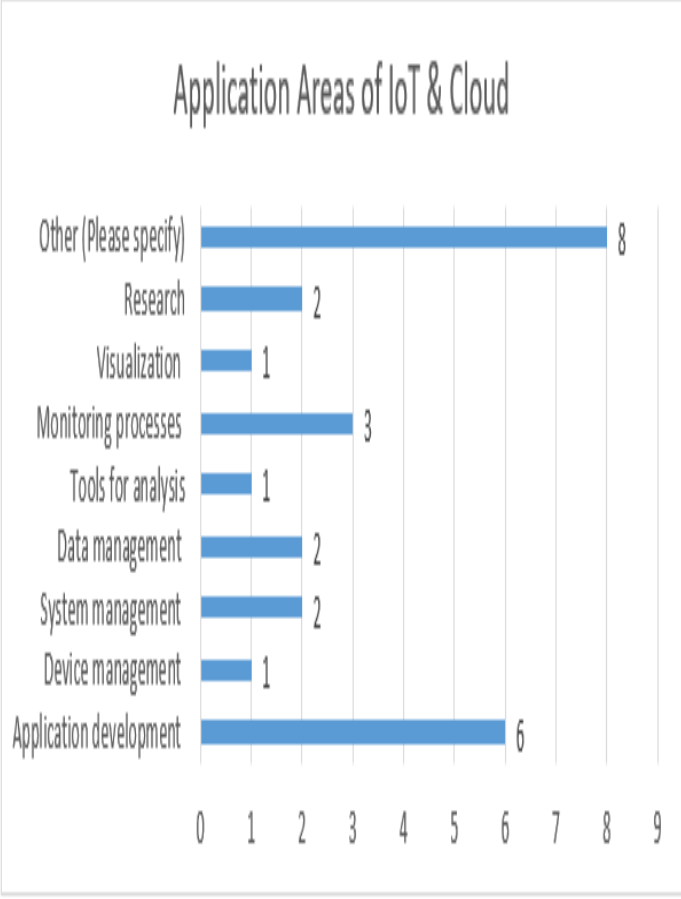

Figure 1 : Application Areas of IoT & Cloud

Apart from all other applications it was observed that, the manufacturing industry use IoT for inventory verification, smart energy consumption, production line automation, automatic inventory control, and automation of production line. Along with all the stated applications they also use cloud technology for storage, and high-performance compute. It can be observed that, application development is one of the applications which is used across the industries.

Table 1-3 Advantages of IoT and Cloud

Sr. No.	Advantages of IoT	Advantages of Cloud
1	• Saves time • Increases Throughput • Rapid response • Maximizing Efficiency • Increase in productivity	• Flexibility • Cost efficiency • Scalability
2	• Saves time • Increase in productivity	• Flexibility • Improved Collaboration • Scalability • Environmentally friendly
3	• Not applicable	• Business continuity • Cost efficiency • Improved Collaboration • Scalability • Data Security • Boosts Productivity
4	• Saves time • Rapid response • Increase in productivity	• Business continuity • Cost efficiency • Scalability
5	• Fewer errors • Maximizing Efficiency • Ensure safety and compliance	• Flexibility • Improved Collaboration
6	• Saves time • Maximizing Efficiency • Increase in productivity	• Business continuity • Cost efficiency • Scalability
7	• Improves forecasting	• Not Applicable

According to all the responses, maximizing efficiency and saving time are the most popular advantages of IoT and flexibility, scalability and cost efficiency are the most accepted advantages of cloud across the industries.

To understand industry wise advantages of latest IoT and Cloud trends, we gathered data regarding the beneficial trends for particular industries. Table 1.4 shows the details

Table 1-4 Industry wise beneficial trends of IoT & Cloud

Sr. No	Industry	Beneficial Trends
1	Industrial Automation, Healthcare	• Better Data Analytics
2	Information technology	• Artificial Intelligence • Distributed Cloud • Global Connectivity • Better Data Analytics
3	Information technology	• Blockchain for IoT Security
4	Information technology	• Artificial Intelligence • Distributed Cloud • Human Augmentation
5	Supply Chain Consulting	• Artificial Intelligence
6	Information technology	• 5G Networks Across the Industries • New Wireless Networking Technologies for IoT • Global Connectivity
7	Manufacturing	• Sensor Innovation • Global Connectivity
8	Automobile	• Better Data Analytics

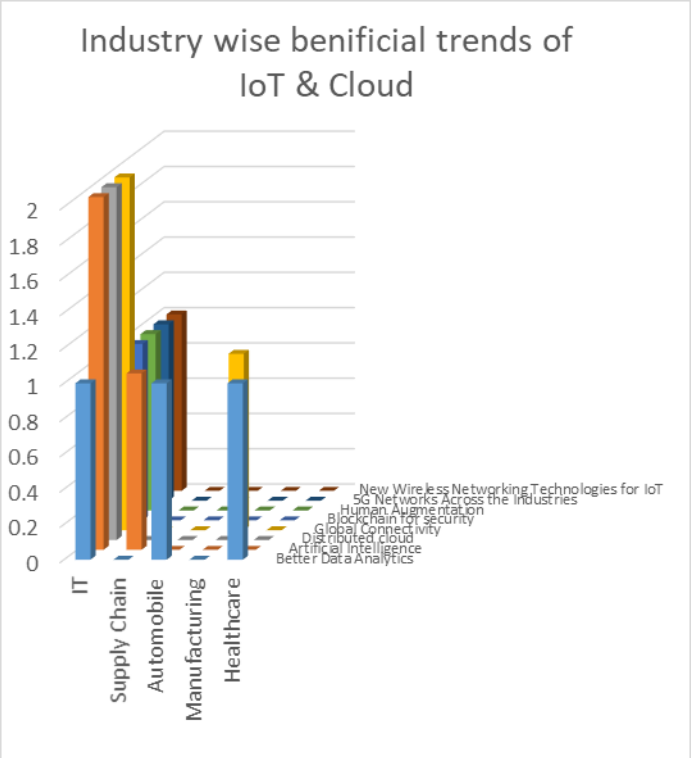

Figure 1 Industry wise beneficial trends of IoT & Cloud

As it can be observed from above table, IT industry is benefitting from artificial intelligence, distributed cloud, global connectivity, better data analytics, blockchain for IoT security, human augmentation, 5G networks across the industries, and new wireless networking technologies for IoT. Healthcare sector benefits from the better data analytic of IoT, Supply chain sector benefits from artificial intelligence, manufacturing sector benefits from sensor innovations and global connectivity and Automobile sector also benefits from better data analytics of IoT and Cloud. From the responses obtained from five sectors, we observe that three sectors (It, Automobile, Healthcare) find 'better data analytics' as a beneficial trend. Two sectors (IT, Supply chain) find 'artificial intelligence' a beneficial trend, and two sectors (IT, Manufacturing) find 'global connectivity' as a beneficial trend. Rest all the trends are popular in the IT industry.

IV CONCLUSION

The latest trends in the field of IoT and Cloud and their integration for better results are the promising combination for all the sectors like manufacturing, automobile, supply chain, healthcare and information technology. The new applications from all these trends open up new progressive path towards more secured, efficient, accurate and cost-effective processes across all the industries.

In this paper we surveyed executives from five sectors in order to identify the most beneficial trends in the field of IoT and Cloud for different industries. Since the adoption of IoT and Cloud enabled many application and process development activities, all the industries will be potentially improved for every sector. Manufacturing industry is leveraging the innovations in sensor devices and global connectivity. Industrial automation saves time and cost of regular system maintenance. IT industry can relish the reduced cost of ownership without compromising on data security. It also helps fulfil the requirements for hardware and software rapidly and boosts productivity. Real time easy access to data with greater speed is also one advantage of IoT and Cloud technology.

The open issues of IoT and Cloud pertain mainly the issues of interoperability, data security, and privacy. The envisioned future path includes the identification of the definitive solution for interpretability of devices and the convergence of a secured platform environment.

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