



Griffith College

**EVALUATION OF THE IMPORTANCE AND EFFECTIVENESS OF IOT
INTEGRATION OF SUPPLY CHAIN MANAGEMENT IN MECHANICAL
COMPANIES OF INDIA**

Research dissertation presented in partial fulfilment of the requirements
for the degree of

MSc in Procurement and supply chain management
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I certify that the dissertation entitled:

EVALUATION OF THE IMPORTANCE AND EFFECTIVENESS OF IOT INTEGRATION
OF SUPPLY CHAIN MANAGEMENT IN MECHANICAL COMPANIES OF INDIA

submitted for the degree of **MSc in Procurement and Supply Chain Management** is the result
of my work and that where reference is made to the work of others, due acknowledgment is
given.

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Abstract

There has been a brief discussion on the application and market demand of IoT devices in the mechanical companies of India. There have been researched methods such as primary and secondary used for analyzing market demand and current requirements of this new technology in the business world. This research paper indicated the future need for this technology in the future to achieve desirable speed and accuracy. The research methodology, approach, design, findings and analysis, ethical consideration, limitation, and future scopes for IoT devices have been discussed with proper explanations. The research findings show a comparison of the adoption capability of new technology in developed countries and India. There has been discussion on future scopes of technical integration in India and perceptions of Indian business owners regarding applying technology have been also discussed. The overall findings of this research indicate towards brighter future of supply chain management in this country by adopting IoT devices.

Acknowledgment

I am extremely grateful to all my classmates and tutors who have helped me to conclude this research study successfully. I have been able to develop my skills in the different approaches related to the research study which focuses on the supply chain management of Indian Mechanical Companies through the implementation of IoT based technologies. I would especially want to convey my deep gratitude to my professor Dr. Dhafer Alahmari who has guided me whenever I needed any help during the study and has been encouraging from the get-go. Moreover, I am thankful to all 5 managers from different industries who took time and participated in my interview process during the Covid-19 period. Ultimately, I would like to thank my and family and friends who have been a constant source of support for me during the conduction of the research.

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Chapter 1: Introduction

1.1 Introduction

This chapter will highlight the background of the study, aim, objectives, research questions, rationale, and significance of IoT in the supply chain management of India. IoT devices are a major beneficial factor for supply chain management in the current times. It is possible to keep raw material and goods in the best possible condition and efficient storage space along with the distribution of products in a well-managed manner is achievable by using IoT. The research rationale will show predictable data of benefits achieved in India by using IoT for supply chain management. IoT reassurance that goods are located to its right location, real-time shipment monitoring, and demand planning and early identification of issues is a major benefit.

1.2 Background of the Study

Internet of Things (IoT) allows business organizations and companies to integrate interconnection between physical devices that can acquire, monitor, and analysis collected data and shared data. In this context, IoT integration in supply chain management (SCM) can help business firms to keep track of products, shipment, inventory management, distribution process, and sales. Implementation of IoT has proved to be an innovative process that developed an effective supply chain for organizations and created an efficient distribution process. Recent developments have helped SCM to flourish in the digital sector where data acquiring and sharing provide effective business operations (Aryal *et al.* 2018). IoT delegations can conduct effective logistics and inbound operations to strengthen the supply chain of warehouses and manufacturers. Supply chain approaches such as Phase Alternate Line (PAL) enable efficient inbound and outbound logistics in organizations and integration of IoT can improve contemporary processes in SCM. According to Akram (2016), nearly 85% of SMEs in India lack of IoT integration and logistical approach in SCM. As a result, such SMEs can acquire cost-effective SCM and proper logistic infrastructure in the supply chain for operational improvement. The use of IoT can introduce a better transport system, inventory management, and resource monitoring and warehouse operations in SMEs in India. Moreover, the integration of IoT can reduce transportation and fuelling costs that can provide cost-effective advantages to supply chain management.

1.3 Research Aim

The study aims to identify the importance of IoT in supply chain management and the effectiveness of IoT integration in Indian SCM activities.

1.4 Research Objectives

- To identify the influence of IoT on supply chain management.
- To recognize various applications of IoT devices IoT infrastructure implemented in Indian supply chain management.
- To analyze the essential improvements of IoT applications in the supply chain of mechanical companies in India.
- To determine complications and issues with IoT in supply chain management for improvement while integrating with Indian business firms.

1.5 Research Questions

Q1: What are the IoT applications in supply chain management?

Q2: What are the improvements IoT can employ in SCM in India?

Q3: How can IoT devices manage the supply chain in Mechanical companies?

Q4: What issues and implications can pose during IoT integration in SCM?

1.6 Rationale of Research

The main issues in supply chain management are customer satisfaction, cost control, risk management, supplier relationship management, and adapting to a fast-changing market. There is a major challenge to deliver the right quantity and quality of product at the right interval of time to customers as customer satisfaction is the ultimate goal of every industry. In the recent market, the delay in unplanned action within the supply chain can bring down the production rate and

supply chain and affect market share. Robust IT infrastructure can increase the close track of component supply and operation procedures.

Indian mechanical Companies have to bear losses due to inefficient delivery of products or excess quality of production of goods without proper planning of supply of products to customers. The earning from the supply chain of contributes 13% in GDP in the Indian economy and this percentage rate is even higher than a well-developed country such as the U.S. The major challenges associated with supply chain management are poor infrastructure, inefficient distribution system, fragmented market and lack of awareness in the latest technology to improve current supply chain rate. India has the second-largest road network (4.2 million kilometres) in the world through the poor maintenance of roads is not in great favor to support required growth in the supply chain of mechanical companies. However national highways maintain a decent quality of roads with 2% of total road networks while carrying 40% of traffic (economictimes.indiatimes.com, 2020). Retailers maintain less than 10% of the country's total retail trade. India has witnessed the slowest growth rate in the past six years at only 4.5% along with lowering Reserve Bank's repo rate from 6.5% to 5.15%

To mitigate these kinds of issues, IoT technology has become the most effective and essential need for this Country.

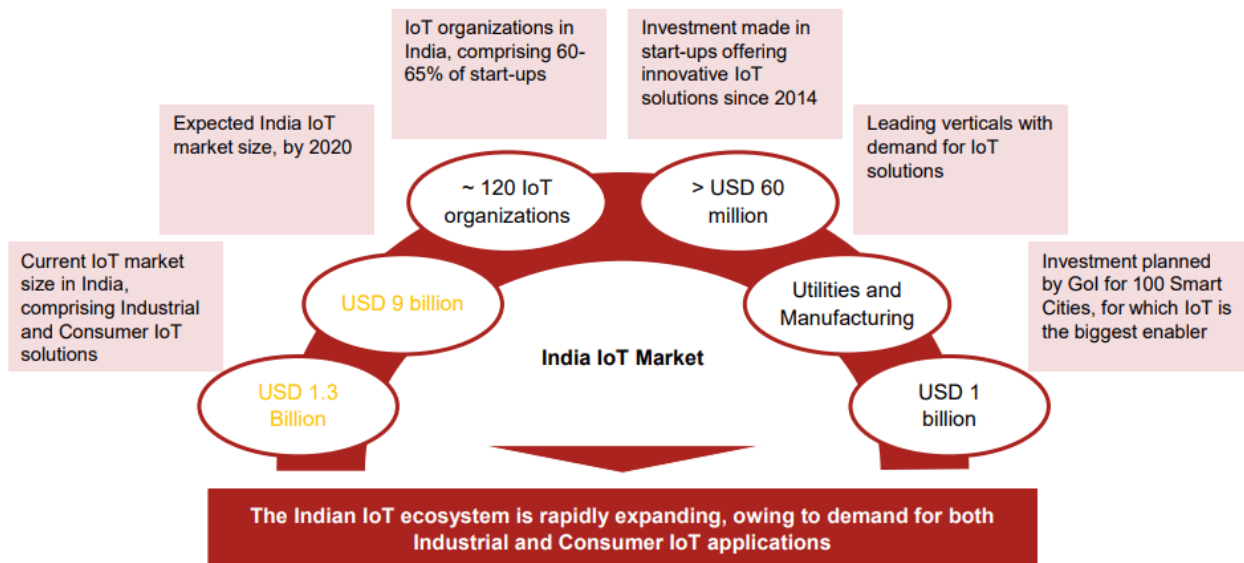


Figure 1: IoT market in India

(Source: Tu *et al.*, 2018)

According to an article by Forbes IoT will reconstruct operational efficiency and revenue opportunities for the supply chain in the coming years (forbes.Com, 2020). Tracking numbers introduced by the IoT system is helping manufacturers to keep track of goods through their journey to customers. RFID and GPS sensors track product locations, helping to data such as the temperature at which good is stored and duration spent in cargo. These data help to keep control over the quality of the product and the forecasting of deliveries. The data record of products also helps to maintain relations with vendors. According to IBM, Watson AI technology used for supply chain management helps to find 65% of the value of a company’s products. Thus IoT is becoming a necessity for manufacturers to apply in their supply chain management to meet the market expectation and maintain the quality of products by tracking their locations. Recently the Chief Informational Officer of Maruti Suzuki said that the IT infrastructure and IoT will play a crucial role in its business operation and will act as a backbone. Maruti Suzuki has around 400 plus Tier I supplier and 2000 plus tier II suppliers most are from India. IoT will increase the effectiveness of business dynamics, cloud, and cybersecurity in the Maruti Suzuki’s Supply chain.

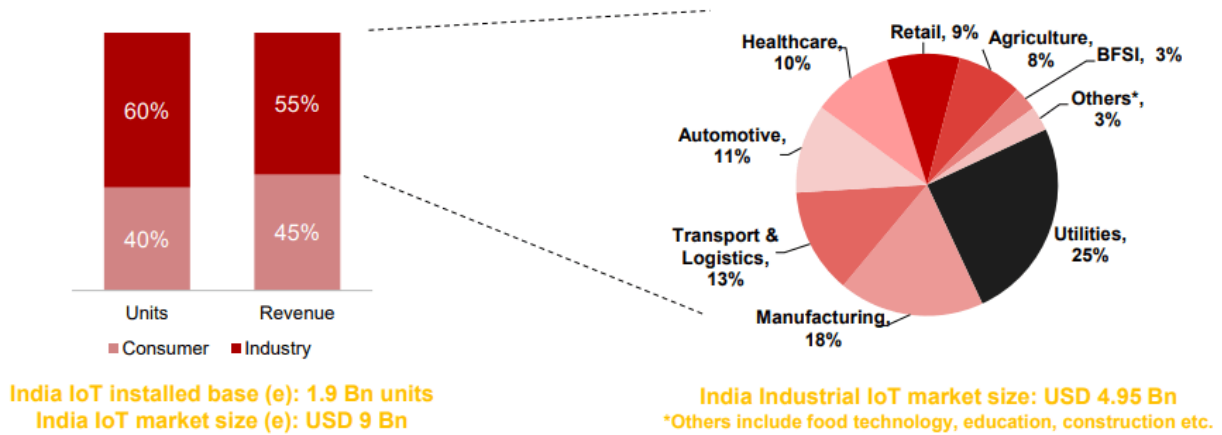


Figure 2: Share of IoT within Supply Chain

(Source: Calatayud *et al.*, 2019)

Mechanical companies depend upon the supply chain management as they have a top plan schedule for production of goods as per the delivery timing and maintaining a stipulated budget by not wasting raw materials in unwanted productions. IoT integration in the supply chain will provide accurate data to mechanical companies regarding the amount of production required and successful deliveries of already manufactured products.

IoT market is gradually enhancing in India and will touch USD 15 billion markets in this country at the end of 2020 and will account for 5% of the total global market. This reflects the fact that IoT devices and their usage are going to increase at a rapid rate and records 200 million units in 2016 to 2.7 billion units by 2020. This data is a clear indication of revolutionary change this country is going to witness in the coming years in the supply chain system (Mostafa *et al.*, 2019). This will encourage innovation and greater solutions to problems associated with goods supply. The manufacturing rate and service delivery mechanism are going to be changed on a broader scale. As per the NASSCOM report, India is going to lead the adoption of IoT and it is being predicted that IoT devices will generate 90 zettabytes of data by 2025 (nasscom.in, 2020). The Indian government is already giving priority to the “Make in India” movement and the aim of this movement is to giving importance to the rise in manufacturing. IoT integration is not only an opportunity but also a need to support such a big mission to change the Indian economy in the future. Sensors and IoT based devices give advantage to linear manufacturing and man-machine integration is necessary to support the current demand rate of customers and meeting business objectives in the present competitive market. In 2019 Tata communication and Microsoft connected vehicle platform build a digital infrastructure for a seamless supply chain market. This will empower the Tata automotive service in terms of in-vehicle systems, scalability, effective management, and post-purchase vehicle service. This wireless technology and internet implementation of this mechanical car manufacturing process effectively increases the supply chain management.

1.7 Significance of the Research

The research study can introduce potential methods and approaches of IoT integration in supply chain management. It is observed that most of the Indian business companies and organizations experience challenges regarding inbound and outbound logistics in supply chain

management. Furthermore, such organizations experience issues in resource management, warehouse management, resource allocation, and transportation. In this context, IoT integration can solve such issues and provide cost-effective advantages and optimal control over the supply chain of companies (Hiromoto, Haney & Vakanski, 2017). The study can acquire contemporary trends of IoT integration techniques in SCM to improve business operations and financial performance. IoT devices can acquire and exchange information with internal departments of business organizations to suggest better logistical control and supply chain activities that can reduce waste, effective use of the resource, and cost-effective manufacturing process. IoT devices can forecast shipment movement and product arrival to distributors, which helps manufacturing companies to plan several activities to maintain effective distribution. On the contrary, the research study can provide insight into various IoT operations and technological dependency on SCM and logistics in India.

1.8 Research Structure

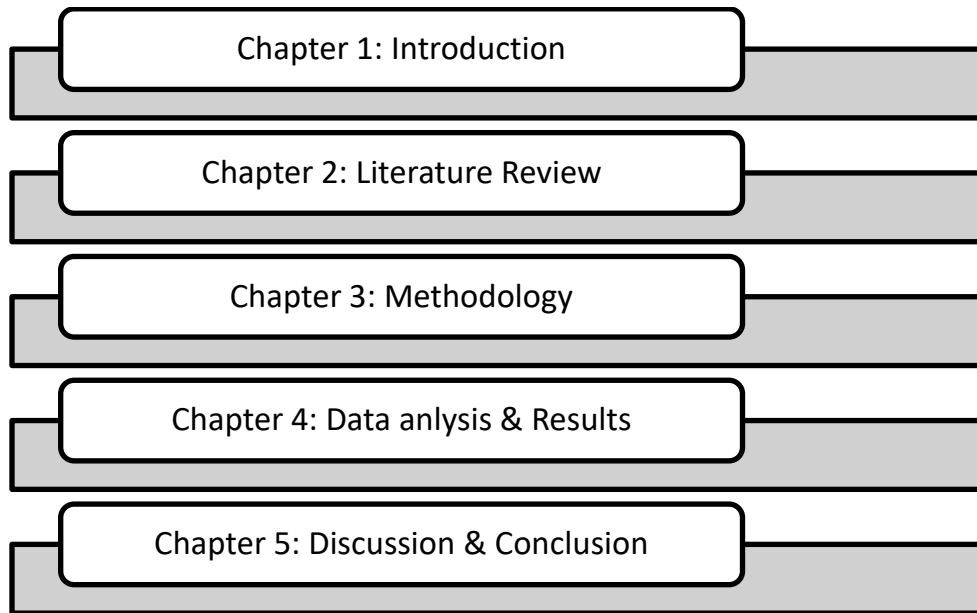


Figure 3: Research Structure

1.8 Summary

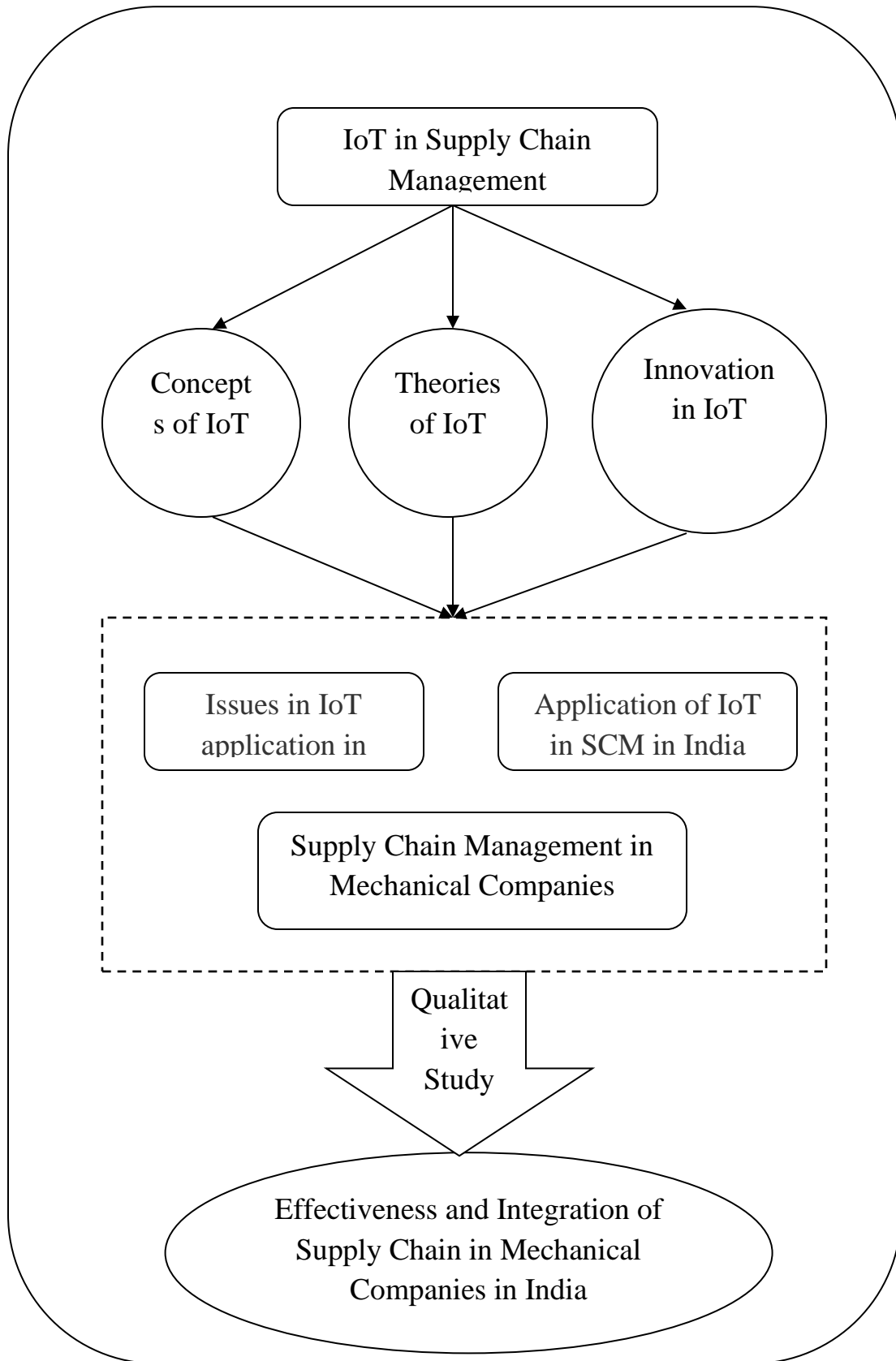
In this above section, it has been defined that Evolution within supply is very effective. Submergence of IoT implication has become an opportunity for Supply chain management. Here in this chapter the aim and objectives of this research and the significance of this study has been also evaluated. This introduction chapter highlights issues regarding the use and necessity of IoT integration in supply chain management of India. The statistical data used in this chapter are a clear indication of growth opportunities and ease in business operation by including IoT in the supply chain.

Chapter 2: Literature Review

2.1 Introduction

In this section of the knowledge regarding IoT and its effectiveness in supply chain management will be analyzed. To make this discussion more effective, the conceptual framework, the concept of IoT, the concept of the supply chain, and its application process in India will be discussed in this section. There are also several theories and its application in innovation is also made in this area of research. Here the IoT is considered as an independent factor and supply chain management is considered as a dependent factor.

2.2 Conceptual Framework



2.3 Concept of IoT

The Internet of Things (IoT) is a system where interrelated computing devices, digital and mechanical machines, objects, peoples, or animals are provided with unique identifiers. Through this, the data can be transmitted over the network without any human to a computer or human to human interaction. As per the views of Tripathi *et al.* (2018), this process can be a person with a heart monitor implemented, an automobile with built-in sensors. The ecosystem of IoT is made of web-enabled smart devices embedded with processors, communication hardware, sensors. This helps to collect and send data and process assigned work. There are also specific deployed applications that help to make proper connectivity and networking and communication protocol.

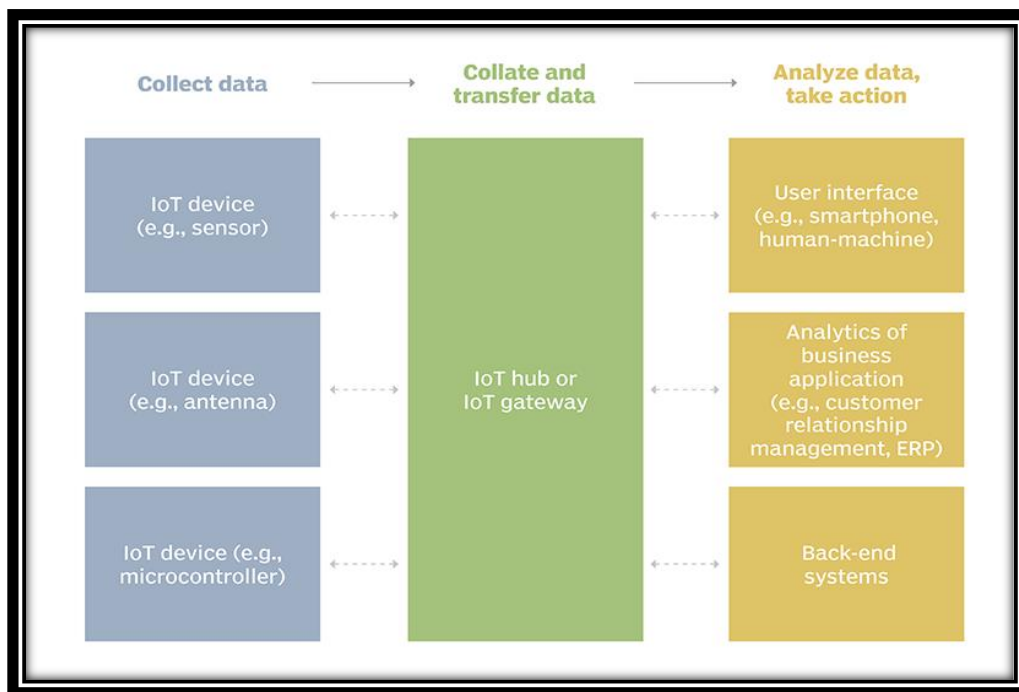


Figure 4: Example of IoT system

(Source: Singh *et al.* 2019)

The IoT helps to make life and do work more smartly and gains complete control over the system. Several smart devices help to automate any work. In view of Gupta *et al.* (2019), IoT is

also essential for business in several ways. Application of this in business helps to make real-time look into the system. This also shows the delivery insights into the supply chain process and logistics operation. Thus, the process can be automated and reduce labor costs. This also makes the manufacturing process less expensive and can offer transparency in customer transactions. This becomes one of the most important technologies in everyday life. There are several benefits of IoT implementation in organization, such are, this helps to monitor overall business processes, improve overall customer experience, save resources and time, and enhance employee productivity. This implementation increases the revenue of the company. In the case of India, the standards of IoT is depends on several aspects such as in building smart cities, smart water projects, smart environment, smart agriculture, smart waste management, smart safety, and smart waste management. There are several advantages associated with this IoT, such are the communication, monitoring, quality of life, business opportunities and sustainability can be increased by these implementations. On the other hand, numbers of disadvantages also come with IoT processes (Mostafa *et al.*, 2019). Such as device compatibility, network complexity, privacy, and data security, network dependency and decreased human recruitments are the disadvantages of IoT.

2.4 Concept of IoT in Supply Chain Management

In the modern business sector, companies adopt IoT in manufacturing and retail businesses' supply chain management. Manufacturers can forecast manufacturing costs, raw material management, and resource allocation from information collected from IoT, whereas, retail businesses can acquire equal distribution, sales, and effective inventory management through IoT applications. As mentioned by Kothari, Jain & Venkateshwar (2018), integration of IoT can solve operations issues such as ineffective stock handling, less asset visibility, improper data handling, ineffective supply-chain risk management, inefficient control on logistics and transportation. Recent innovations in internet services can accommodate the proficient integration of IoT in supply chain management. In this context, IoT devices can recognize real-time locations of product shipment, real-time tracking, and avoid duplication of shipment for the company. Abdel-Basset, Manogaran & Mohamed (2018) argue that business organizations need to adopt proper infrastructure to employ IoT integration with the framework for securing a smart and efficient system. The framework and system can consist of layers of services, interfaces, and transmission procedures and data collection through RFID sensors or technology. As a result, IoT integration

can develop the design of virtual factories, sustainable manufacturing processes, smart control on production, and innovative production chain with factory visibility in supply chain management.

The sustainable improvement of technologies used in the supply chain management process can be made through the implementation of IoT in the production process. The utilization of supply chain management can be done through customer insight, Goods monitoring process, product lifecycle management, inventory management, asset tracking, maintenance, and effective marketing practice. On views of Gupta *et al.* (2020), the goods monitoring process can be done through several sensor systems. Though the IoT sensors any mechanical business can track the data of environmental conditions like humidity and temperature. In general IoT in the automotive supply chain involves with automotive tracing system. This process is built by the global positioning system and the advanced implementation of a cellular device. There are armed with IoT power tracing system and the monitoring process is building better in fracture for real-time location of transits good. This can be possible due to the cloud-based monitoring and analysis platform. Through this process, the reverse logistics process can be determined more effectively. In the case of a business with multiple warehouses, the management process becomes more complex (Muhammad *et al.*, 2018). Here the use of IoT can reduce the overall complex within management. Asses tracking are one of the most important parts of the supply chain management process. The implementation of IoT over their supply chain management ensures the efficiency of the supply chain compared to the conventional method. The IoT sensors help to track their asset location in real-time. These sensors can provide detailed information such as status update, transit time spending, and selves time spending. Besides, the supply chain management consists of multiple components such as containers, trucks, ships for delivery purposes. The connection between these components through the IoT increases control over them and helps to make more organized connections. Thus, this ensures the product delivery to the consumers without any delay.

The current state of IoT in India depends on Industry, Startups, and governments. The automobile industry is considered as 4th largest in the world and ranked as 7th largest as a commercial vehicle manufacturer. Here Renault Nissan Technical Centre builds the electric mobility that can be controlled through the Nissan Connect App. The Mercedes Benz R&D in India also involves IoT in its supply chain management system to make it effective in-vehicle communication, vehicle to vehicle communication (Prashar *et al.*, 2020). Apart from that, the

Godrej consumer products limited, invest in IoT technology, and robotics for an effective manufacturing process in India. GCPL uses this technology for debottlenecking certain production lines and improving effective outputs. In addition to that, the Indian automobile company also uses 3D technology IoT for car components, machine learning in manufacturing units, and AI blockchain and robotics.

2.5 Theories and Concepts

The devices of IoT generally allows the segmented sectors for the supply chain management for working and connecting in a specific approach that will be helpful for the acquisition of the optimal profitability from the supply chain management. The theories of the supply chain to the adaptation of IoT can provide insight into Network theory and Agency Theory for specific elaborations of identification.

Network Theory

The better view can be provided with the help of the network theory of the interactions related to inter-organizational in the environment of the network. The dynamics related to the network environment can be highlighted by the network theory and the influence of the partner's relationship can also be recognized in the operation of an organization. It has been analyzed, that with the help of the network approach the chain of supply can be designed by the organizations and it will also be considered beneficial for the organization such as the powerful reliability along with creating the flexibility for managing their responsiveness (Gupta *et al.* 2020).

The network theory implementation helps to make effective coordination within different parts of the supply chain management process. The implementation of network theory increases the best development line of work. This also helps to make a focus on discovery and centrally offer access to information. However, network theory is a less developed tradition and focuses on discovery and adaptation (Tan *et al.*, 2020). There are different internet-connected sensors, like an immediate alert for any kind of fragile automotive part, harm full handling, and high-temperature experience can give real-time feedback to the desired location. Therefore an effective real-time solution can be made as soon as possible. This, implementation of IoT in a mechanical company

will increase the network to the supply chain management system and also increase the scope for the solution.

Interface theory

The interface theory is related to the two major fields of research, such as Cyber-Physical System (CPS) and computer networks. The code of mobility and trust depends on the several local proxy servers and scripted code. It is required to execute a large number of entrusted codes to regulate local area networks carefully. The IoT also allows actor networks to access actors. The service implementation process involves the request and response process. The dataflow model of IoT can be considered as an actor. There are several object-oriented languages are being used in this process, such as Java, C++, and C#. Here in this case behavioral interfaces can be developed based on Interface Autonomy (IA), compatibility, refinement process. The implementation of IoT in SCM is also based on some types of behavioral models. As an example, the interaction of producer and consumer at the time of exchange, and post-modification of products can be done effectively through IoT implementation. However, this integration process with proper behavioral nature increases effectiveness. The interaction process is required to be effective to ensure an effective communication process. This interface theory model helps to understand the logical time and physical time for this effective communication process (Henrique *et al.*, 2019). The interaction between consumer and manufacture is made through several channels for different reasons. Implementation of IoT enables the required information for this possess. Apart from that this also blocks input and delayed outputs for security concern. Thus, IoT development effectively depends on interface theory. On the other hand, this interface theory is being played an effective role to make IoT innovation.

Agency Theory

This theory is based on the principles of problem-solving motivation. In the case of IoT innovation practice, there are several innovation processes related problems available. The development of IoT in SCM required some problem-solving abilities. There are several agents related problems that reduce their profit. This IoT implementation through agency theory primarily made their focus on long term performance. There are different ways available to solve agent

related problems, such as monitoring and bonding (Dr Ray *et al.*, 2017). This monitoring process can be imposed through the implementation of IoT in the supply chain management process.

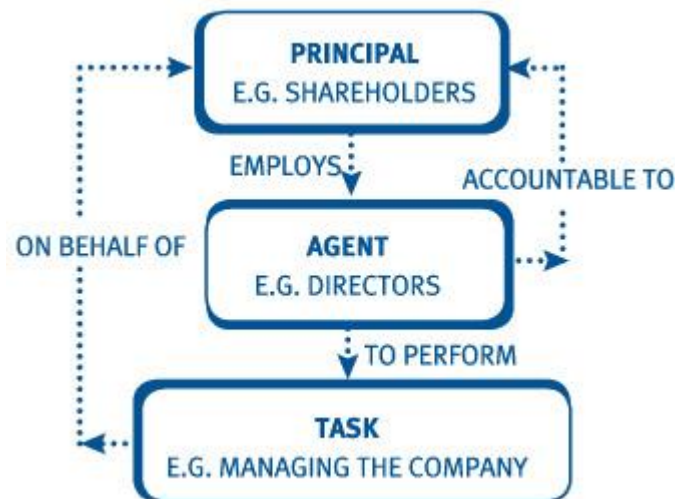


Figure 5: Agency Theory

(Source: Ping *et al.*, 2018)

It has been analyzed by Ivanov *et al.* 2018, that in the relationships of agency one member needs to delegate the work with the other member for compensation for the lack of expertise along with focusing on the core competencies. At the time of action of the agent, the agency theory plays an essential role in resembling the behaviors such as performance for the advantages of the principal or acting as the resemblance of the principal along with the employee. Efficient management is related to agency problems such as the acquisition of the information, mismatch of preference, capability, and effort generally associated with the agent and is also considered to be in any relationship of the principal-agent. A usual framework can be provided by the agency theory for the analysis of the behaviors and relationships in the chain of supply due to these chains can be replaced with the dyads of the agent of principle.

2.6 Digital Supply Chain Management

The Internet of Things refers to the collection related to the interconnection of physical devices that can report and monitor for sending and exchanging the relevant data. The devices of

IoT are generally connected to the systems of computers via Wi-Fi networks or data. It has been observed, that the management of the supply chain has also been revolutionized with the help of IoT devices. The IoT devices are also considered as helpful to track the goods to the specific location along with its storage (Scuotto *et al.* 2017). Digital supply chain management plays an essential role in the implementation and integration of information technology for better information management along with the statistics related to the chain of supply in the systematic form (Attaran, 2020). The IoT devices also play a major role to track the movement speed as well as the traffic product flow for making the prediction easier to move the goods with the help of the chain of supply. The specialist devices of IoT are also considered to be beneficial for monitoring the areas like humidity, temperature, the intensity of light, exposure to an atmosphere along with other factors of the environment. It has also been analyzed by Agrawal & Narain (2018), that route planning and goods tracking with the help of the IoT devices can be helpful to identify the location of the goods at the time of delay in transit.

The digital supply chain management consists of the layer of digital technologies. This layer includes predictive analysis, automated re-alignment solution, and robotics to speed up the assembly and picking. This also involves IoT sensors to gather real-time feedback from vehicles and manufacturing equipment. Primarily the digital supply chain consists of two definitions. The first definition of the digital supply chain is related to the digital aspects of the physical supply chain. Another definition of the digital supply chain reflects that the companies involved with the delivery of digital products. There are several types of risks associated with the digital supply chain. The DDoS attack on DNS provider din is effective to down large portions of IoT processes. The digital supply chain management process helps to increase overall consumer behavior, distribution channel, and information distribution techniques. IoT helps SCM to adopt the ownership types and business approach and make effective communication processes. This significantly reduces the complex nature of supply chain management processes. In modern technology, the cloud-based network and its connection to the internet allow more effective technological solutions required by any mechanical company. There is a GPS tracking process, inbuilt sensors are art as an input system, and software and informational solution are acting as an effective processing area. This cloud network can be connected with any IoT enabled devices and create a proper solution as per requirement. This increases the safety of the overall procurement process required for production, manufacturing, and product supply process. The digital

information allows conducting proper communication with other suppliers and the processes. This allows effective information technology integration and implementation for better management of information and statistics related to the supply chain management process. The digital SCM mini works with the data collection process and management of various factors within SCM. There are several control variables such as industry size, ownership types, business types, and business approaches that can segregate the functional supply chain management process. The digital supply chain is primarily made of the IoT, blockchain process, big data analysis, Artificial Intelligence technologies, and Software as a service process. This effectively increases the effectiveness of process management, material flow, supply and demand planning, inventory levels, and resource planning. There is a wide range of Indian mechanical companies that are planning to introduce the IoT in their SCM process.

2.7 Application of IoT in SCM in India

The internet of things can be considered as the technology, which helps to build the views of the big picture along with the creation of the functional frameworks for the management of supply chains. It has been observed, that the systems of IoT facilitate the updates related to the information of assets. Despite making the entry of the data manually into the spreadsheet, the software helps the manager to rely on updating the status of all the assets. The full potential of IoT devices also plays a major role in the management of the large warehouses for big retail companies in India. The application related to IoT supply chain management empowers the connected device that locates autonomously moves and locates the goods across the warehouse. The technical tools as well as the IoT devices share information with the help of the telecommunications and networks for connecting the manufacture, suppliers, the activities of consumers and distributors digitally. It has also been analyzed by Ben-Daya *et al.* 2019, that the convergence of the human-technology in manufacturing along with the chain of supply helps the managers of warehouses enhance the productivity of their workers with the engagement of them in more demanding and complex tasks.

Increased rate of scope in mechanical infrastructure development ensures the implementation of IoT. According to Mani *et al.* (2017), the involvement of IoT in the supply chain in the Indian market ensures deeper penetration in the Indian value chain market. The increased rate of GDP and supply chain improvement involves several Indian leading companies

to adopt IoT in their SCM process. There is also operational differentiation between supply chain and production that can increase the prediction of productivity. On the other hand, Ghadge *et al.* (2019), argues that operational differentiation and productivity and the business based in ICT helps to improve the quality and proposition in supply chain management in India. The infrastructural change has been affecting the current market of the supply chain.



Figure 6: IoT in different parts of SCM

(Source: Abdullah, & Faizal, 2018)

The use of IoT is being used in India for several SCM. Most of the solutions are being made through Ultra Wide Band and infrared technologies. The location tracking technology is being used by the major Indian companies to track delivery facilities from vendors to the manufacturing facility. This increases the knowledge of material delay and based on this effective secondary plan can be implemented. Apart from that, the environment sensing or monitoring system is also used by several Indian mechanical companies to reduce product damage or loss. This is also used in several Indian automobile companies to avoid asset-related risks. These implementations require effective Wide based RTLS and in the Indian supply chain process, this is effectively used. In the case of metal mechanic companies, processing like metal pressing, metal

cutting, and metal shaping is done by the robotic mechanism. This included Wi-Fi and RFID technology for safer and better metal processing.

It has also been experienced, that the IoT plays a major role in reducing the costs of operating for the managers of the supply chain by detecting leaks of resources. The use of IoT cases for the chain of supply also offers the stakeholders sufficient data for understanding the capability of the company for spending the number of resources in the warehouses (Lee *et al.* 2018).

2.8 Innovation in IoT in SCM

The supply chain management innovation concept is based on the phases, such are, logistic management phase, value chain phase, and supply chain network phase. In the case of making effective innovation within the supply chain management process, the internal SCM process is required to be considered first. The logistics management process consists of three processes such are internal supply chain, suppliers, and management. This helps to make focus on the relationship between the procurement manufacturing, sales, and marketing department. The supply management process is made between the enterprise and the supply chain. The use of the supply chain in logistic management helps to increase the connectivity among the internal supply chain. This also helps to increase the effectiveness of supply management within the enterprise. Apart from that, this helps to enable a credible financial solution through the asset digitization process. Several technologies enable smart supply chain management. The use of RFID technology increases the visibility of the supply chain management process more effectively (Henrique *et al.*, 2019). The innovation of RFID helps to collect digital information from several internal parts.

The next processes of innovations are associated with the value chain process. This value chain consists of the production chain and end customers and users. The consumer's position and the demand of supply can be understood from this area. Here the technological improvement is mainly focused on the forecast, recommendation, and automatic orders. There are several IoT systems like sensors, and RFID helps to make improvements. The RFID systems consist of three components such are, RFID tag, RFID readers, and RFID antennas (Tan *et al.*, 2020). Network systems and radio waves make a more convenient situation for the digital information transfer

possessed. This integration also can be integrated through the enterprise system like MES (Military Engineer Services), PIMS (Production Information Management System), ERP (Enterprise resource planning), DSC (Digital Signature Certificate), and WMS (Warehouse Management System).

The supply chain network is mainly focused on the supply chain network surrounding the core business and helps to make strategic partner relationships. Here the innovation is associated with the planning function. This increases the level of visualization, transparency, and stability of the supply chain. Thus, by innovation practice data transfer within smart devices can be increased more effectively. The innovation of IoT increases organizational coordination for a better supply chain. Innovation in procurement helps to generate real-time and accurate information for the procurement process. The implementation of RFID technology manages to deliver quality raw material to the suppliers and precisely manage the variety of model numbers, batch, and production date of raw materials. This also ensures innovation practice in logistics (Gupta *et al.*, 2019). The application of IoT made any traditional logistics to intelligent logistics. There are the characteristics of raw material; real-time monitoring of the entire possession can be made through the innovation of logistics. Several associated logistics costs can be minimized. Above all this significantly reduces the waste associated with the logistic process and maximizes the overall profit. As per the views of Negi & Anand (2019), the IoT network includes four essential layers, such as sensor layer, network layer, server layer, and interface layer. The construction of every IoT technology is based on these 4 basic layers.

There are also several innovation practices done on technologies like Near Field Communication (NFC), Cloud Computing, and Wireless Sensor Network Technologies. NFC technology is one of the most important and less expensive technologies that are also used in several Smartphone devices. This helps to make communication within the range of 10 centimeters. This effective technology can be used to share important data within devices at the time of supply chain management. In recent days the cloud computing process plays an important role in supply chain management. Information related to the product and services can be stored and processed through cloud computing technology. Apart from that, the wireless sensor network technologies can be spatially distributed to monitor physical environmental conditions like

temperature, pressure, and sound. This also can identify the smart object and interactions with them.

2.9 Issues in IoT application in SCM

There are several reasons for the growth of IoT in the Indian market. The increased rate of availability of smartphones in the Indian market, growth of hardware ecosystem due to low cost of sensors, increase focus on semiconductor companies, and increase the rate of corporate and government investment in IoT increase the opportunity of this technology. However, several challenges are also available for IoT in the Indian market. One of the primary challenges is associated with the fragmentation of standards (Muhammad *et al.*, 2018). In India, the fragmentation of standards with every new emerging technology makes this more complex situation for observers.

Security is also one of the crucial factors for IoT related challenges. Every time with new IoT technology, security becomes a concerning factor. The new IoT technology for the supply chain process of mechanical companies requires effective training and familiarization processes. This process is less effective in the Indian market. On the other hand, the types of vulnerability involved with new IoT are often unknown. One of the major challenges is the internet connectivity. In the case of a multichannel supply chain, there are different types of sensors and IoT are required. Apart from that, there are huge numbers of investments are also required in the research and development process to make effective and desired IoT devices for the supply chain. There are huge differences in recognition processes are still consist of urban and rural areas. This becomes the hindrance to the growth of IoT in the Indian mechanical industry supply chain. Another important concerning factor is the lack of a skilled workforce in India for the implementation of the IoT environment in production areas. As per the labour bureau report, only 3 % to 5 % of Indian labourers are considered to be skilled (Dr Ray *et al.*, 2017). In the case of the mechanical supply chain, the use of IoT can be beneficial in terms of material planning, procurement and integration, distribution, warehouse and fulfillment, and repairs and return practice.

In the case of the internal struggle between the operational management and IT term in the Indian market the implementation of IoT in this market becomes more challenging. The IoT

environment making procedure is effectively hampered by this situation. The existence of an old regular process of working procedure for mechanical manufacturing processes creates a repulsive force to the IoT implementations. To integrate the supply chain process of the manufacturing industry and IoT implementation, complex labour skills are required. India effectively lacks labour with complex skills.

2.10 Relationship between IoT and SCM

The application of IoT in Supply Chain Management is further enunciated in issues and innovation, a distant relationship in addressing supply chain management issues through IoT in mechanical companies is articulated in this section. IoT has acted as a disruptive Technology in Supply chain management for mechanical companies through addressing SCM issues in the early stages of development. IoT has offered unprecedented visibility in SCM, in aspects of offering proceeding early warnings signs its internal and external risk through detection at the early stage (Udine & Al Sharif, 2016). These risks from external and internal sources are reduced through IoT application as early warning system engages early remediation process that allows SCM managers to safeguard the whole supply chain.

IoT has its impact on the Supply chain functioning of Warehousing, Order Management, and Inventory Management, and even transportation. In warehousing operation, the IoT has an Impact through Enabler of Joint Ordering; it saves around 81% to 99% of the time in joint order place and warehousing goods through the technology usage of Smart RFID (Radio Frequency Identifier) tags in the storage of material. The IoT product of smart things in RFID tags allows 100%-time savings in processing material and goods in warehousing. Furthermore, usage of Temperature Sensors in collaborative warehousing safeguards the material in storing the products or material in its required temperature range. Another new technology of IoT in collaborative warehousing is used Smart Things and Multi-agent systems that help the SCM Manager in processing the goods at collaborating warehousing much efficiently (Caviars & Alarcon Valero, 2018). This reduces the time and allows mitigation of risks in collaborative warehousing. The last aspect in which IoT has impacted a lot in warehousing operation is Warehouse and yard management from the aspect of safety and security of goods stored in warehouses. Here the IoT technology that has been used is Smart Things and EPC Global that allows SCM managers to have

a deliberate eye on goods and ensure the products in storage are safely and securely stored in Warehouse and yard of company.

In supply chain manager of mechanical and spare parts company, IoT is helpful in order management and inventory management. The process in which the IoT has impacted in this management procedure is in the area of information sharing and enabling VMI (Vendor Managed inventory) through Real-Time visibility by real-time information sharing through the usage of EPC Global and Smart things of IoT. RFID tags have an impact in inventory shrinkage, inventory misplacement and shelf replenishment in order management inventory managed as the RFID tags give manage and idea regarding actual inventory and allow to mitigate the risk from Inventory misplacement, and inventory shrinkages through remediation by self replenishment by getting an accurate idea regarding actual inventory (Kohl *et al.*, 2019). The mechanical money especially space parted manufacturer used the RFID tags to generate accurate inventory data and out of stock of products through identify data generated from tag to process their demand from market and manufacturer upcoming spare parts according to inventory data and demand.

The transportation activity in supply chain management has seen a huge impact through the application of IoT. The Wireless network of IoT devices has a positive impact on the shipper, receiver, and customer in generating data regarding the application of the product in transportation; this increases transparency that allows easier and accurate data generation and data flow. The Sensor -Enabled RFID tags allow the SCM manager in transportation account in making autonomous decision-making and checking product condition during transportation for quality monitoring of product at real-time. The IoT allows real-time responsive in price optimization through the usage of sensor networks and RFID tags in wireless networks across transportation systems in mechanical companies. Real-time visibility from IoT eases the transportation service by mitigating the risk of in route adulteration. The enhanced real-time visibility in point shopping intermodal shipping in SCM through Smart containers and smart things allows SCM in getting real-time product details and translation location to access and risk from product quality deterioration of mechanical products. The IoT also real-time visibility based on quality matrix through sensory information sharing to cloud serve that undertakes cloud computing to form accurate and timely delivery timely. This results in 300% time spacing in scanning and rescoring of products through RFID tags and smartphones (Yu *et al.*, 2016). The fleet management in

mechanical space companies in dynamic route optimization is essentially helped through Smart Things that generate route data for dynamic route allocation. This time-partition, initiation, and wireless sensor help in quality control of products during transportation in the smart pack going to do the logistical service in SCM into a quality-controlled logistical service.

In Metal-Mechanical Company, there is differentiation operation prosecutes for different departments; usage of RFID technology allows monitoring and management of data in the manufacturing stage and each competent workload at every factory session. The KPIs are monitored through IoT products to produce more accurate information (Ben-Daye *et al.*, 2019). This is applied through the As-Is/To-Be methodology in the improvement of a matrix of quality and meaning product quality across the supply chain management process.

2.11 Literature Gap

Through assessing literature from various research papers has indicated that mechanical companies have utilized IoT in manufacturing processes. There are wide applications of IoT devices in Supply Chain Management addressed. However, there is some literature gap in IoT application of supply chain management for mechanical companies. The literature gap identified mechanical companies' ability in using IoT in their supply chain management activity. The issues and innovation and in easing mechanical companies operating in supply chain management are seen. The spare part manufacturing company ground application of IoT in its manufacturing, and quality deliverables across the supply chain is missing from the literature. There needs to be an assessed rest part of the dissertation to understand the mechanical company application of Supply chain management.

2.12 Conclusion

This section of literature review has given us ample undertaking regarding the application IoT though concepts of Supply Chain Management, the literature review gave us an idea regarding various concepts and theories of SCM through the application of IoT also this literature review gave us an idea regarding innovations in IoT and applications of IoT in different aspects of SCM in mechanical companies.

Chapter 3: Research Methodology

3.1 Introduction

In this chapter of the research methodology, the research methodology has been outlined for conducting successful research. Research has accumulated information regarding various physical materials. The procedure of this research endeavors through this research material is presented. This important as effective methodology would ensure the research objectives are met, and uncertainty risk associated with research is overcome through correct research methodology. The research study can approach with primary data collection method where qualitative data analysis can be adapted to acquire information and relevant data. Also, the qualitative study involves interview questions that can acquire information regarding IoT applications in SCM. The researcher utilizes five managers from business firms for extracting the primary data in supply chain management in India.

3.2 Research Onion

Research onion plays an essential role to list the important steps to manage the research successfully. The proper order can be maintained by the researcher with the help of the research onion for the collection of data from several sources of supply chain management.

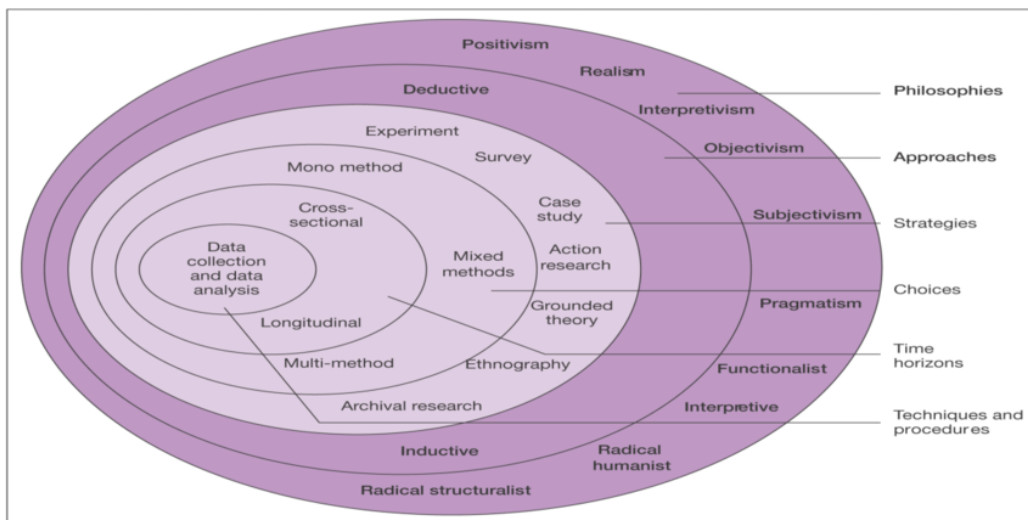


Figure 7: Research Onion

(Source: Saunders, Lewis & Thorn hill, 2009)

3.3 Research Outline

This section outlines each research methodology choice undertaken whole research on the topic of application of IoT in mechanical companies for Supply Chain Management. The tools, approaches, techniques, and methodology for research are illustrated below;

Research methodology	Approaches Used
Research philosophy	Post Positivism research philosophy
Research approach	Inductive approach
Research Design	Descriptive
Research strategy	Interview
Methods for Data Collection	Data collection from primary sources (interviews) and secondary sources (published articles and journals with a relevant theme)
Approach for Data analysis	Qualitative analysis

Tools and techniques	Google form, Google sheets
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3.4 Research Philosophy

The selection of research philosophy is an essential part of undertaking this research for meeting research objectives. The research on IoT application in SCM of mechanical companies such as spare part manufacturing companies has to be followed through given research philosophy. The selection of correct research philosophy while leading to more accurate data findings, from different research undertaken in this field in India is done. Selection of appropriate research philosophy is dependent on nature research was undertaken and possible kind of research outcome to be formed (Fuchs, 2017). There are three research philosophies available for researchers; these are post-positivism, pragmatism, and interpretive. Every research philosophy has its benefits that dictate the term of the research process. The correct research philosophy has been considered through philosophy's benefits and disadvantages. Research philosophy of post-positivism allows research to examine research questions through an analysis of available facts and data, interpretivism research philosophy dictates the reaching process to be examined through perception people regard fresh questions and its solution. Post-Positivism research philosophy in making logical analysis res topic through fresh data and devices backed facts to progress into research understanding of real work though scientific in a query. The Interpretivism research study has the elements of interpretive research through the aggregation of people's perception. It is necessary to select the philosophy of research as it is concerned as beneficial for understanding the topic to the reader. Post positivism has been selected by the researcher for this research topic that deals with theories, models, and many more (Ivanovo & Deluge, 2020). Post positivism is essential for ensuring the discussion related to the hidden information and facts of the digital supply chain management.

Justification

The selection of post-positivism research philosophy is undertaken to understand the implication, impact, and applications IoT devices in supply chain management of Indian

Mechanical companies through existing models, theories, and real-world data from source to format a whole undertaking of the project. The research study has effectively selected post-positivism as it has an area of undertaking an analysis of research questions on the topic via a standardized protocol (Tobi & Kampen, 2018). The selection of post-positivism is essential to align with the research objective the post-positivism research uses the standard data collection methodology to minimize research issues through personal bias that can come from interpretivism. The post-positive research philosophy mitigates this personal bias of research and respondents through logical analysis of data, not of opinions. Another reason for not selecting interpretivism is due to the expansion of interpretivism in observation data collection opinion foundation through analyses of people's perception and not based on real facts. This is the reason for the selection of post-positivism in research philosophy.

3.5 Research Approach

There are three methods of reasoning; deductive, inductive, and abductive approaches. The research approach that can be selected for undertaking this research is the deductive and inductive research approach. This research approach is selected through formulating the research structure. The research approach helps research in establishing the research structure according to data availability and information pieces regarding the research topic. The deductive research approach uses the state where the emphasis is put on obtaining research knowledge for researching a particular field in the process of top - to - bottom approach. There the hypothesis is created for undertaking a literature review on a particular topic, and then its relevant literature review is performed. However, in the inductive research approach, the methodology adopted is bottom - to - top where an initial literature review gives helpful insights and overall understanding of the research topic, upon which the research hypothesis is, formulated (Liu, 2016). Inductive research is helpful in the formation of a new theory or hypothesis through undertaking literature review initialization, whereas in the deductive research approach hypothesis is established initially, whose confirmation and negation purpose literature is reviewed. As per the availability of the information as well as data an inductive approach has been selected by the researcher as a research approach for this topic. The new models along with the relevant theories can be easily built up by this approach. The deductive approach also plays an essential role in collecting the information

and data to the researcher from several sources for meeting the objectives of the research (Melnikovas, 2018).

Justification

The selection inductive research approach is one though careful analysis of the pros and cons of research approach, the nature of research in which new impact from IoT usage in SCM of mechanical companies is to be formulated requires an inductive research approach. The justification for the selection of inductive research approach comes from the research statute here inductive research would analyze the existing theories, report, company adoption rate of IoT its impact to formation of a hypothesis regarding impact and application, adoption of IoT in supply chain management of mechanical companies in aspects that being analyzed through literary review in this research topic. This research approach is different from the deductive research approach where a hypothesis is initially developed, which is confirmed or negated after undertaking a comprehensive research literature review on a given research topic (Sendall *et al.*, 2018). An inductive research approach allows a researcher to gain a broad understanding of a topic and not get trapped into the limited scope of the deductive research approach. The inductive research approach has a broad scope of development of new hypotheses from analyzing existing research studies; it would allow the researcher in getting a detailed broad knowledge acquisition to develop new hypotheses regarding the research topic on IoT application in supply chain manager for in quality deliverables by mechanical companies.

3.6 Research Design

There are three research designs available for undertaking a complete successful research study. The three research designs are exploratory research design, descriptive research design, and conclusive research design. The sectional research design is essential for completion of research as in research aim and objective; appropriate research design selection would help in serving the research framework though supporting proceedings and tasks for completing research. The exploratory research design emphasis is laid on the psychological aspect of research can undertake generation through research direction from specific topic to general concept and idea formation, in exploratory research design aim is to speed the research study aspects without any intention of

formation of any conclusive final research answer of a research question (Rink, 2016). However, in the research design of descriptive, the research layers focus on delivering or information research confusion that answers the research question and meets fresh objectives through conclusive research conclusion formation. In the last conclusion research design, the researcher undertakes a researcher study with a specific purpose of verification of the research hypothesis and other insights that are developed initiation. The conclusive research design allows researchers to proceed with research design on chosen research topics and verify the industry insights to confirm research design. The research approach can be broadly divided into three parts such as Exploratory, Explanatory, and Descriptive Research. The descriptive research has been selected for this topic as it helps find the questions related to how, where, when, and thus has helped in underpinning the IoT usage in the supply chain.

Justification

The selection is a descriptive research design for the study of application and impact of IoT in supply chain management of Mechanical Companies is done. This study would help us undertake the usage of IoT, application of IoT, quality deliverables managed through the usage of IoT, and other applications in mechanical companies. The descriptive research design allows the researcher to approach the research question and objective in a research study to find answers. The descriptive research design allows researchers to formulate a descriptive answer to the research question. The objective of finding answers to research questions can only be fulfilled by descriptive research design, and therefore a descriptive data analysis is needed for quite understanding the impact of the research topic, which is IoT on SCM of mechanical companies. The sample size for data collection is limited; According to Renner, (2018), a description of research study research to establish research. The descriptive research design would allow researchers in completing and collecting qualitative research data and allows it to be analyzed to formulate well-laid plans out research that has format structure design to present the whole researcher on IoT application in SCM in mechanical companies. Furthermore, it would allow researchers to gather relevant information for answering research questions and meet research objectives.

3.7 Research Strategy

The research strategy is adopted to deliver research-backed by facts and data. The collection of data and its approved strategies for analyzing its data is used. These researcher strategies describe the procedure of research primary data collection tools. The available research strategies are overview, observational data, interview consumption, contextual text analysis information, survey, and many more (Brandy *et al.*, 2018). The information gathered through the research strategy is analyzed to form conclusive research. The interview allows the researcher to get qualitative research data from ground through interviews of professionals with great experiences in SCM in mechanical companies and to new usage of IoT in its SCM process.

Justification

Through analyzing the literature research, research felt there is a deep need to ground reality understanding of IoT usage in mechanical companies for their supply chain management. For undertaking this endeavor, a research strategy of interviews is selected that provides research in having a great understanding from working professionals about usage, application, and impact (Padilla-Díaz, 2015). This strategy of interview allows the collection of enriched original data collected from major mechanical components. The open-ended interview question would always have their manager to present their opinion and undertaking of IoT impact on SCM of their companies. This opened-ended questionnaire would allow interviews to present their opinion and attitude towards the research question topics through research interview questions.

3.8 Data collection method

There are two types of data collection methods such as Quantitative and Qualitative. The data has been collected in the form of a qualitative method by the researcher in this research as it helps to provide detailed information related to this topic. The research has used primary qualitative data to elaborate on the aspects of IoT in the supply chain. Qualitative data analysis through interviews provides practical concepts, human perspective, and managerial preferences for adopting or implementing IoT devices in Indian supply chain management.

Primary Research Sources

The primary research is stored through interviews. The data collection method of qualitative research through interviews allows the research to have updated data from working professionals to develop much more authentic, fact-based research. For undertaking as a descriptive research design, a more research approach of relevant data from different data courses is to be used to formulate a conclusion research question (Shrivastava *et al.*, 2018). The data collected from open-ended questionnaires is well-structured and allows specific data collection from different sources of interviews of managers of mechanical companies to provide research data. It would give deep insistence and add depth to an understanding of research questions through online qualitative research data collection. In terms of sampling and size, the researcher has acquired the sampling of the probability of five managers for observing the test for the sample. The five managers have been chosen for the interview questionnaire in this research. The interview session can derive information according to the research objectives and acquire relevant primary data from selected five research participants

Secondary Research Sources

The collection of secondary data occurs through newspaper articles, journals, magazines, and other research study material from various publican and government sources. The data collected from secondary sources can provide background information on the research topic on the Applications IoT in different SCM processes of mechanical companies.

3.9 Data Analysis

The thematic analysis method is used for analyzing the data, it aims to fulfill the objectives of the qualitative data as it would add a greater understanding of ground reality regarding the effectiveness of IoT in SCM for mechanical companies. The six steps of thematic analysis are familiarization, coding, generating themes, reviewing themes, defining and naming themes, writing up. After the collection of data, the researcher must analyze the research for

understanding the issues, along with its solutions. The development of the findings as well as the progress of the research usually depends on the analysis of data. In this term, the research has used interview analysis to explain and underpin the major aspects, whereby the supply chain can be elaborated in terms of its efficiency and usage.

3.10 Ethical Consideration

The ethical consideration for undertaking this research is in the area of conducting interviews of respondents, which are managers from mechanical companies in India. The researcher would ensure that data collected from different primary resources be not utilized for any commercial purpose but only for academic purposes. The respondents are allowed to leave the survey at any time they feel like, they would not be pressured to undertake part in this survey, and their consent regarding job has to be asked from respondents. The data collected has to be in accordance with the Data Protection Act, 1988, a deception or exaggeration of fact to meet the objective done would be acceptable for undertaking this research study.

3.11 Research Limitation

The main limitation for the researcher is the time and budget as both of them are restricted. It is also found that the researcher is not sure about the accuracy of the information and data. The sample size for qualitative data is five, where the researcher has collected interview responses from five managers involved in Indian supply chain management and distribution procedures. The gate pass is necessary for the researcher for entering into the organization for the purpose of the interview. It is also necessary for the researcher to provide proper attention at the time operation of the research interview. The data need not be utilized by the researcher for the purpose of any commercial use. The policies and procedures of the company need to be disclosed by the data that have been extracted by the researcher.

3.12 Conclusion

This chapter gives ideas regarding the whole research methodology along with research philosophy, design, and approach to complete the study. The usage of various research tools and techniques admits justification in selecting these research tools is also present in the session. The

research philosophy of post-positivism is selected for conducting indicative research on a topic of IoT application in SCM in Indian Mechanical companies. The descriptive research design with data collection from both primary and secondary sources through a qualitative research data analysis that is collected from interviews of five managers is well established with its justification. Finally, with the data analysis technique description and ethical consideration, the research methodology section is completed.

Chapter 4: Findings and analysis

4.1 Overview

This chapter of the research paper is focused on the data findings and analysis of the gathered results from the analysis of the collected data. The qualitative analysis involves the preparation of a questionnaire consisting of 10 questions which will be confronted by 5 managers from different companies. Data gathered from the responses of these managers will determine a conclusive answer to the research questions. Apart from the qualitative analysis, various journals have been selected in this section to conduct a thematic analysis to analyze the data collected from secondary sources such as journals, articles, and magazines.

4.2 Qualitative Data collection

Q1.What IoT devices are your company adopting to manage an effective supply chain?	
Manager 1	<i>“ I think RFID Chips and mobile sensors are must track goods throughout their journey from shipment to reach final destination location ”</i>
Manager 2	<i>“Devices capable of providing GPS connection and sensors which monitor pressure and temperate signals which helps to identify authorization and condition of products”</i>
Manager 3	<i>“Location tracking is a big concern so RFID and other IoT devices like Edge gateway are used to track the location of product all the time will be needed”</i>
Manager 4	<i>“My company uses IoT devices such as End node which is used to send</i>

	<i>environmental data to the gateway. Gateway is a device which transmits data from the end node and transmits to the internet”</i>
Manager 5	<i>“ I just want to get rid of my outdated manual processing for supply chain and expecting to add speed with accuracy in the supply chain of products for which I use a server for collecting data”</i>

Q2.What possible issues and challenges can your company experience while adopting IoT in SCM?	
Manager 1	<i>“Employees in production and shipping team should get familiar with IoT devices soon otherwise issues will arise”</i>
Manager 2	<i>“Proper maintenance of the devices can be quite challenging and costly, moreover if sufficient training of using of IoT devices are not given may lead to time consumption”</i>
Manager 3	<i>“I have to arrange a special team in the IT department who will manage troubles associated with IoT devices on a daily basis”</i>
Manager 4	<i>“Employees will have to learn about the functions and features of devices as soon as possible”</i>

Manager 5	<i>"I have to make sure that good network connectivity should be available all the time to make sure the proper functioning of IoT devices"</i>
Q3.Which improvements are necessary for your company's infrastructure to adopt IoT in the supply chain activities?	
Manager 1	<i>" I think my company required inductance of training programs for employees regard IoT"</i>
Manager 2	<i>"Infrastructure improvement is must for IoT inductance"</i>
Manager 3	<i>"I think the skilled labours and workforce system required to be improved"</i>
Manager 4	<i>"I think A proper line of resources and investment required for adapting IoT based supply chain"</i>
Manager 5	<i>"For me, proper management required, supply chain required to be lead by someone who has it based knowledge"</i>

Q4.How is supply chain management of your company without IoT implementation?	
Manager 1	<i>"Definitely speed and accuracy is low in managing supply chain of products"</i>

Manager 2	<i>"I face daily troubles of problems associated with exact location of goods after dispatching from production house"</i>
Manager 3	<i>"Employees often mistakes in recording details of product manufactured and about their location details"</i>
Manager 4	<i>"Sometimes delay in delivery of products causes serious loss but this is a common thing in business"</i>
Manager 5	<i>"I used to worry about the supply of products and their locations"</i>

Q5.How can your organization improve existing infrastructure and internet interfaces to adopt IoT in SCM?	
Manager 1	<i>"I have to manage a special team that will work on improving the internet facilities of the company "</i>
Manager 2	<i>"I always prefer broadband connections provided by the local broadcast providers"</i>
Manager 3	<i>"I will make changes in technology to match the criteria of IoT devices to work "</i>

Manager 4	<i>“Production houses are established in remote areas so have to change current Internet facilities to a reliable network to support the requirement of IoT devices”</i>
Manager 5	<i>“My company is already using advance routers also I am using a private broadcast partner for internet facilities”</i>

Q6.How do you think the company can address IoT implementation issues and challenges in existing SCM?	
Manager 1	<i>“I think this will be a necessary change for better use of technology and IT team in my company will arrange all the requirement ”</i>
Manager 2	<i>“IoT devices are going to replace man efforts made in supply chain management and current SCM seriously need integration with technology to achieve required speed”</i>
Manager 3	<i>“Existing SCM system needs a makeover and adding IoT devices are the only option to make the whole system faster and better”</i>
Manager 4	<i>“Depending upon the facilities provided by IoT devices, I would say we should have accepted this technology earlier ”</i>

Manager 5	<i>“This is exhausting to call again and again to monitor the location of the product in a way for delivery so I will eagerly welcome new technology”</i>
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Q7.How can Indian internet infrastructure help the company’s IoT managed supply chain?	
Manager 1	<i>“We have issues regarding internet infrastructure of this country but comparing to the past we are reaching to desirable position”</i>
Manager 2	<i>“It is improving and I hope that very soon we will self invent good technologies to improve the flexibility of different IoT devices”</i>
Manager 3	<i>“The current situation of internet facilities are pleasing and definitely can support IoT devices to work”</i>
Manager 4	<i>“Internet facilities in remote areas need to be improved so that we can track our product on its journey”</i>
Manager 5	<i>“ Overall Improvement is needed in several locations only cities are not part of our business ”</i>

Q8.What issues does the company solve in the supply chain activities while integrating IoT?

Manager 1	<i>“Speed and accuracy will be definitely increased”</i>
Manager 2	<i>“I will be less worry about authorization and delay in product delivery”</i>
Manager 3	<i>“Sensors used in IoT devices will help to identify product authorization”</i>
Manager 4	<i>“GPS monitoring of product will be easier”</i>
Manager 5	<i>“This is going to solve issues like location tracking, goods getting lost or delayed will be identified and real-time shipment will be observed”</i>

Q9.How can IoT devices help the organization’s manufacturing process, resource management, and distribution?

Manager 1	<i>“The record of the manufactured product and their delivery location will be all-time available”</i>
Manager 2	<i>“I think distribution will be faster as every good can be delivered at the right time”</i>

Manager 3	<i>“This system will help to stop wastage of money on excessive production of goods without demand”</i>
Manager 4	<i>“Speed in the supply chain will improve the overall profitability of the company”</i>
Manager 5	<i>“Profit range will obviously get high by proper management of goods supply”</i>

Q10.Which contemporary practices can your company employ in IoT integrated logistics and SCM?	
Manager 1	<i>“Application knowledge of device, data collection skill from IoT devices are some basic contemporary practices required for IoT supply chain implementation”</i>
Manager 2	<i>“In our company, most of the employees are having mechanical skills thus, employee which has IT-based knowledge can implement contemporary practices for IoT implementation”</i>
Manager 3	<i>“Data collection, data management, and knowledge of IoT devices are some contemporary practices required within a company”</i>

Manager 4	<i>“Within a company like mine, the experience of working with RFID technology can be considered to be enough for contemporary practices”</i>
Manager 5	<i>“IT skills such as knowledge of basic computers can be considered to be effective contemporary practices for IoT implementation.”</i>

4.3 Findings and analysis

Three different themes have been selected for this research paper.

IoT based technology has improvised Supply chain management

IoT is recognized as a collection of interconnected physical, internet-enabled devices that are capable of providing the report, monitor as well as sending and receiving data. As stated by one of the managers *IoT devices are going to replace man efforts made in supply chain management and current SCM seriously needs integration with technology to achieve required speed* This property of IoT devices greatly influences the supply chain management of an organization. In addition to this, IoT is generally connected to the computer system through wireless connections and Wi-Fi networks. Hence, considering its contribution to the supply chain, it can be described that these IoT devices can effectively be used for tracking and authenticating goods and shipments with the help of GPS and other innovative Technologies (Tu *et al.*, 2018). This technology can also be used for monitoring the inventory and other **“storage conditions”** of the storage unit. This enables your organization to improve quality management across their entire supply chain network.

Adoptions of IoT Technology and devices have immensely revolutionized the traditional approach of supply chain management (SCM) that the leading business forms used to take. Adoption of IoT devices for managing supply chain networks has enabled do business firms to easily e locate their goods at any point in time and gather information on the storage conditions of the warehouse where the goods are being stored. Also, this technology has enabled devices firms

to make predictions and provide unexpected time for a product to reach a certain location (Aryal *et al.* 2018). Some of the benefits organization avail after adopting IoT technologies to manage their supply chain is as follows;

- Companies able to authenticate the locations of the products at any given time
- Companies IoT technology can effectively track the speed two of the product-moment and can predict the time of arrival of the product to a specific location
- Implementation of IoT Technology has greatly enhanced the capability of a company to streamline the problematic movements of the products that occasionally serves as a barrier to enhancing the efficiency and productivity of their organization.
- IoT technology has enabled the organizations to effectively monitor goods right after receiving the reception of the products

Besides, it has been revealed that some of the organizations have to ensure that their products are stored in an adequate environment. For example, ***Sun Pharmaceutical***, an Indian pharmaceutical company has to ensure that their chemical products are always stored at an appropriate temperature within the warehouse. Considering this example it can be described that there is a strong possibility for an organization to suffer losses in case they fail to notice any change in the temperature within their warehouse. However, the implementation of IoT devices within their Storage place and warehouse in India will allow companies such as ***Sun Pharmaceutical*** and ***Dr. Reddy's laboratories*** to ensure that their storage conditions optimum for their chemical products. Hence, the implementation of IoT devices enhances the security of the products within their warehouse (Calatayud, Mangan & Martin, 2019).

Also, it has been revealed in this study that the implementation of IoT technology has enabled real-time process price optimization through the use of sensor networks and RFID tags in wireless networks across mechanical enterprise transportation systems. IoT's real-time visibility and ease the transportation business by reducing the possibility of adulteration in the road.

IoT application and infrastructure is a major factor for SCM within Indian companies

Major benefits enjoyed by Indian organizations after adopting IoT technology in regards to aspects of SCM are as follows;

- Gaining reassurance that the Products are located stakeholders are employing they are both considering both at rest and at the time in motion (Haddud *et al.* 2017).
- Implementation of IoT technology allows organizations to identify involved issues, risks, and challenges with the supply chain prior to its occurrence. These issues can include loss of products or delays in delivery.
- IoT also allows Indian companies to effectively track their inventory status and conduct a better inventory forecasting while analyzing the demand and supply constraints of the products.
- Implementation of IoT technology also enables organizations to effectively manage their supply chain in a better way as compared to traditional approaches.
- Convenient planning of supply and demand, as stakeholders understand when to anticipate acquire and transmit organizational products
- IoT technologies also assist Indian companies in terms of better quality control and management. This is generally achieved by ensuring that raw materials and finished products are stored in optimum conditions.
- Effective storing and delivery of products as a result of the easy location of products within warehouses
- According to NASSCOM there are 5000 IoT patents are done in the last 5 years (nasscom.in, 2020).

In addition, opinions of the managers shared in interviews and information gathered from these article alignments. Furthermore, it has been revealed that the IoT market in India is expected to reach more than USD 15 billion by the end of 2020. Moreover, considering the current pandemic

situation, the adoption of these IoT devices has become more crucial for maintaining uninterrupted organizational operations while ensuring the sustainability of their business firm.

Implementation of IoT devices allows the Indian companies to track the traffic of distribution flow and the movement of the products across their supply chain network. This makes it there for the company to predict the movement of the products across its supply chain network. Manufacturers, suppliers, and delivery centers should plan to accept products, thus growing processing times and ensuring supplies are handled efficiently (Mostafa, Hamdy & Alawady, 2019).

Various products including food products and chemical drugs used as medicines can be processed in optimal conditions. *“Specialist IoT devices”* are capable of monitoring areas such as moisture, temperature, light intensity, atmospheric exposure, and other environmental factors. These devices may even trigger an alarm if they breach certain thresholds. This makes monitoring the consistency of the product across the supply chain and rising spoilage even simpler.

Some Essential improvements required within IoT employment

It has been determined from the analysis of different journals and articles that it is required for an organization to ensure that its implemented IoT technology organization is constantly upgraded while focusing to maintain an up to date IoT infrastructure which is becoming a requirement. Considering the vast population of India, it has been estimated that at the end of 2021 there may be 11.6 billion working IoT devices within this nation. Furthermore, it has been anticipated that by the end of 2025, there will be more than 21 billion IoT devices across the world and to work effectively and provide greater productivity, it is required for organizations to constantly adapt innovative IoT Technology into their organizational activities (Rejeb, Keogh & Treiblmaier, 2019).

With rapidly advancing technology, it is quite likely that hackers and cybercriminals will be using IoT devices for organizing DDOS attacks. Hence, it is required for Indian company's student to ensure that their infrastructure has effectively adopted all the patch files that will allow these organizations to have secured infrastructure systems that will allow your organization to either

slow down the cyber-attack, or swiftly take effective measures to combat the situation, or entirely prevent the event of Cyber-attack on the organization.

Moreover, improvements in IoT infrastructure will allow the Indian companies to step up within their competitive business environment while creating a competitive advantage with the help of advanced technologies. The primary objective of adopting innovative technology within their organization's supply chain is to provide consumer satisfaction and purchasing experience for their target consumers. Apart from this, it is also required for organizations to focus on improving their technical aspects which will allow them to reduce operational costs. Furthermore, the improvement of IoT technology can potentially lean an organization towards the automation of its organizational procedures.

It has been revealed in the study that most of the organizations such as *“Godrej consumer products limited”* “invest heavily in the research and development sector to improve technology being used within their organization. Similarly, other organizations such as *“Renault Nissan Technical Centre”* “have developed an electric automobile that is connected with their innocent connect app which provides information about the speed and the distance traveled by that automobile (Tu, Lim & Ming-Fang, 2018).

Issues and barriers to IoT integration Indian

IoT systems are dependent on decent network connections to run well. They need to be able to relay their locations to GPS satellites, and certain IoT system forms that need Wi-Fi, Bluetooth, or other networking. In environments with loads of electrical or radiofrequency disturbances, they do not work as effectively. Hence, it can be deduced that stable and powerful internet connection can be considered as one of the challenges for an organization to overcome. Considering most of the IoT devices are connected to the network wirelessly, it is required for the organization to establish wireless connections in the network set up.

IoT devices often depend on being correctly assembled and operated. Skilled people can just treat them, add them, or delete them. It is also crucial to use the right IoT tool for the right work because if they are not handled properly they can easily be destroyed. Hence, it is

recommended for Indian companies to hire skilled and competent employees for their network management team (Singh, Ashutosh & Srivastava, 2020).

One of the major challenges an organization has to face while integrating IoT technology within its supply chain network includes enabling their employees to effectively use this technology. This challenge simply involves taking effective advantages of the change made by the organization by the employees. In order to overcome this change, it is strongly suggested for the organization to provide effective training and educational suggestions for their employees (Yan *et al.* 2018). This strategy will not only educate the employee about the effective usage of IoT devices but also enhance the skills and capabilities of the employee at an individual scale.

4.4 Summary

This section of the study comprises an analysis of data findings from both primary and secondary data sources. A questionnaire with 10 questions has been prepared for conducting an interview within which 5 managers from different companies have participated. In this interview, these 5 managers were subjected to the 10 open-ended questions. Hence the managers were free to provide their own opinion within a few words as an answer to the interview questions. Hence a total of five responses have been generated for each interview question for this research paper. In addition to this thematic analysis has been conducted to analyze the information gathered from the secondary sources. The systematic analysis involves the analysis of the journals and articles by aligning common themes shared by all of these articles. Contents of these articles and journals have been compared and contrasted in the semantic analysis to derive conclusive statement for the research questions of this study.

Chapter 5: Conclusion

5.1 Summary of research findings

The mode of business has been changing throughout the years. The technological evolution has been developing the ways of business day by day, among them, the Internet of Things (IoT) is one of a kind that has been growing its popularity in recent times. Within this concern research, it has been seen that Indian is being a developing country has been tried to improvise its effectiveness within the mode of business. Starting from business motoring to supply chain management technological improvisation has reflected profoundly. Mechanical industries of India such as TATA, Godrej, Hindustan petroleum all are accumulating and managing their supply chain for business through IoT devices. From this concern research, it has been also seen that the supply chain management business within India is very large. Almost 13% of GDP has been collected from the supply chain business. Although the mega industries of Indian have been accumulating technologies of IoT deceives, almost 85% of SMEs have been lacking from the use of these technologies.

IoT devises business within Indian has a brighter future as it has been expected that by the end of 2025 it will be a billion-dollar industry. This concern technology is very effective for business management purposes as it integrates interconnection between physical devices that can be acquired. Inventory monitoring transported monitoring and project progression status analysis all kinds of data have been effectively collected and shared through these devices. In this research, it has been evaluated that IoT device inductance for a Mechanical company is not only effective for supply chain management but also essential for inventory management, resource management, and product.

As the main focus of this concern research has been about SCM (Supply chain management) thus the approaches for this concern have been evaluated here. From literature analysis, it has been Highlighted that most of the supply chain within Indian has been managed through the Phase Alternate Line (PAL). From the findings, it has been evaluated that this approach enables efficient inbound and outbound logistics in organizations and integration.

It has been found within literature research that business infrastructure is also a very important part of the technological implementation of IoT. Many researchers have developed their perspectives toward the proper adaptation of infrastructure to employ IoT integration framework for securing smart and efficient systems. In this analysis, it has been reflected that the infrastructure of the IoT system required having several layers of services, interfaces, and transmission procedures, and data collection methods.

These all can be ambulated through RFID sensors and digital marketing technology. This assessment of framework implementation has future scope for IoT integration can develop the design of virtual factories, sustainable manufacturing processes, smart control on production, and innovative production chain with factory visibility in supply chain management. As an example of infrastructure implementation Godrej consumer products limited have been considered. Within this research, it has been found that this concerned company has invested in IoT technology and robotics for an effective manufacturing process in India. The issue of the production line which was bottlenecking this certain issue has been improved through Technological application. However, several Indian automobile companies also use the 3D technology IoT for car components, machine learning in manufacturing units, and AI blockchain and robotics. From this concern, it has been evaluated that mechanical Companies of Indian have implemented IoT within their production line, but for supply chain improvisation not much effectiveness has been reflected. However, the tracking system, inventory counting systems are some sort of IoT based technology that has been observed to be used within the line of the supply chain.

5.2 Linking with objectives

Linking with objective 1:

For this objective, the research study focuses on questions 2, 3, 5, and 6 of qualitative analysis. It has been found that there is a huge influence of IoT on supply chain management of mechanical companies in India. Most of the supply chain managers involved in the analysis process expressed their desire to switch on IoT devices for supply chain management in their firms. The primitive way of product delivery and supply chain management cannot meet the current demand rate of the market. This research also records disappointments of supply chain managers that are managing their product supply using old methods. As per their view, there is a loss of time

and accuracy by depending upon the primitive way of the supply chain. Today IoT has made revolutionary changes in supply chain management by fast track GPS location monitoring of products and exact authorization of products at delivery locations. The research part, especially data analysis done by interviewing 5 supply chain managers of mechanical companies in India highlights the need and advantages of switching techniques of the supply chain with the latest IoT devices. Thus the influence of IoT in supply chain management is adding speed and accuracy that is a vital requirement of current market cognition.

Linking with objective 2:

This objective of the research is achieved in the finding and analysis section. The application of IoT devices is highlighted as better storage capacity, fast delivery, location monitoring of goods, and convenient planning of the production of goods and future demands can be estimated. IoT is completely changing perception regarding quality monitoring and finding control over the entire transaction process of products. Indian business market is ready for this revolutionary change as industries in this country are focussing on the integration of technology to achieve a desirable rate of goods transaction. This research paper also includes data records of companies that are already using IoT devices in their business operation to maintain a smooth delivery rate and controlling entire functions associated with supply chain management. The qualitative data analysis of this research paper highlights the current perception of supply chain managers regarding the usefulness of IoT devices in supply chain management. The qualitative data record of this research includes an interview report of 5 supply chain managers of reputed mechanical companies of India. Their perception of this new technology is positive and they want to get rid of the old primitive way of supply chain management and they now understand adding this technology will not only economically beneficial but also the market image of companies will be improved by adopting new changes of the business world.

Linking with objective 3:

This objective is achieved in the data collection part of the research. The data analysis has been done by asking 10 questions based on the application and usefulness of IoT devices in India, The response of supply chain managers involved in this research clearly indicates green signal and

big market scope for this new technology. The improvements in supply chain management after adding IoT devices are appreciable and business owners are satisfied with these device applications and speed and accuracy can be restored by using the technology. Developed countries such as America and Japan have already dedicated their supply chain management services to this new technology and are earning big profit by this technical integration. Now, this is the right time for India to adopt this device as this country is on the verge of development, new technology, strategy, and speed is must to meet market expectations. This research paper includes a statistical data record of the future scope of IoT in the business market of India and the results are satisfactory.

Linking with objective 4:

The complication and issues associated with the application of IoT devices are also part of this research. There are several locations, roadway, and highways that need better construction and network capability also require improvement before completely relying on the technology. This country is making improvements though there is a need to fast track changes to make resources better for the adoption of IoT in India. Many supply chain managers in qualitative analysis express their problem regarding the poor condition of highways and network connection issues in their business operation areas. As per their view, there is still a need for the government to focus on these matters for making India top in the business world. The current ruling government of India has given priority to "Make in India " and made a vision to export goods manufactured in their own country and thereby making economic development in the coming years. This vision cannot be achieved by avoiding the utilization of technology and taking the right step at the right time. This research paper explains all possibilities steps to improve conditions of Supply chain management by adding technology.

5.3 Recommendations

The first priority of business owners should be to force their government to make changes in infrastructures of roads and network capability of India. This is a broad level change and single business owners cannot arrange all facilities alone. There should be a combined motive of all

business owners to urge their ruling government to make required changes in highways and networking of this country (Akram, 2016).

Each supply chain manager has to understand the demand of future customers which will be speed and accuracy. These requirements can only be achieved by adding the latest technology such as IoT devices which will allow them to store their goods in good condition. Also, their services delivery rate will improve after the integration of this new technology. The statistical data shows that the Indian business market has a brighter future in the business world but using primitive technology is stopping this country from achieving a desirable rate in business operations (forbes.com, 2020).

Awareness about new technology is also a dependent factor. There are many business owners with a perception to depend on a primitive method of supply chain management. There will be a need to spread awareness about the usefulness of new technology. Probably marketing and advertising by IoT application providers can help to make maximum business owners aware about the application of this new technology.

5.4 Research limitations

This concern research aimed to find the influence of IoT technology on Supply chain management. Several kinds of qualitative and secondary methodologies of data collection have been inducted within this research to achieve this concern aim. It has been found that in conductance of research investigation and data collection there are several kinds of limitations faced. These concern aspects of limitations have been causing hindrance to accumulate this concern research adequately. In this concern research, those limitations were unavailability of respondents for qualitative data collection. To collect some industrial data about IoT devices, some managers from different mechanical companies have been asked some questions. Unavailability of their time and interest in some cases has been causing limitations to data collection. On the other hand, secondary data has been collected from several journals and websites. In some cases, articles require paid subscriptions. In this context, the limited budget of this concern research has been considered as a limitation. Lack of authentic books and news are also causing hindrance to the manner of data collection.

5.5 Future scope of the study

The market of IoT devices has been increasing day by day, in this scenario, the implementation of technology has also become an essential part of associated business. The supply chain has always been a core part of technology-based business. Thus improvisation of the supply chain through the proper association of IoT based devices can be considered as a future of this technology. This concern research is based on the evolution of IoT devices thus in the context of academic purpose, this research has the scope of defining this technology for more effective ways of improvisation. Not only tracking goods and inventory status but also any kind of hurdle within the supply chain can be estimated through the data collection method of this concerning technology. In future IoT based technology has potential for theft control, road accident identification, bottleneck identification of supply chain, and so on.

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Appendix 1: Interview Questions

Q1: What IoT devices are your company adopting to manage an effective supply chain?

Q2: What possible issues and challenges can your company experience while adopting IoT in SCM?

Q3: Which improvements are necessary for your company's infrastructure to adopt IoT in the supply chain activities?

Q4: How is supply chain management of your company without IoT implementation?

Q5: How can your organization improve existing infrastructure and internet interfaces to adopt IoT in SCM?

Q6: How do you think the company can address IoT implementation issues and challenges in existing SCM?

Q7: How can Indian internet infrastructure help the company's IoT managed supply chain?

Q8: What issues does the company solve in the supply chain activities while integrating IoT?

Q9: How can IoT devices help the organization's manufacturing process, resource management, and distribution?

Q10: Which contemporary practices can your company employ in IoT integrated logistics and SCM?