RESEARCH REPORT

"A STUDY ON INFLUENCE OF INTERNET OF TINGS (IOT) IN SUPPLY CHAIN"

Submitted to the INDIAN MARTIME UNIVERSITY in partial fulfilment

of the requirements for the award of degree,

MASTER OF BUSINESS ADMINISTRATION IN INTERNATIONAL TRANSPORTATION AND LOGISTICS MANAGEMANT

Submitted by

AJAI KURUVILA

MBA – ITLM

IV- SEMESTER

(Reg No:1905305004)

Under the guidance of

Dr. JAYAN P.A

Head of department - School of Maritime Management

Indian Maritime University, Cochin

Date of Submission: 28. June. 2021

SCHOOL OF MARITIME MANAGEMENT

INDIAN MARITIME UNIVERSITY

COCHIN CAMPUS

(A Central University, Government of India)

DECLARATION

I **Ajai Kuruvila (Reg No:1905305004)** student of **School of Maritime Management, Indian Maritime University, Cochin** hereby declares that this research report titled **"A Study on Influence of Internet of Things (IoT) in Supply Chain"** Submitted on the partial fulfilment of the requirement for the award of degree of **"Master of Business Administration in International Transportation and Logistics management"**. The research report is my original work carried under the guidance of my project guide **Dr. Jayan P. A.** The report has not formed the basis for the award of any degree/diploma of any University or Institution. The information submitted is true and original to the best of my knowledge.

DATE:

PLACE: KOCHI **AJAI KURUVILA**

CERTIFICATE

This is to certify that, this project titled "**A STUDY ON INFLUENCE OF INTERNET OF THING (IOT) IN SUPPLY CHAIN**" submitted to **SCHOOL OF MARITIME MANAGEMENT, INDIAN MARITIME UNIVERSITY, COCHIN CAMPUS** by "**AJAI KURUVILA**" for the partial fulfilment of the requirements for the award of the degree of **MASTER OF BUSINESS ADMINISTRATION IN INTERNATIONAL TRANSPORTATION AND LOGISTICS MANAGEMENT** is a bonafide record of work carried out by 'his/her' under my guidance.

DATE : **Dr. JAYAN P.A**

PLACE: COCHIN **(HOD, SMM-IMU COCHIN)**

ACKNOWLEDGEMENT

I wish to express my sincere gratitude to the Management of the School of Maritime Management, Indian Maritime University Cochin, who enhanced my knowledge in the field of International Transportation and Logistics Management.

My thanks and appreciation to my Institution in developing the project and people who have willingly helped me out with their abilities.

I am thankful to Dr. Jayan P.A sir (HOD, School of Maritime Management, IMU Cochin) for his help, guidance and support in completing the research report during the COVID-19 situation and also in time. My sincere gratitude to all other faculties of IMU Cochin.

I perceive as this opportunity as a big milestone in my career development. I will strive to use gain skills and knowledge in the best possible way, and I will continue to work on their improvement, in order to attain desired career objectives. Hope to continue cooperation with all of you in the future. I also thank my family and friends for the continuous support in completing my project work.

AJAI KURUVILA

EXECUTIVE SUMMARY

This report is a detailed overview of my research “A study on the Influence of IoT In Supply Chain”. The main aim of the report is to have an adequate knowledge about the different types of technologies used in supply chain management and how beneficial and effective while using the same.

During the research I have learned about IoT applications and integration in supply chain, inventory management and logistics activities. I have known about the usage and implementation of IoT in supply chain and warehouses. I have theoretically learned about different types of IoT devices and its usages.

In this report there are five chapters, all chapters focus on the influence of IoT, Applications, Devices, Supply chain, Smart Supply chain, Industry 4.0, Benefits of using IoT in supply chain and more. From this research I had a great opportunity to theoretically learn about, how supply chain evolving and improving in different way by the influence technologies in the world. However, this report has been written in a short period of time. I have tried my level best to make it meaningful by reflecting my research. Also, I have summarized my overall research experience, with my learning and challenges faced as a researcher.

ABBREVATIONS

IoT	**Internet of Things**
SCM	**Supply Chain Management**
RFID	**Radio Frequency Identification**
WSN	**Wireless Sensor Network**
UID	**Unique Identifier**
NFC	**Near Field Communication**
AI	**Artificial Intelligence**
IT	**Information Technology**
IoS	**Internet of Service**
ERP	**Enterprise Resource Planning**
DLT	**Distributed Ledger Technology**
GPS	**Global Positioning System**

LIST OF FIGURES

TABLE OF CONTENTS

CHAPTER - 1

INTRODUCTION

1.1 INTRODUCTION

In Supply chain the Internet of Things (IoT) is highly influenced. In today's supply chain and its operations is under in everchanging manner and hence are vulnerable to a variety of risks. Every day there are millions of products that need to be shipped, tracked and accounted for by trucks, ships and people. Connecting these goods, assets and people in the supply chain through IoT creates efficiencies and streamlines processes saving companies time & costs.

IoT devices have the capacity to impact all aspects of the supply chain, including warehouse management, transportation and logistics, and last mile delivery to the end customer. Manufacturers can drive operational efficiency, reduce theft and counterfeit, and deliver great customer service by acting on the data coming from the IoT devices in their supply chain.

There are different types of IoT devices in the supply chain, such as autonomous vehicles, sensors that optimize energy consumption, and sensors that alert employees of potential dangers in the workplace. The most exciting example of how IoT is used by manufacturers though is by embedding smart sensors in a product's packaging. After all, this allows manufacturers to trace their products throughout the entire supply chain direct into their customer's hands and not just one isolated part of a journey.

1.2 AIM OF THE RESEARCH

Objective of the research is to fulfil the requirements of MBA in International Transportation and Logistics Management course by preparing and submitting the research project on "A study on Influence of IoT in Supply Chain". Apart from that, the general objective of this report is to gain insight IoT in supply chain and the advantages of using IoT for the supply chain management.

1.3 OBJECTIVES OF THE RESEARCH

The main objective of this research is to study the economic and social impact of adapting Industry 4.0 and IoT technology in supply chain management, to show how it can help in saving money for any industrial organization and to show how it improves its performance by proposing in detail a theoretical framework of implementing IoT in supply chain. The sub-objectives are to study the impact of Industry 4.0 on the supply chain and how it affects SCM functions, and to study the main components of the IoT application.

- The other objectives considered for this project research are:
- Getting an overview of the influence of Internet of Things (IoT) in Supply Chain.
- To review the areas of the Internet of Things (IoT) in Supply Chain.
- To Evaluate the benefits of using Internet of Things (IoT) in supply chain management.

1.4 SCOPE OF THE STUDY

The study mainly focuses on the improved technologies and innovations in existing supply chain, and the emergence Industry 4.0, smart supply chain, benefits of IoT integrated supply chain and IoT enabled warehouses. Especially the study focuses on the increase in efficiency and decrease in cost by the usage of IoT in Supply chain.

1.5 RESEARCH METHODOLOGY

Research methodology is the specific procedures or techniques used to identify, select, process, and analyse information about a topic. The methodology describes the design for the research and also justifies the methodology adopted for this research.

The methodology is the general research strategy that outlines the way in which research is to be undertaken and among other things, identifies the methods to be used in it. These methods described in the methodology define the means or modes of data collection or sometimes how

a specific result is to be calculated. Methodology does not define specific methods, even though much attention is given to the nature and kinds of processes to be followed in a particular procedure or to attain an objective.

Data collection

It is the process of gathering and measuring information on variables of interest, in an established systematic fashion that enables one to answer stated research questions, test hypotheses, and evaluate outcomes. The data collection component of research is common to all fields of study including physical and social sciences, humanities, business, etc. While methods vary by discipline, the emphasis on ensuring accurate and honest collection remains the same.

The gathering of data in a research project and the quality of the same will reflect on the understanding of the theoretical framework. The information can be collected from primary or secondary data.

Secondary Data

Secondary data is the data that has already been collected through primary sources and made readily available for researchers to use for their own research. It is a type of data that has already been collected in the past.

A researcher may have collected the data for a particular project, then made it available to be used by another researcher. The data may also have been collected for general use with no specific research purpose. A data classified as secondary for a particular research may be said to be primary for another research. This is the case when a data is being reused, making it a primary data for the first research and secondary data for the second research it is being used for.

For the purpose of this research data were gathered from journals, articles for conducting the literature review. The journals and articles were obtained from site related to Internet of Things (IoT) and Supply Chain from the internet. The main key words used for online search includes IoT, Supply Chains and Logistics.

1.6 LIMITATION OF THE STUDY

Every report has its limitations and this report is no different. Basic limitations were:

- Time constrains, within this short period of time it was really difficult to gather vast amount of data to have an make an intense report.
- Lack of primary data and data collection process, the data used in the report is mostly secondary data.
- There was no real-time experience because of COVID-19 situation.
- Emergence of technologies related to the research topic is continuously changing.

CHAPTER - 2

LITERATURE REVIEW

2.1 LITERATURE REVIEW

In this chapter the theoretical aspects of the research are discussed. The literature review will give an insight of influence Internet of Things (IoT) in Supply Chain. The Internet of Things (IoT), refers to a network of connected devices, objects, and sensors, that collect and communicate information. When applied to the global supply chain, IoT technology can help businesses serve their customers better, while also saving the business money and improving overall efficiency.

IoT devices and services helps supply chain managers plan routes, taking into account the number of accidents or other delay-inducing occurrences that happened on the highway. The Internet of Things curates all data needed to develop flexible contingency plans and get to the cause of existing delays. In today's highly competitive market place, management of supply chain is not just important, it requires serious development through research and innovate to meet the dynamic and ever rising expectations of customers at manageable cost (Jinesh Jain et.al. 2010).

The industry 4.0 revolution is well and truly underway and is redefining traditional manufacturing processes once and for all. The manufacturing industry is moving towards a more digitised, automated, agile and, ultimately, efficient operation and there is no better example of this than in the supply chain network. In today's world, the supply chain is a multi-faceted ecosystem linking product development, manufacturing and distribution networks into one fully transparent and digitised system. With multiple streams to take into account, by bringing their supply chain online manufacturers have been able to reap the benefits of a fully automated and integrated supply chain from the very beginning.

The industrial sector acts as a key driver for the economic growth of most countries; for example, it accounts for about 80% of innovations and 75% of exports in Europe (Hofmann

and Rüsch 2017). Industry 4.0 helps companies achieve massive gains in productivity, reliability, and efficiency in order to satisfy customer needs and hence gain more profit (Degryse 2016).

The industry 4.0 is based on the five keys of technologies. The Internet of Things, big data and analytics, cloud computing, cyber-physical systems and augmented reality. In this the Internet of Things are mobile internet and IoT technologies which help in making interactions between human and machines, and between machines to machines, and can easily implement intelligent identification, location, monitoring, tracking and control. Industry 4.0 is an integrated system of communication, computing and control used for bringing together the physical and virtual worlds in many fields such as motor vehicle manufacturing, transportation, and logistics (Zhou et al. 2015).

The Internet of Things also can be determined as information sharing, the information sharing has played an important role in supply chain management. The sharing information between partners is necessary but not enough to achieve a significant improvement. The core is to focus on making supply chain partners more cooperative and to strengthen the internal integration between them by achieving tasks together so that the relationship between them is built on trust. Managers should identify the information to be shared and the best mechanism to share it, with the objective of improving the total supply chain performance.

Many supply chains still suffer from miscommunication between different stakeholders and inefficient exchange of information. Hence, new approaches and techniques should be adopted to provide more efficient information sharing. Using IoT has a stronger impact on the operational performance when used for upstream integration rather than the integration with customers. This can increase speed and accuracy and can improve delivery performance.

Radio-frequency identification (RFID): It allows identifying, tracking and transmitting information. There are five main classes of RFID tags (López et al. 2011).

Wireless sensor networks (WSN): It is a network composed of a set of sensors to monitor and track the status of different devices like their location, movements or temperature. Sensors can be used for a multitude of purposes such as temperature, pressure, flow, level, imaging, noise, air pollution, proximity and displacement, infrared, moisture and humidity and speed (Rayes and Salam 2016) [16]. There are several literature reviews on the subject of IoT and supply chain. In this section, most relevant to the review and explain how the review is different. The literature on smart factories and thus focus only on the manufacturing sector.

CHAPTER - 3

INTERNET OF THINGS AND SUPPLY CHAIN

3.1 INTERNET OF THINGS (IOT)

Internet of things (IoT) is a network of varied physical devices which connects physical devices and allows / facilitates exchange of data. The physical devices with built in electronics and software connect through a whole lot of actuators, sensors. Each device can be identified by its embedded computing system. This makes devices to inter-operate within the established infrastructure.

The advantages of Internet of Things (IoT) are limitless such as

Communication: IoT provides a transparent system with better ways of communication thus increasing the quality of service.

Automation and Control: Faster and timely output.

Monitor: Monitoring the supplies helps keep track of availability in warehouses as well as their locations in transport or warehouses.

Time: Helps reducing the time by accelerating supply chain process.

Money: Alerts can be provided in case of breakdowns, and damages to the system. Hence, save money by using this technology.

Efficient and Saves Time: The machine to machine (M2M) interaction provides better efficiency.

3.1.1 IoT platforms

An IoT platform is what connects the four components into a cohesive, manageable, and interpretable system. These platforms help make data ingestion, communication, device management, and application operations a smooth, unified process.

There are five types of IoT platforms:

Connectivity Platforms

Connectivity platforms are, as the name suggests, centred around the networking component of IoT systems. They provide users with the software, connectivity hardware, and data directing necessary for keeping your devices online. Their networks generally rely on existing carrier services and Wi-Fi, configuring the connection in a way that allows for easy IoT set up.

Device Management Platforms

Device management platforms specialise in the grunt work involved with IoT devices. They ensure that everything is connected and secure, and keep you updated on the status of your devices. Device management platforms update the firmware, notify you of changes in your devices, report metrics, and patch security. This kind of IoT platform will help you with the routine tasks associated with your devices, no matter how many you have.

Cloud Platforms

Cloud platforms provide users with the infrastructure required to create a cohesive IoT system. They're a central location for all of your backend process and data to exist and operate. One of the biggest benefits of cloud platforms is their scalability; regardless of how small you start; a cloud platform can grow with you and your IoT system.

Application Enablement Platforms

Application enablement platforms are a one-size-fits-all approach that offers users everything they need to get an IoT system off the ground. They provide you with the devices, software, development, and deployment of IoT systems. They're a one-stop shop for kickstarting your system, saving you from having to manage developers, network configuration, and hardware engineering yourself.

Advanced Analytics Platforms

Advanced analytics platforms are a great solution for data-driven IoT systems. Users looking for sophisticated IoT systems that utilise machine learning, artificial intelligence, statistical modelling, and mass data harvesting can use this kind of platform to interpret and act upon the gathered data. IoT systems that primarily work to ingest data, rather than perform tasks, will benefit the most from these platforms.

3.1.2 Important Considerations When Picking the Right IoT Platform

Picking the right IoT platform is extremely important when first starting out. The bigger your IoT system is, the more costly and challenging it will be to migrate to an IoT platform. You not only need to pick the kind of platform that best suits your needs, but also has the reliability and service to keep you supported over time.

The most important considerations when picking an IoT platform, aside from deciding on the type of platform that suits your needs, are security, reliability, and ease of use. An IoT platform should streamline your IoT system into an easily manageable, understandable unit. Security is vital as well since your IoT system will be harvesting and transmitting virtual tons of data about your operations. And lastly, reliability. Going with a less expensive IoT platform may save you money in the short term, but if their service is unreliable, you'll see the effects of it reflected in millions of devices.

The Internet of Things (IoT) is a scenario in which objects, animals or people are provided with unique identifiers and the ability to transfer data over a network without requiring human interaction. There are some important considerations and frequently used IoT devices are mentioned below.

WSAN (wireless sensor and actuator network)

A wireless sensor and actuator network (WSAN) is a group of sensors that gather information about their environment and actuators, such as servos or motors, that interact with them. All elements communicate wirelessly; interaction can be autonomous or human-controlled.

WSANs are an element of the increasing trend toward the Internet of Things (IoT), in which any entity imaginable can be outfitted with a unique identifier (UID) and the ability to transmit data over a network. As with many other elements of the IoT, WSANs raise privacy and security issues.

RFID (radio frequency identification system)

Radio frequency identification system (RFID) is an automatic technology and aids machines or computers to identify objects, record metadata or control individual target through radio waves. Connecting RFID reader to the terminal of Internet, the readers can identify, track and monitor the objects attached with tags globally, automatically, and in real time, if needed. This is the so-called Internet of Things (IoT). RFID is often seen as a prerequisite for the IoT. This paper introduces the technologies of RFID and IoT, discusses the applications and challenges of RFID technology used in IoT.

Internet-Connected Wearables

IoT and wearables have emerged as an element of intense business and social change, as well as a result of global forces that are driving this change. It has reshaped modern society in many good ways. Wearables are changing business and management processes, operations and models, while creating new value, improving efficiency and leading to new ways of making money and delivering greater value to customers.

Low power embedded systems

These low power embedded devices (i.e., sensors, RFID tags, actuators) in IoT are entirely addressable, inter-connected and inter-linked in a heterogeneous wireless environment through standard communication protocols.

The goal of this special issue is to provide low power consumption architecture of embedded devices for various IoT microsystem environments, which can be applied in the fields of smart homes, smart cities, smart building, autonomous vehicles, considering energy consumption, processing power, communication technologies, resiliency, cost, performance, etc.

Use of mobile phones

Smartphones do play a large role in the IoT, however, because many IoT devices can be controlled through an app on a smartphone. You can use your smartphone to communicate with your smart thermostat, for example, to deliver the perfect temperature for you by the time you get home from work. Another plus? This can eliminate unneeded heating or cooling while you're away, potentially saving you money on energy costs.

There are many more devices, sensors and technologies are available and linked with the IoT, and also the new types of technologies are emerging and invented every minute.

3.1.3 Requirements of IoT

The above-mentioned sensors and devices need some specific requirements for IoT environments that support them such as:

People and Things:

In these early days of the Internet of Things (IoT), much of the focus has been on industrial applications, such as improving operations with autonomous machines, or standalone consumer products, like a Fitbit. But human-centric category of IoT activity starting to emerge.

It’s less about automation and more about personal augmentation; less about individual devices and more about “living services” that let people program and connect smart devices however they want.

People and things are the important requirements of IoT, because every activity or action related to the IoT is from the usage from the people.

Edge Communication.

Edge Computing Architecture is a new model for providing storage and substantial computing properties near to the devices. This bringing of storage and computing nearer to the devices improves response time and lessens the bandwidth. Edge computing involves all types of computations which occur at the edge of a network outside the cloud. Edge time works on real-time data generated by sensors and real-time applications. The enormous emergence of IoT devices has pushed the bandwidth demands to the extreme levels, resulting in delay. Edge computing moves services closer to the edge and enhances service delivery.

The various edge devices capture data and communicate via IoT protocols, sending data to the edge gateways. The protocols used for the data transfer can be Ethernet, Bluetooth, Wi-Fi, NFC, ZigBee, etc. In short, every data generating device will be considered as an edge device.

Data collection, analysis, and actuation

IoT data collection is the process of using sensors to track the conditions of physical things. Devices and technology connected over the Internet of Things (IoT) can monitor and measure data in real time. The data are transmitted, stored, and can be retrieved at any time.

IoT analytics is the application of data analysis tools and procedures to realize value from the huge volumes of data generated by connected Internet of Things devices. ... IoT analytics offers

similar benefits for the management of data centres and other facilities, as well as retail and healthcare applications.

Another type of transducer that you will encounter in many IoT systems is an actuator. In simple terms, an actuator operates in the reverse direction of a sensor. It takes an electrical input and turns it into physical action.

Scalability

Scalability is the measure of a system's ability to increase or decrease in performance and cost in response to changes in application and system processing demands. Examples would include how well a hardware system performs when the number of users is increased, how well a database withstands growing numbers of queries, or how well an operating system performs on different classes of hardware. Enterprises that are growing rapidly should pay special attention to scalability when evaluating hardware and software.

Scalability will be key to handling the explosive growth in the Internet of Things (IoT). This means that IoT applications must have the ability to support an increasing number of connected devices, users, application features, and analytics capabilities, without any degradation in the quality of service.

Security

IoT security is the act of securing Internet of Things devices and the networks they're connected to. In the business setting, IoT devices include industrial machines, smart energy grids, building automation, plus whatever personal IoT devices employees bring to work.

Every connected IoT device is a data collector. So, unless the organization want other people to know all about the organization activities, they need to secure each device. Organization

needs to secure their network, but also need to ensure there are no weak links in the network by checking that each individual device is secure.

Application and Services

IoT applications promise to bring immense value into our lives. With newer wireless networks, superior sensors and revolutionary computing capabilities, the Internet of Things could be the next frontier in the race for its share of the wallet. IoT applications are expected to equip billions of everyday objects with connectivity and intelligence.

IoT Applications:

- Wearables
- Smart Home Applications
- Health Care
- Smart Cities
- Agriculture
- Industrial Automation

IoT (Internet of Things) is a network of devices which are connected to the internet for transferring and sensing the data without much human intervention; since IoT is supposed to make the device smart, this technology is used by various industries and domains to get services like Medical treatment, Remote Control, Enhance Light Experience, Automobile industry, Integration of AI application, to get a better-personalized experience, etc. these services are termed as IoT services in the IoT ecosystem.

Some specific requirements for IoT devices and environments that support them as shown in Figure No. 1:

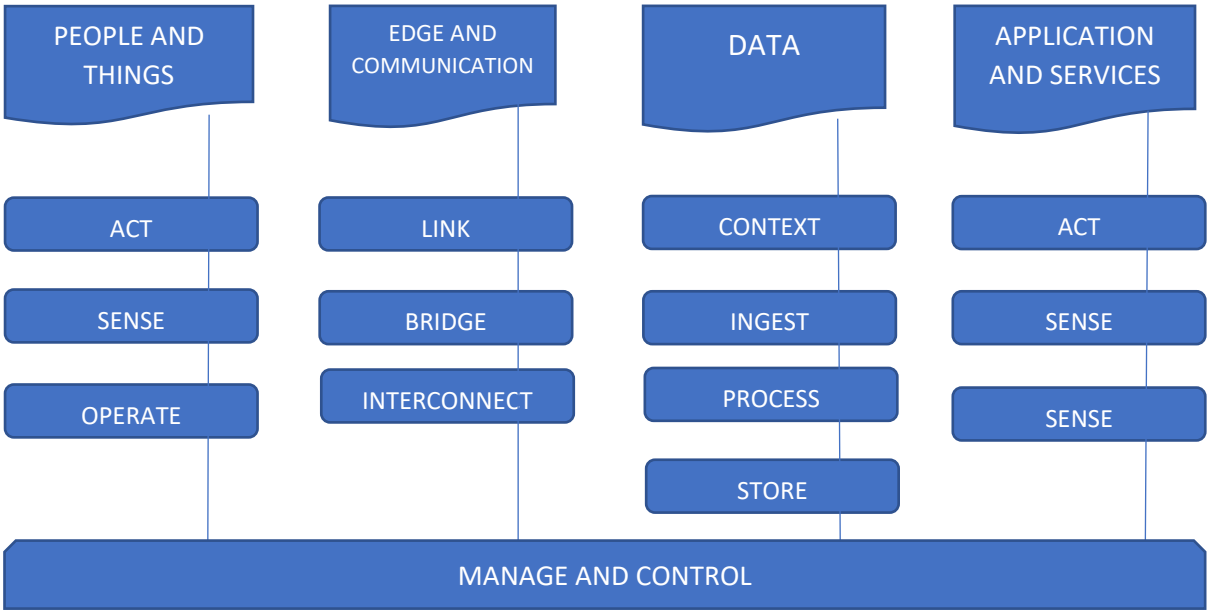

Figure No. 1

IoT Definitions: The term Internet of Things generally refers to scenarios where network connectivity and computing capability extends to objects, sensors and everyday items not normally considered computers, allowing these devices to generate, exchange and consume data with minimal human intervention.

3.2 SUPPLY CHAIN MANAGEMENT (SCM)

Supply chain management (SCM) is managing the flow of goods and services. Management of supply chain includes movement and storage of raw materials, inventory, and finished goods from point of origin to point of destination. A supply chain is managed by designing, planning, execution, control and monitoring. It serves the purpose of creating net value, building competitive infrastructure leveraging worldwide logistics, synchronizing supply with demand and measuring performance globally.

Supply chain management (SCM) is the active management of supply chain activities to maximize customer value and achieve a sustainable competitive advantage. It represents a conscious effort by the supply chain firms to develop and run supply chains in the most effective & efficient ways possible. Supply chain activities cover everything from product development, sourcing, production, and logistics, as well as the information systems needed to coordinate these activities.

3.2.1 The concept of Supply Chain Management (SCM) is based on two core ideas:

1. The first is that practically every product that reaches an end user represents the cumulative effort of multiple organizations. These organizations are referred to collectively as the supply chain.
2. The second idea is that while supply chains have existed for a long time, most organizations have only paid attention to what was happening within their "four walls." Few businesses understood, much less managed, the entire chain of activities that ultimately delivered products to the final customer. The result was disjointed and often ineffective supply chains.

The organizations that make up the supply chain are "linked" together through physical flows and information flows.

- Physical Flows

Physical flows involve the transformation, movement, and storage of goods and materials. They are the most visible piece of the supply chain. But just as important are information flows.

- Information Flows

Information flows allow the various supply chain partners to coordinate their long-term plans, and to control the day-to-day flow of goods and materials up and down the supply chain.

3.2.3 Importance of Supply chain management:

Supply Chain Management (SCM) is the process of overseeing and controlling the movement of goods and services from manufacture to the customer. A supply chain manager's goal is to improve the efficiency of the supply chain, reduce costs. There are some important activities or functions in supply chain that make supply chain more potential and efficient, they are:

- ***Customer Service***

Customer service is critical in supply chain management. Supply chain is a strategic concept that entails comprehending and managing the sequence of activities that add value to the product supply pipeline, from supplier to customer. Its primary goal is to improve customer relations.

- ***Reduction of Costs***

Supply chain costs often represent a considerable percentage of the sales price of a good or service. Cost savings flow directly to the bottom line. In cost reduction there are some fundamental areas in supply chain like transaction cost, mismatched processes and uncertainty.

There are different types of costs in supply chain, these costs can be reduced by different strategies like, Forecast and planning, reduced product packing, paying for the right transport services, diversification of carriers and modes and identifying the cost-efficient workflow.

- ***Decrease Production Cost***

Production cost is the cost incurred to procure raw materials & convert those raw materials into finished products. In other words, all costs related to the factory are included in the production cost.

Production cost is the combination of the different types of cost that inquired at the time of the production like direct material cost, direct labour cost and factory/manufacturing cost. All the

sum of these costs that is calculated as production cost and there is increase or decrease in this cost will influence the supply chain and its activities.

• ***Decrease Total Supply Chain Cost***

Supply chain costs are defined as costs that constitute a considerable percentage of the total sales price of a product or service. Manufacturers usually define supply chain costs using the total cost of ownership. The total cost of ownership is defined as the combination of the purchase or acquisition price of a good or service. To this, they add the additional costs incurred before or after the product or service delivery. Applying the total cost of ownership analysis to the supply chain implies identifying all direct, indirect, and other associated costs.

• ***Improve Financial Position***

The supply chain management function most directly impacts the net income generated for the firm. To build an effective model between supply chain decisions and organizational performance, the supply chain organization in a firm must understand how its actions and decisions link to the financial components of the firm.

The technology associated with transportation management systems provides multiple financial benefits. By automating manual processes, businesses improve productivity. Access to information increases the accuracy of forecasting and planning. Better scheduling of staff also is possible.

• ***Reduce inventory costs***

Inventory costs can be reduced by various supply chain activities. In supply chain inventory management have an important role, optimisation of supply chain reduces the costs inquired in inventory management like “get the right reorder point, minimum order, quantities work for

you, avoid overstocking, get rid of your deadstock, decrease supplier lead time and use inventory management software".

• ***Improves handling of goods***

Essentially, handling of goods is a process that includes short-distance movement inside the scope of a building, or between the transportation vehicle and the building. It uses various types of equipment such as manual, automated, and semi-automated. In addition, the handling of goods processes involves the movement, protection, storage, and control of materials. This handling process occurs in manufacturing shop floors, warehousing, distribution, and even in material disposal. This is why material handling is an important process in every facility.

In handling of goods supply chain activities need to be more careful and need most aware of the goods, because there are different types of goods required more care or handling activities. Supply chain can improve the handling of goods by different ways and procedures.

• ***Improves process integration***

Business process Integration refers to a business model wherein an acceptable business process model is defined through the specifications of events, sequence, hierarchy, logic of execution and the information pathways between systems, within the same enterprise or various interconnected enterprises.

Integrating a supply chain is an incremental process, with priority typically given to the highest potential returns on investment. Based on strategies, needs, and potential returns, different priorities and approaches may be assigned to the supply chains of different segments of a business.

There are some most important advantages to having an integrated supply chain:

- Increased collaboration and visibility.

- Stay on top of demand.
- Flexibility.
- Eliminate waste.
- Higher profit margins.

3.2.3 Weak links in supply chain:

A supply chain is only as strong as its weakest link. The key to avoiding or at least mitigating supply chain disruptions is to plan ahead by adopting a supply chain risk management system. The first step is to identify your organization's supply chain exposures – its so-called weak links.

Here are some of the more common weak links found in the supply chains of middle market companies:

- Adaptability: Managing sudden changes in demand
- Visibility: Difficult to gain proper visibility of the market requirements.
- Agility: Responsiveness to customer requirements.
- Analytics: Not efficient enough to be deployed to the entire supply chain.

3.3 SUPPLY CHAIN 4.0 OR SMART SUPPLY CHAIN MANAGEMENT.

Supply Chain 4.0 - the application of the Internet of Things, the use of advanced robotics, and the application of advanced analytics of big data in supply chain management: place sensors in everything, create networks everywhere, automate anything, and analyse everything to significantly improve performance and customer satisfaction.

Industry 4.0 creates a disruption and requires companies to rethink the way they design their supply chain. Several technologies have emerged that are altering traditional ways of working.

On top of this, mega trends and customer expectations change the game. Besides the need to adapt, supply chains also have the opportunity to reach the next horizon of operational effectiveness, to leverage emerging digital supply chain business models, and to transform the company into a digital supply chain.

Industry 4.0 is basically an outline for digitizing the worth chain from processing plant to client. It joins coordination, creation, IT, designing, creation to digitize business tasks. Advances included are the Internet of Things (IoT) and the Internet of Services, which thus make the Smart Factory.

Smart factories – Smart factories optimize efficiency and productivity by extending the capabilities of both manufacturing devices and people. By focusing on creating an agile, iterative production process through data collection, smart factories can aid decision-making processes with stronger evidence. Automated and flexible manufacturing processes that are integrated with customers and business partners in support of product lifecycle changes – will impact current factory layouts.

The Internet of Services (IoS) –

Under the Internet of Services (IoS) everything that is needed to use software applications is available as a service on the Internet, including the software itself, the tools to develop the software, and the platform (servers, storage and communication) to run the software. Connecting production facilities across geographies and company boundaries to create virtual production capabilities will create new business models and disrupt current supply chain designs.

Advanced analytics – Capitalizing on big data and predictive analytics – to drive flexibility at the process level, not just production lines or factories – will put more pressure on organizations to use production data to its fullest.

Focus on the knowledge worker - The rise of smart machines will not see the demise of the knowledge worker – rather, this increasing complexity demands supply chain professionals expand their problem solving and systems engineering skills.

A supply is smart if it is "Instrumented, Interconnected &Intelligent Smart supply chain overcomes the weak links in the system by use of Internet of things (IoT)". IoT rapid solutions to the challenges of a traditional supply chain like:

1. Product tracking

   IoT-enabled asset tracking. The potential for IoT-enabled asset tracking is enormous. Whether your devices monitor vehicle fleets, locate containers, trace stolen goods, or detect changes to environments, IoT asset tracking provides the tools to improve efficiency in a wide range of industries dramatically.

2. Improve Transactional Efficiency

   Integration of IoT in supply chain will improve Transactional Efficiency by the use of different types of technologies and devices, like real-time tracking, changes in orders and more.

This gives end-to-end visibility of the entire supply chain.

This chapter discussed about the key components or main factors of the report. IoT, Supply chain, IoT application, weak links in supply, requirements of IoT and all others factors related to the report. This briefing is essential for the next chapter of the report.

CHAPTER - 4

INTERNET OF THINS IN SUPPLY CHAN

4.1 IOT IN SUPPLY CHAIN

A properly executed IoT framework can improve a business's demand. Via automation in collection of data, IoT frameworks help improve information exactness and give supply chain managements better materials to drive demand forecast. IoT improves the collection of data in different ways. The Internet of Things (IoT) is changing the manner in which we take a gander at everything from preparing and putting away food in the home to following items as they move from the production line to store racks. The coordination's business is only the most recent in a long queue of areas embracing this new associated innovation.

In the supply chain, Internet of Things devices are an effective way to track and authenticate products and shipments using GPS and other technologies. They can also monitor the storage conditions of products which enhances quality management throughout the supply chain.

4.2 BASIC ARCHITECTURE OF IOT IN SUPPLY CHAIN

For successful IoT-based supply chain management, basic IoT architecture needs to be established and updated continuously to commission and decommission the IoT assets. There are normally three layers in internet of things architecture they are perception, network and application, in the case of IoT in supply chain the number of layers were expanded including four layers: object layer, communication layer, application layer and data service layer. Each layer has centre parts and fundamental functionalities.

Object layer*:* it consists of physical objects such as devices, machines, sensors, RFID tags, and readers. The object layer is responsible for sensing the environment, identifying objects, and collecting data. This object layer strives to be miniaturized to become energy-efficient, location independent, and cost-effective. RFID tags and sensors are often embedded in the machines and devices.

Application layer: it consists of a set of problem-specific software tools that interact with users, solve problems, store data, and share data with other applications and users. The application layer is responsible for presenting data and images to the user in a user-friendly format.

Network layer: it consists of a network of wired/wireless networks, the Internet, and protocols. Its main function is to handle transmission of data obtained from the object layer to other devices or datacentres. The IoT is driving the rapid diffusion of the wireless network due to its flexibility and low cost compared to the wired network.

Data service layer: it consists of private/public cloud and related data management systems. Its main function is to store data generated by sensors, devices, and machines and provide the object layer with access to stored data. At the request of the users, data are processed into a form useful for decision makings. Data mining often is conducted to discover knowledge hidden in the sea of data at the data service layer. Unlike the above three layers which are mostly owned and managed by an individual company, the data service layer may be owned and managed by public cloud service providers.

4.3 INTEGRATING IOT AND SUPPLY CHAIN

IoT enables supply chain managers to connect the vehicles, equipment, and devices to get the real-time status of the trucks. The integration gives the real-picture of the processes going on in the supply chain, from a warehouse to different stakeholders and customers.

Integration: A traditional SCM will have supply chain managed by business process using planning the shipment or transport of the goods from manufacturing to the end user. But when IoT is used the system architecture changes as shown in figure below the new architecture is:

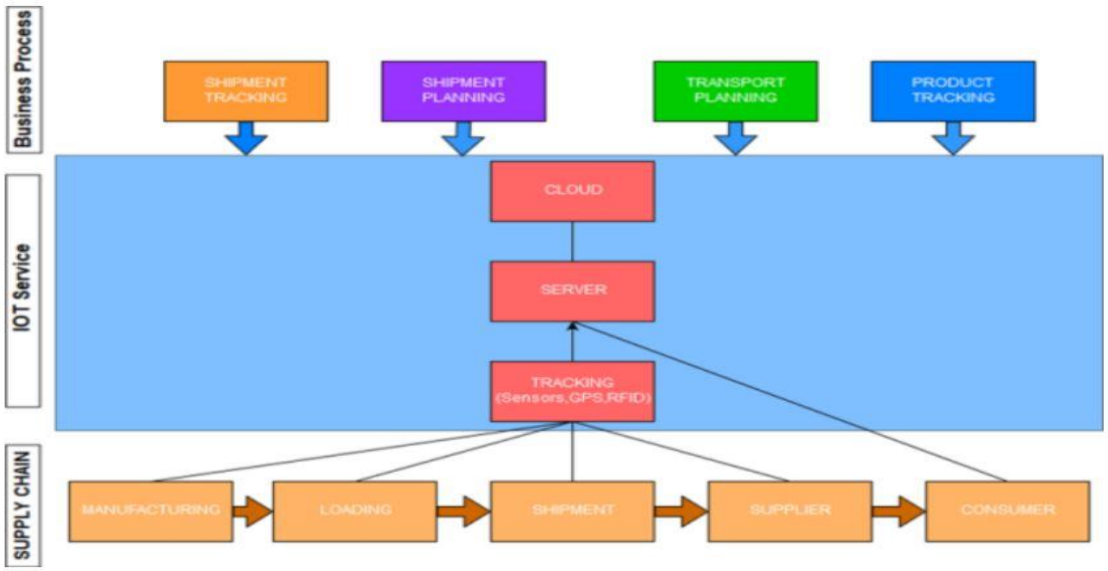

Figure No. 2

4.3.1 The supply chain:

- ***Manufacturing***

Manufacturing companies can support other manufacturers, distributors or consumers with fabricated or assembled products. Manufacturers can have extensive supply chain issues within their own facilities, depending on the number of products produced and the manufacturing processes they are engaged in.

- ***Loading***

While loading the goods from the manufacturer's premises or warehouse it has to be confirmed that all goods meet all requirements. Protection measures for goods have to be taken in consideration.

- ***Shipment***

Shipment is the physical moving of good from one point to another, such as the moving of merchandise from the warehouse to the customer. The shipment process follows the manufacture and the packing of goods and will be controlled by a shipping or logistics

company. Transportation modes include trucking, rail and air. These modes are the link between manufacturers, suppliers, retail stores and consumers.

- ***Supplier***

Suppliers come in many forms and are a crucial link from manufacturers to other business and consumers. Suppliers may also perform assembly operations, carry inventory or operate the transaction as coordinators between Suppliers and other businesses or consumers.

- **Consumer**

A consumer is a person or a group who intends to order, orders, or uses purchased goods, products, or services primarily for personal, social, family, household and similar needs, not directly related to entrepreneurial or business activities. They buy and use the product, give feedback for the products and their demand changes the market demand.

4.3.2 Business process:

- ***Shipment planning***:

Shipment Planning is used to describe conditions that control how shipping is done. These include whether certain items can be shipped together, such as regular and rush orders, whether to use Economic Shipping Parameters, and how routing is performed. Shipment planning includes the strategic planning of supply, manufacturing, distribution, production scheduling, demand forecasting, and supply chain network design.

- ***Transport planning:***

The purpose of transportation planning is to address current and future transportation, land use, economic development, traffic demand, public safety, health, and social needs. It deals with the flow of goods while they are taken from one SCM component to other. It plans the route that will be taken, which mode of transportation depending on the demand.

- ***Shipment Tracking:***

Shipments are tracked by the use of IoT where the products, vehicles transporting the products are considered and their locate tracked. Shipments can be tracked to know the location, route taken for transportation

- ***Product Tracking:***

In the supply chain and logistics of many types of products, track and trace or tracking and tracing, concerns a process of determining the current and past locations (and other information) of a unique item or property. Product tracking is important so to avoid frauds and losses, know their exact location whether they are in transport vehicle, in warehouse or with suppliers.

4.3.3 IoT service:

- ***Tracking:***

Tracking refers to the methods and systems used for tracking resources throughout their movement and storage. With logistics tracking you'll know where your products, materials, or other resources are physically located at any time, as well as what is scheduled. The tracking process involves various IoT devices. They sense conditions, calculate distance or give the location of the products or vehicles in SCM.

- ***Server:***

Servers are used for communication between cloud controllers and the tracking devices as well as end users. Servers take action predefined by the business process if need arises for instance if a container having perishable raw material being kept below a certain temperature if the temperature rises beyond the threshold data is sent to server which updates on cloud and sends alert of the same to the person in charge.

- ***Cloud:***

Cloud computing is an application-based software infrastructure that stores data on remote serves, which can be accessed through the internet. To understand how cloud computing works, it can be divided into front-end and backend. Cloud is where everything is present like product information, customer information, routes to be taken, algorithms for alert situation, vehicle information, real time data etc.

4.4 THE BENEFITS OF USING IOT IN SUPPLY CHAIN MANAGEMENT:

Accurate Tracking

In the supply chain industry, track and trace refers to the ability to identify the past and present locations of all product inventory, as well as a history of product custody.Smart sensors are effective for tracking the movement of assets. Scanners placed at strategic locations can provide accurate updates about the movement of goods and their status including damage. It provides businesses better insights into the inefficiencies in their supply chain to take corrective actions.

Better Inventory Management

IoT solutions enable businesses to check inventory levels efficiency with the aid of smart sensors. They can monitor the movement of goods to ensure that benchmark inventory levels. It enables informed decision making with the provision to place reorders automatically.

Proactive Maintenance

One of the biggest benefits of using IoT devices in supply chain management is that they can provide real-time updates. It includes wear and tears detection in the manufacturing unit since any disruption there has cascading effects throughout the supply chain. An IoT solution provides a predictive alternative to the preventive maintenance schedule typically followed by

manufactures. It provides critical insights to stakeholders to plan for failures in advance to avoid disruptions.

Automatic Ordering

IoT solutions can automatically place orders for multiple products and make payments to suppliers too. For instance, a car manufacturer who relies on multiple raw material suppliers to manufacture cars requires carefully planned IoT in Supply Chaining. An IoT solution can accelerate inventory management using data from smart weight sensors to detect inventory levels. If it detects lower than necessary levels then it will automatically place orders to all vendors.

Quick Trend Analysis

The analysis of IoT data can provide valuable insights to accelerate supply chain processes. Businesses can gain critical insights for better route planning, financial planning, and regulation compliance.

4.5 HOW THE INTERNET OF THINGS RELATES TO THE SUPPLY CHAIN

IoT devices have revolutionized supply chain management (SCM). It's much easier to understand where goods are, how they are being stored and when they can be expected at a specific location.

Authenticate the Location of Goods at Any Time

IoT devices can be attached to specific storage containers or to raw materials or products themselves. The IoT device will transmit its location, which can be picked up by GPS satellites and used to track movement of goods.

Track Speed of Movement and When Goods Will Arrive

Tracking speed of movement and the traffic flow of products makes it much easier to predict how goods will move through the supply chain. Suppliers, manufacturers and distribution centres can prepare to receive goods, which reduces handling times and ensures the efficient processing of materials.

Monitor Storage Conditions of Raw Materials and Products

Some goods like food and chemicals need to be stored in ideal conditions. Specialist IoT devices can monitor areas like temperature, humidity, exposure to an atmosphere, light intensity and other environmental factors. These devices may even trigger an alarm if certain thresholds are breached. This makes it much easier to track the quality of goods through the supply chain and to reduce spoilage.

Streamline the Problematic Movement of Goods

Goods tracking and route planning through IoT devices can identify where and when goods are delayed in transit. This allows for contingency planning and alternative routes to speed up the supply chain.

Locate Goods in Storage

Goods can remain tagged with IoT devices when they are in a distribution center. This can make it much easier to find specific products within a large warehouse and ensures accurate identification and management of goods.

Administer Goods Immediately Upon Receipt

Verified tracking through IoT devices means that SCM can validate exactly when goods arrive. This can trigger other administrative tasks like supplier payments or onward shipping requests.

4.6 WHY THE INTERNET OF THINGS MATTERS TO THE SUPPLY CHAIN?

IoT devices are a major benefit for all aspects of supply chain management:

- Reassurance that goods are located where stakeholders say they are, both at rest and in motion
- Early identification of issues with goods getting lost or delayed
- Real-time shipment and inventory visibility and tracking
- Easier supply and demand planning as stakeholders know when they can expect to receive and process goods
- Better quality management due to keeping raw materials and processed goods in optimal conditions
- Efficient storage and distribution of products due to the easier location of goods in warehouses

4.7 THE CHALLENGES OF USING THE INTERNET OF THINGS IN THE SUPPLY CHAIN

IoT devices rely on good network connectivity to function well. They need to be able to transmit their positions to GPS satellites and other types of IoT devices may require Wi-Fi, Bluetooth or other connectivity. They will not function as effectively in areas with lots of electrical or radio frequency interference.

IoT devices also rely on being installed and powered properly. They should only be handled, attached or removed by trained people. It's also important to use the right IoT device for the right job, as they can easily be damaged if they're not used correctly. There are some other challenges in using or integrating IoT in Supply chain they are:

Security as a barrier to IoT

Security is a major issue for every internet-connected industrial system. In a world where cyber-attacks are becoming more common, IoT technology could be just another lure for hackers. With new malware being discovered, it is clear that the risk exists more than ever. As IoT applications are to be built on many sensor nodes, the threat level increases drastically, whether it comes from bad data being injected into the system or data being extracted from it. This is a serious challenge that may require companies who adopt this technology to develop new practices in order to guarantee maximum security and stability by integrating more advanced cyber threat protection solution into their network.

Reliability And Integrity

With any new technology comes the question of reliability. Enterprises transitioning to IoT will expect to have back-up solutions in case of technology failure, as it could impact the entire supply chain and lead to irrevocable damages. Therefore, industrial enterprises will need to clearly define the goals and boundaries of their IoT projects. Based on enterprises' operational requirements and technology capabilities, IoT solutions and tools should be defined and ultimately applied.

IoT systems and scalability

Along with reliability comes the question of scalability. IoT systems will have to be adaptive and scalable enough to provide tailored solutions to multiple industries. From a more technical standpoint, IoT solutions will have to integrate with existing solutions through software or ad hoc functionality. Usually, functionality is added by either using vendor-defined black boxes, or by designing proprietary or custom end-to-end solutions. While using vendor-defined black boxes provides a solution that can be implemented rapidly, it is difficult to acquire and analyse the data generated. The custom solution, on the other hand, allows for easy access to data, but the proprietary nature of these solutions means the system itself becomes a black box. In this configuration, black box systems need to communicate properly, which represents a big challenge for engineers trying to develop custom end-to-end solutions.

There are more unidentified challenges being formed, because of the universal applicability and rapid changes in technology. As well as the challenges being solved by improved updates.

4.8 USE CASES FOR THE INTERNET OF THINGS IN RETAIL AND MANUFACTURING SUPPLY CHAINS

IoT helps store managers be aware of the number of products on the shelves and in the inventory, replenish stocks on time, and more. The technology can also send automated reports that will later improve financial management and taxing. Connecting online and in-store experiences.

- Farmers can use IoT devices to monitor soil moisture and decide the optimum time to plant or harvest.

- Manufacturers can use IoT-enabled cameras to spot defects and reject faulty products.

- Chemical manufacturers can ensure that raw materials stay safe by monitoring and triggering an alarm if they're exposed to high temperatures.

- Manufacturers can take advantage of "just-in-time" manufacturing by preparing to produce goods just as they're scheduled to arrive.

- Food retailers can monitor the temperature and humidity of goods in storage to ensure they reach stores in optimum condition.

- Retailers can work with specialist logistics fleets to track products as they're en route to distribution centres.

Supply chain connectivity is defined as the seamless flow of materials, information, and financial resources along the supply chain, enabled by two factors: information systems connectivity and physical connectivity, the below shown figure explains the IoT in supply chain management.

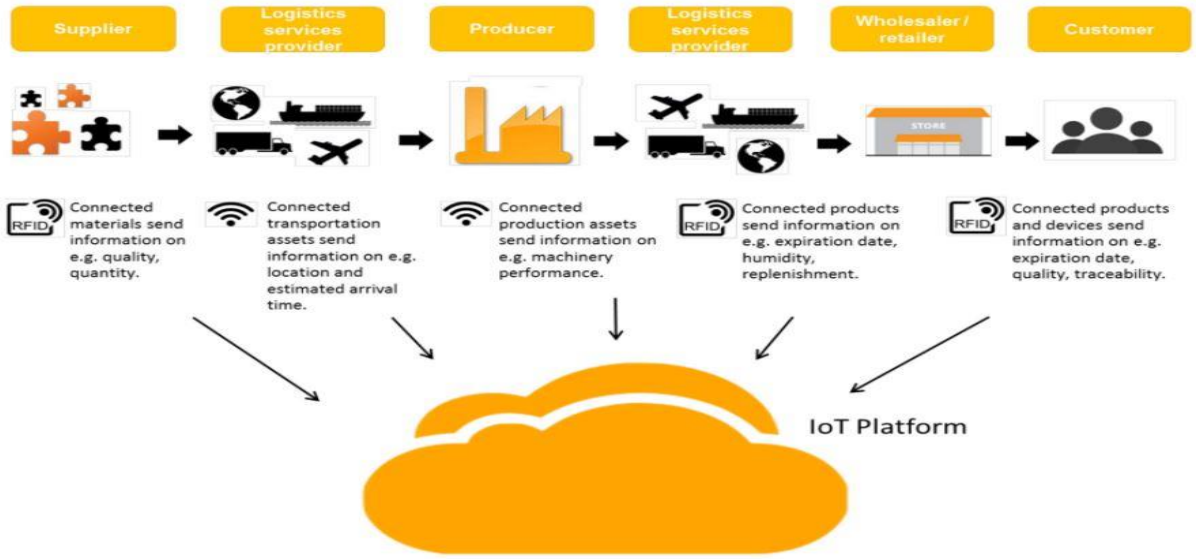

Figure No. 3

This figure shows the usage of IoT platforms in supply from raw materials supplier to the customer through various factors like producer or manufacturer, wholesalers, retailers and especially through various logistics partners.

4.9 BLOCKCHAIN AND IOT

Blockchain is a distributed ledger technology that combines with IoT to make machine-to-machine transactions possible. It uses a set of transactions that are recorded in a database, verified by multiple sources and entered in a common ledger distributed across every node. The combination of IoT and blockchain offers various potential benefits and allows a smart device to function autonomously without the need for a centralized authority. It can also track how devices communicate with each other.

This application of blockchain technology allows enterprises to manage data on edge devices in an IoT system, reducing costs associated with IoT device maintenance and data transfer. It reduces the risks of managing data, because there is no centralized data repository and the ledger is not vulnerable to cyberattacks. It eliminates the IoT gateway or any other intermediate device for data exchange and reduces the time required to process the data.

4.10 BLOCKCHAIN AND IOT IN SUPPLY CHAIN

Both the company, as well as the consumer, can track the entire product life cycle throughout the supply chain using blockchain and IoT technologies. Blockchain is an accurate data record where all the communications among IoT devices are saved in the history. A blockchain-based supply chain management system is built on a shared distributed ledger which provides an indisputable record of all the data related to shipment status, truck status, storage environment conditions and more.

Minimization of paperwork is another area where blockchain and IoT technologies can be beneficial. Transportation of a container from one place to another involves many intermediaries. As most of the companies are still using traditional methods of trade, the requirement of paperwork remains. Blockchain and IoT allows companies to save on labour cost and ensure data protection by removing paperwork throughout the ecosystem.

Combining blockchain and IoT to strengthen supply chain management can provide significant benefits for manufacturers, suppliers, and logistics service providers. In the following sections, find out key value drivers that the combination of blockchain and IoT provides for contemporary supply chains.

Advantages of Using Blockchain and IoT for Supply Chain Management:

End-to-End Real-Time Supply Chain Visibility

The involvement of multiple parties in a supply chain makes it difficult to achieve end-to-end visibility and transparency. Using IoT devices to track the status of moving goods through the blockchain based supply chain and storing this information on a DLT (distributed ledger technology) solution can ensure that all participants in the chain get access to data in real-time.

Global Supply Chain Financing

Supply chains involving parties across borders and cross-border transactions require voluminous paperwork and bureaucracy. It impacts the timely execution of international payments. It is because they involve multiple parties that are subject to local banking regulation. Additionally, any discrepancies like duplicate invoices can cause delays in payment settlement and clearing.

Data-Driven Insights

In a blockchain and IoT powered supply chain, all stakeholders and things in the ecosystem can share data securely. Further, the use of the latest machine learning techniques on this holistic dataset, when combined with third-party data sources, can derive insights across supply chains.

The combination of Blockchain and IoT can significantly address key issues of global supply chains while adding value to enterprises. If you want to explore opportunities created by blockchain in supply chain management, connect with us. Both IoT and blockchain have started gaining traction across industries. It is likely that they will accelerate into production as the technologies become more developed.

4.11 BENEFITS OF USING IOT IN WAREHOUSE MANAGEMENT

IoT for warehouse tools are a cut above traditional ERP (Enterprise Resource Planning) system. Instead of gathering inventory data manually, staff members can outsource the task to a range of connected sensors or RFID tags. The data is then stored on a cloud-based platform, processed and analyzed. Warehouse management plays a strategic role in the supply chain by enabling inventory distribution, sorting, or cross-docking processes that strive to meet the growing demand of the market. In a supply chain, warehousing function is very critical as it acts as a node in linking the material flows between the supplier and customer. There are some benefits in using IoT in warehouse management such as:

Real-time Product Tracking: IoT enabled warehouses gives businesses real-time data on product locations, transportation details, packaging, and routing. Due to these instant updates,

store managers ensure no inventory is lost during transportation. Also, they ensure supply chain vendors manage deliveries responsibly.

Enhanced Visibility: RFID technology enables businesses to track goods that enter and leave the warehouse in real-time. It results in stronger inventory control and gives businesses the ability to dynamically modify orders. IoT devices enable store managers to gather warehouse and supply chain data in real-time and share it with customers.

Improved Inventory Management: Smart shipping containers and shelves full of connected products will make it easy for store managers to locate and manage inventory in the warehouse. These systems can automatically generate alerts if the product is out-of-stock or temperature conditions are affecting the quality of goods. In addition, IoT devices make it easier for store managers to manage returns as they have relevant information like status, location, and ultimate point of disposition.

Reduces Risk: Using IoT devices in warehouses enables businesses to detect risk and avoid accidents that can create disruptions in the supply chain. IoT sensors in warehouses can monitor temperature conditions. In addition, data gathered from vehicles, shipping conveyances and products can be combined to reduce counterfeiting, theft, and spoilage.

Predictive Maintenance: A predictive maintenance system detects early signs of equipment malfunctions enabling the store managers to avoid downtime and stock spare machinery. Predictive maintenance is a technique that uses data analysis tools and techniques to detect anomalies in your operation and possible defects in equipment and processes so you can fix them before they result in failure.

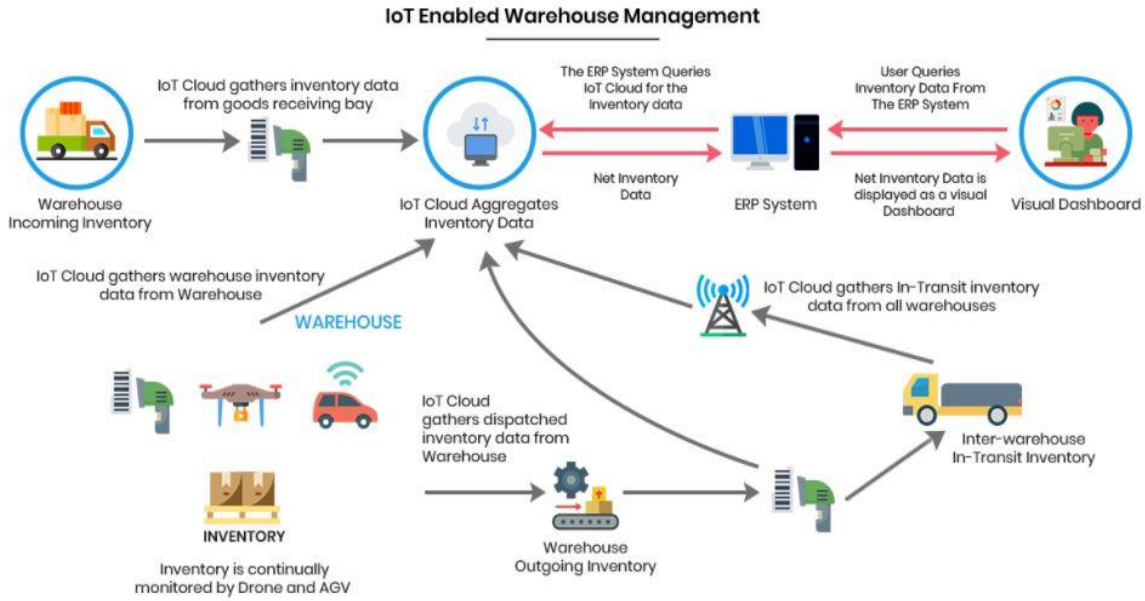

Figure No. 4

This figure shows the process of a IoT enabled warehouse management in supply chain.

In conclusion of this chapter, chapter is the combination or integration of the factors mentioned in the third chapter which is most relevant to the research topic. Other than, this chapter is discussed about blockchain, IoT enabled warehouse, benefits and challenges using IoT in supply chain management.

CHAPTER - 5

FINDINGS AND CONCLUSION

FINDINGS

In general, the combination of technology and people creating innovations in every second, the possibilities offered by digital technologies are so great. Nothing is further from reality as digitalization accentuates the need for having the best human team and the best work environment to amplify the generation of value. The characteristics of technology are immutable, hack proof, energy efficient, no central control and lack of failure in activities.

The key finding in this research IoT and Supply chain have different structure and divided over two time periods, after the several innovations and the impact of Industry 4.0, the influence of IoT in supply chain made huge impact in financially and operationally. The influence of IoT in supply chain changed the overall strategies and procedures from the traditional supply chain management by improving and implementing customer service and support, supply chain network, systems and performance. After all the improvement and benefits IoT enlarged from general supply chain and business information management to more specific context including supply chain design, model and performance.

It has been observed that it is not difficult to understand the usage of IoT in Supply chain management, but has limitations as it is relatively a concept that updating and changing in every second, therefor the knowledge to apply is limited but it can be managed easily by providing training to the people and by practicing it in the right field.

CONCLUSION

The objective of this research was to analyse the influence of IoT in supply chain and the benefiting processes and the respective benefits obtained with the integration of IoT in the supply chain management of organizations.

IoT is a key technology of the fourth industrial revolution Industry 4.0. IoT is considered one of the most promising technologies to control and improve the performance of supply chains, warehouses are key parts of supply chain that contribute to the success of any industrial organization, so new technologies are gaining vast attention from a wide range of enterprises to improve performance, reputation and hence gain more customers and profit.

It is concluded that management of the supply chains in various industries has developed significantly from earlier manual, laborious and risk prone operations to real time, automatic and risk-free operations to a large extent. The advent of IoT and its applications in to supply chain management has developed to an extent which has not only helped tracking and of goods in transit but has impacted the efficient management of inventories and reducing losses of supply chains. This has resulted in large scale economic benefits to the companies and has helped in expanding supply chain operations over large geographies. Beginning from simple goods identification devices to complex network of physical devices operating in a coordinated manner, the application of IoT has granted greater visibility in manufacturing of goods as well as the supply chains to deliver the finished goods till end user.

The research can be extender by experiencing real-time IoT operation in supply chain process of an organization and the efficiency of the research can be enhanced by the future IoT innovation and its related articles and journals.

REFRENCES

Books and Journals:

1. Internet of things drives supply chain innovation: A research framework. Li, Bo, and Yulong Li. 2017.
2. Zhou, Keliang, Taigang Liu, and Lifeng Zhou. 2015. Industry 4.0: Towards future industrial opportunities and challenges. Paper presented at 2015 12th International Conference on Fuzzy Systems and Knowledge Discovery (FSKD), Zhangjiajie, China
3. Degryse, Christophe. 2016. Digitalisation of the Economy and its Impact on Labour Markets (10 February 2016). ETUI Research Paper—Working Paper 2016.02. Available online: https://ssrn.com/abstract=2730550 (accessed on 27 January 2019).
4. Lopez, T. S., D. C. Ranasinghe, B. Patkai, and D. McFarlane. 2011. "Taxonomy, Technology and Applications of Smart Objects." Information Systems Frontiers.
5. Rayes, A., and S. Salam. 2016. "The Things in IoT: Sensors and Actuators." In Internet of Things from Hype to Reality. Cham: Springer.
6. Musa, A., and A. A. A. Dabo. 2016. "A Review of RFID in Supply Chain Management: 2000–2015." Global Journal of Flexible Systems Management
7. The Societal Impact of the Internet of Things. Available online: https://www.bcs.org/upload/pdf/societal-impact-report-feb13.pdf

Websites:

1. https://internetofthingsagenda.techtarget.com/definition/Internet-of-Things-IoT
2. https://www.emerald.com/insight/content/doi/10.1108/SCM-03-2018-0149/full/html
3. https://link.springer.com/chapter/10.1007/978-3-319-19210-9_11
4. https://www.emerald.com/insight/content/doi/10.1108/IJLM-11-2016-0274/full/html
5. http://oaji.net/articles/2017/1992-1530704104.pdf
6. https://www.intechopen.com/books/multi-criteria-methods-and-techniques-applied-to-supply-chain-management/supply-chain-innovation-with-iot#:~:text=Enhancing%20the%20visualization%20of%20supply,any%20time%20and%20any%20location.
7. https://link.springer.com/chapter/10.1007/978-981-15-2647-3_46
8. https://www.geeksforgeeks.org/architecture-of-internet-of-things-iot/
9. https://www.insidetheiot.com/categories/

10. https://www.iotforall.com/connecting-the-internet-of-things
11. https://blog.jtiot.com/the-5-types-of-iot-platforms
12. https://spgcontrols.com/zh/elements-of-iot-2/
    https://www.sciencedirect.com/science/article/abs/pii/S0141933120307894
13. https://www.digiteum.com/iot-data-collection/
14. https://supplychaindigital.com/supply-chain-2/five-benefits-iot-enhanced-supply-chain
15. https://www.scnsoft.com/blog/connected-supply-chain-top-questions-answered
16. https://www.ibm.com/topics/blockchain-iot
17. https://www.iotevolutionworld.com/smart-transport/articles/442715-six-ways-supply-cha-benefits-from-iot.htm
18. https://www.inboundlogistics.com/cms/article/how-the-internet-of-things-impacts-supply-chains/