CHALLENGES AND APPLICATIONS OF INTERNET OF THINGS ON SUPPLY CHAIN MANAGEMENT

Abstract

One of the best ways for businesses to give exceptional customer service is to make efficient supply chain management a strategic goal. Supply chain management (SCM) stands the process of actively managing supply chain actions in order to provide a competitive advantage over the long term and maximise the value of the customer. Sensors in IoT devices assess certain aspects of the world around them, such as, temperature, location movement, handling, humidity, movement speed, light levels and other environmental parameters. GPS and other technologies are used for Internet of Things devices. It can track, validate products and deliveries in the supply chains. IoT in supply chain management is becoming increasingly important, and it has the potential to create a strategic competitive advantage. IoT-powered supply chain management is gaining traction as a viable solution to supply chain management's control and visibility issues, while also adding value and solving other challenges. It can also keep track of improving quality control across the storage conditions for the products and supply chain. Supply chain components must be prepared to place their belief in wearables makers to protect their data in order for wearables to continue to benefit the supply chain. The problems and applications of IoT on supply chain management are surveyed and summarised in this study.

Keywords: Supply Chain Management, IoT, Wearables, Location Tracking, Sensors, Google Glasses.

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I. INTRODUCTION

The management of the full manufacturing flow of a good or service, from the procurement of raw materials to the delivery ofthe finished product to the customer, is known as supply chain management. Supply management, product and demand planning, sales and operations planning, and supply planning are all included. Systems for managing the supply chain efficiently reduce costs, waste, and manufacturing cycle time.

Supply chain management process

There are four primary components that make up the supply chain management process, including:

- Demand management
- Supply management
- Sales and operations planning (S&OP)
- Product portfolio management

In supply chain management, "IoT" refers to tying together numerous data points (devices utilised in the supply chain) to produce a desired result, such as improved operational efficiency or more accurate demand forecasting for products. Even for tiny businesses, it is a rising habit. IoT promises to increase transparency along that route. That definition is significantly altered by the Internet of Things to include equipment that gathers more data automatically rather than manually. An IoT supply chain is a system that uses device connection to more effectively distribute a product to a consumer while still achieving the same goals. Fig. 1 depicts the IOT supply chain process.

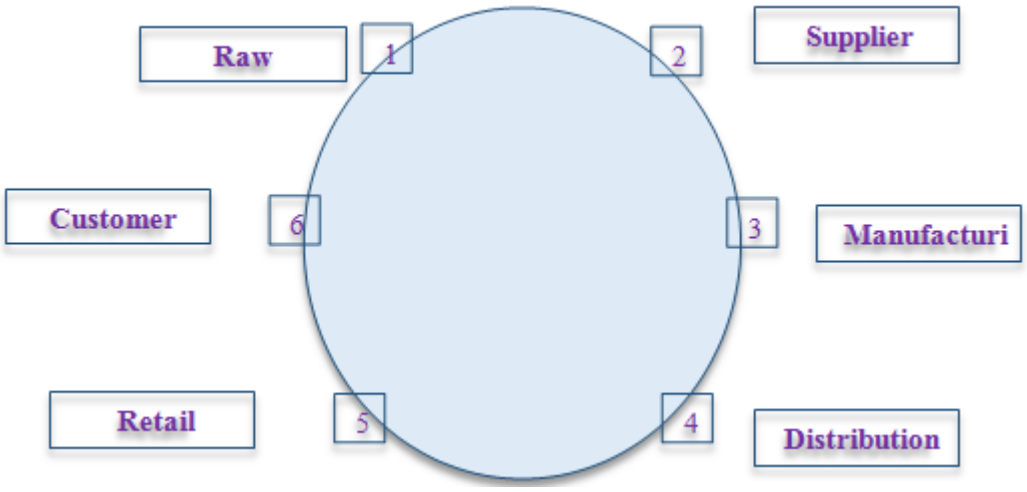

Figure 1: IOT for Supply Chain

Supply Chain Management is being transformed by the Internet of Things. In most cases, data or Wi-Fi networks are used to connect IoT devices to computer systems. utilise sensors to detect several characteristics of their environment, such as their position, temperature, humidity, light levels, movement, handling, and speed. The form factors of IoT

devices vary, and they include RFID chips,smart gadgets, and mobile sensors. Understanding where items are, how they are being held, and when they may be expected at a particular location is considerably simpler. There are many advantages of IOT in SCM. Authenticate the Location of Goods at Any Time.

- Follow the progress of the goods and their arrival date.
- Keep an eye on how raw materials and finished goods are stored.
- Streamline the Difficulty of Goods Movement.
- Find Items in Storage.
- Administer the goods as soon as you receive them.

The proper operation of IoT devices depends on reliable network connectivity. Other IoT device types can need Bluetooth, Wi-Fi or other connectivity in order to convey their positions to GPS satellites. In locations with a a great deal of radio or electrical interference they won't work as well. Additionally, Because improper use puts IoT devices at danger of damage, it's essential to use theright IoT device for the task at hand. They will not function as effectively in areas with lots of electrical or radio frequency interference.

II. LITERATURE SURVEY

IOT is perceived as a brand-new idea that has been in existence since the 1990s. By the year 2013, IOT had developed into a system that utilised a variety of technologies, ranging from sophisticated wireless networks to the automation of houses and buildingsIt is clear that when things interact, value is created for both customers and enterprises. IOT could bring about fresh benefits in this area (Saarikko et al., 2017). When deciding whether to avoid imposing unnecessary restrictions on the expansion of the IOT market, considerations regarding ownership of customer data and its analysis process or the process of creating appropriate legislative and technical frameworks to put more supervision over such a complex environment should be taken into account (Fernandez-Gago et al., 2017).

The fact that various stakeholders hold varying views and shift in their orientation over time is another issue that could jeopardise the IOT concept. Each of them has a distinct vision and function in the implementation of the IOT concept. This increases environmental dynamics and makes it much harder to foresee IOT application, taking into account the technological revolution as well(Zarpelo et al., 2017; Fernandez-Gago et al., 2017). The IoT deployment enhances data gathering, partner communication, business intelligence, and visibility of goods movement, according to the thematic analysis conducted using NVivo. However, merchants face difficulties because of a lack of top management effort, the expense of acquiring new technology, stakeholders' resistance to change, a refusal to share data, and a lack of system compatibility across partners. The study provides evidence of IoT advantages that support IoT-related investment decisions, illuminates adoption issues, and develops hypotheses for further investigation (Tharaka et.al 2021).

An efficient system that makes it easy for customs officials and everyone else in charge of commodities in transit to control the goods from the time they are made until they are delivered to the final consumer. We focus on a creative approach to managing the entire supply chain process that effectively and safely utilises a variety of modern IoT technologies,

including Wi-Fi ,RFID, GPS, EPC,and QR codes [Caballero-Gil et al. 2013]. Measurement is the initial step that leads to control and ultimately to improvement, says Dr.

H. James Harrington [Harrison J], who has been active in quality and performance improvement programmes since the 1950s. By measuring something, one can identify potential issues and take steps to control and enhance them. According to the hypothesis, quality enhancements result in less rework, fewer errors, fewer delays, and better use of time and resources, which in turn cut costs and increaseproductivity.

The Japanese production philosophy known as Just In Time (JIT) [Schonberger] aims to increase business return on investment by lowering in-process inventory and related carrying costs. The method relies on signals or Kanban between different points in the process, which instruct production when to manufacture the next part, in order to achieve JIT targets. The presence or absence of a part on a shelf is one example of a basic visual signal that can be used as a kanban, which are typically "tickets." When properly implemented, JIT emphasises continuous improvement and can raise the effectiveness, efficiency, and return on investment of a manufacturing company.

III. CHALLENGES OF IOT ON SUPPLY CHAIN MANAGEMENT

Our daily lives are incorporating the Internet of Things more and more. However, a few issues are hindering the supply chain from utilising technology to its full potential. The Internet of Things has exciting potential for the manufacturing sector as well. The Industrial Internet of Things (IIoT) offers countless advantages. The supply chain, however, is not fully utilising the technologies. Thefollowing three factors:

- Security as an IIoT barrier.
- Integrity and dependability.
- Systems for the IIoT and scalability.
- Internal conflict between the IT teams and operational management.
- Complex and lacking skills.
- Controlling and processing all data.

IV. THE SUPPLY CHAIN AND WEARABLE TECHNOLOGY

It was previously impossible to use wearable technology. Employees couldn't logically support about a tablet attached to theirbreast and manually fill out data while doing crucial supply chain tasks. Nevertheless, contemporary wearables, like the Apple Watch, Fitbit, Samsung's Smart Watch and Google Glasses, allow workers to perform crucial tasks. In addition, wearables and the Internet of Things (IoT) are continuously supplying information to the company's ERP and when added to other systems, RFID,WI-Fi and using low-energy Bluetooth gadgets inside the cloud. But many in the supply chain are still unaware of how wearables will change and enhance procedures. In general, wearables give the impression that their only function is data collection and accuracy, but they actuallyhave a number of important advantages for the supply chain.

V. BENEFIT OF WEARABLE'S FOR THE SUPPLY CHAIN

They can perform hands-free barcode scanning, input data, search up information, locate parts, get instant notifications, get fresh information, and free their hands to work more effectively because the computer/wearable is constantly with them. Due to the epidemic, businesses must ensure the safety of their employees while successfully running their operations. The use of social distancing is now easier and more effective thanks to these wearables. Workers are able to maintain their distance while still performing their work effectively and efficiently. These wearables have the ability to inform the worker when the 1-meter social distance rule is violated, which is one of their functions.

Wearables include

- Augmented reality (AR)-capable smart watches that can be used to extend the functionality of these devices. Applications that exploit the high-quality cameras on consumer smart phones are being developed for use in barcode and product scanning.
- When it's time for a break or when a car is in their blind spot as they change lanes, truck drivers wear smart watches that vibrate. They also wear glasses that, by monitoring the user's eyes with LEDs, can let them know when they are about to fall asleep.
- Barcodes are scanned, videos are recorded, and information is processed using smart glasses in the warehouse without the needfor manual labour.
- Ring and finger-trigger scanners enable workers to accomplish more with more lightweight, portable equipment. All day long, employees handle a lot of shipments. Despite the low likelihood of catching the virus through packing, it is nonetheless criticalto minimise any potential for contact.

VI. APPLE WATCH

Apple is renowned for its design and creativity. Few people are aware that Apple's inventory management practises are also acontributing element to its success. In fact, Apple's supply chain has topped Gartner's Top 25 list of supply chains since 2013. In a nutshell, Apple buys materials and parts from a variety of suppliers, then has them sent to the Chinese assembly facility. From there, things are sent straight to customers who purchased them from Apple's online store (through UPS/Fedex).

VII. FITBIT

A Fitbit is an activity monitor that you wear on your wrist like a watch to track your daily activity, including riding a bike, walking, swimming, running and going to the gym. The two primary Fitbit product categories are trackers and watches. Trackers are more exercise and tracking-focused whereas Fitbit Smartwatches feature smartphone-like capability. American manufacturer of activity trackers is Fitbit. Around 10 different versions of activity trackers are manufactured by this company. Purser claims that the company'ssecret sauce is a blend of ethical business practises, competent personnel, and the appropriate technologies to support sourcing decisions. The organisation has been advancing its digital sourcing strategy over the past few years while making sure to use the data it gathers toreally make business decisions.

A significant component of Fitbit's approach is the supply chain. We consider things from a technological standpoint and how we might source them. Beginning with the design phase, we consider thatShould we purchase, create, or co-develop this? Which model—a hefty one or a light one—should we jointly develop? how much work the partner has put in. We have those discussions right away during the product design process. These [questions] are beginning to guide the way we create, construct, and deliver those things.

VIII. GOOGLE GLASSES

Google Glass will push the boundaries of innovation in the supply chain market by adding a layer of real-time data, including social media, regarding actual items and locations, such as carton boxes, pallets, vehicles, employees, spare parts, your warehouse, deliveries, and of course, your consumers. Additionally, it will be simpler than ever to make critical decisions in real-time and to engage with anyone along the whole supply chain thanks to the apps that are expanding the context for the Google Glass platform. Now that you know why a part is out of stock and when the next batch will arrive, you will also know that it is.

The consumer goods, life sciences and healthcare, and energy and resources industries are advancing supply chain innovation with the use of smart glasses and mixed reality wearables. Adoption of these hands-free technologies can boost operations' efficiency and while enhancing accountability and quality. In practical sectors including manufacturing, shipping, field services, inspection, and operations, smart glass technology is already advancing. According to a recent study, 93% of major industrial organisations either use or are considering adopting smart specs in their processes. This finding suggests that decision-makers anticipate wearables becoming a crucial corporate platform. The supply chain can benefit from contextualised information, greater workflow standardisation, hands-free support, and documentation thanks to smart glasses and augmented reality. The Primary and Secondary benefits of Google Glasses is shown in Fig 2.

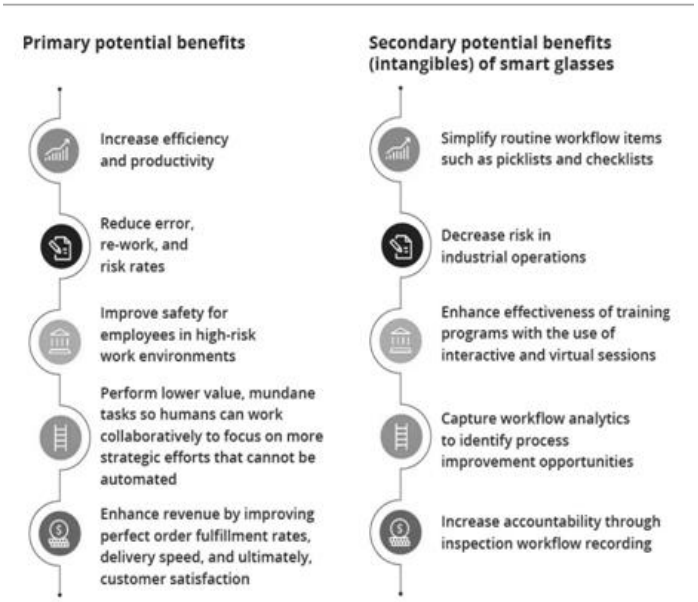

Figure 2: Primary and Secondary benefits of Google Glasses

IX. BENEFIT OF WEARABLES FOR THE SUPPLY CHAIN

Speed and accuracy: The key benefits of wearable technology in the supply chain are speed and accuracy. If wearable technology automatically provides the information, the employee won't need to check the documents or establish his or her tasks. Being associated with the Internet, which is now monitoring the supply chain entity's unique inventory levels, Workers may be able to detect whether a product is in the right place and ready for pickup automatically. The information can then be returned to the ERP utilising the wearable device's automatic data capture technology after the product has been selected, reducing the enhancing accuracy and eliminating the requirement for the employee to manually enter the selected products.

Improved safety and quality: The chance of suffering a a stroke ,cardiac attack, or other serious health crises at work is further raised by maintaining a rapid pace and persistent perspiration, which can cause dehydration, an elevated heart rate, high blood pressure and heat exhaustion. What does this have to do with the supply chain for wearable technology? Consider what Fitbit accomplishes. A supply chain organisation or warehouse manager may be able to automatically detect when a worker's heart rate crosses a potentially harmful threshold and advises them to take a break. While it can seem counterproductive, By reducing the likelihood of a occupational wound or happening, doing this could potentially save the supply chain money. The likelihood that employees will be happy with their jobs and pay attention to what they are doing increases when they work in a nice environment. In other words, products will be appropriately disposed of in a container rather than being thrown out like yesterday's rubbish. Better environmental and product quality management, as well as decreased downtime due to unwanted health issues, are directly affected by this.

Identification of inefficiencies: Wearable technologies will increase the capacity of the supply chain to gather additional information, which the company's ERP may use in order to spot inefficiencies. It might be as easy as redirecting workers when a invention box turns out or "telling" them that choosing Path D from Opinion B to Opinion C rather than Path C will excluding them 45 minutes because Path B has problems loading freight. Wearable technology use in the supply chain shows that security issues will become more of a worry for supply chain entities in the future. But wearable technology manufacturers are engaged in a never-ending struggle to protect their customers' privacy and the security of their products at any costs.

X. IOT APPLICATIONS ON SUPPLY CHAIN & LOGISTICS

IoT devices have a significant positive impact on all facets of supply chain management.

- Confirmation that things, both at rest and in motion, are located where stakeholders claim they are.
- Early recognition of problems with lost or delayed products.
- Real-time perceptibility and chasing of shipments and inventories
- Demand planning and Simpler supply as a result of stakeholders being aware of when items will be received and processed.
- Improved quality control as a result of maintaining ideal conditions for raw materials

and processed goods.

- Because of the easier organisation of goods in warehouses, there is effective product distribution and storage.

Some of the primary goals for IoT deployment in supply chain management include tracking and monitoring. Warehouse and fleet managers can monitor their inventory and freight thanks to technology. However, the Internet of Things offers more than just the possibility for asset management.

Location tracking: Today, efficient supply chain management is turning into a key competitive advantage. One automated method for managing supply chain operations is none other than a GPS monitoring system. The Internet of Things gives managers a consistent stream of real-time information on the product's location and the environment surrounding transportation. In addition to being able to keep an eye on the delivery of both finished items and raw materials, you will be informed if the product is transported in the wrong direction. It gives us full visibility into your shipping processes by enabling us to check status, remotely track the location and condition of your goods in real-time. This enables you to take immediate action and reach choices more faster to support delivery on schedule.

The organisations will gain from a GPS tracking system for supply chain management in a number of ways, including.,

- Use of the supply vehicles efficiently.
- Inventory control.
- Automated fleet upkeep.
- Better communication amongst different stakeholders.
- Vehicle ROI is quicker.
- Thorough fleet management.
- Declining Over Time.
- Effective handling results in customer references.
- Lower Operating Costs.

Environment sensing: In the universal supply chain, conservational monitoring has grown-up in importance. It offers substantial indicators that support speedy conclusions that may have a result on dealers and logistics. Indicators that warehouse owners are involved in chasing during natural calamities include air quality, wind, humidity, temperature and carbon dioxide (CO2). Fusion of past and present data from weather stations, other sources and air quality sensors can be used in more complex scenarios. The impact of these circumstances and any potential effects they may have on supply chain operations can then be forecast using machine learning (ML) models.

Fleet management: This approach can be employed when it's necessary to optimise pathways for safety based on how the surroundings are changing. For logistics operations to run well, fleet management is a crucial activity It entails making sure that the fleet's regulatory compliance, resource and fleet utilisation, and overall transportation expenses are all at their best. Fleet management's essential elements include:

- Fleet managers
- Truck fleet management
- Fleet drivers
- Fleet maintenance

Leading supply chain participants are aware that little adjustments to fleet operations quickly produce significant gains. They also understood that minimising the consequences of uncertainty as soon as feasible is the best strategy to achieve supply chain robustness. Because, in the end, we have more influence over how we respond to uncertainty than we do about knowing when or how it will strike.

Monitoring inventory: The products or materials in inventory are those that a company plans to resell to customers for a profit. Tracking inventory from producers to warehouses and from these locations to a point of sale is inventory management, a crucial component of the supply chain Having the right products at the right location at the right time is the aim of inventory management. This necessitates inventory visibility, which entails being aware of when, how much, and where to store stock. Basic inventory management procedures include:

- Buying inventory: Products that are ready to sell are bought and delivered to the warehouse or right to the point of sale.
- Inventory is kept in storage until it is needed. Materials or goods are moved around your fulfilment network until they areprepared for shipping.
- Profiting from inventory: The quantity of the product available for purchase is managed. Orders are filled by pulling finished goods. Customers receive product shipments.

RFID or radio frequency identification is a system that wirelessly transmits the identity of a product in the form of a unique serial number to track items and provide detailed product information. The RFID-based warehouse management system can boost productivity, increase inventory visibility, and assure quick self-recording of deliveries and pickups.

XI. ASSESSING DEMAND

An organization's ability to modify its capacity to meet fluctuations in demand or to manage the amount of demand through marketing or supply chain management tactics is known as demand management. Demand forecasting, often known as prediction, is a supply chain management method used to make sure products can be delivered and please customers. Striking a balance between having enough inventory to meet consumer demand without having an excess is the objective. The challenges of demand management are:

- Implementing demand management frequently meets a few common difficulties.
- One of them is a lack of comprehension of automated algorithms, or more specifically, how the replenishment systems'parameters have been established.
- Balancing sales and collaborating with retailers to develop demand models to choose the time, intensity, and location ofpromotions are other considerations.

- The third category is "elusive signals," which refers to situations in which manufacturers lack a data structure or a set procedure for acquiring, storing, and utilising point-of-sale data from retailers.

Demand planning spans several aspects, with the three primary areas being:

- Product Portfolio Management.
- Statistical Forecasting.
- Trade Promotion Management.

XII. CONCLUSION & FUTURE WORK

The Internet of Things (IoT) is a system of actual things and appliances that are occasionally linked to one another and to the Internet. This is a network that is continually expanding. Supply chain management connects all phases of a product's development. Every link in the chain needs to be reliable because weak points could result in greater costs and consequently reduced profit margins, such as transport delays, worn-out equipment, or operational errors. The supply chain benefits from the IoT's sensor network and information sharing since it provides a meaningful connection between the data and the objects. It is then sent via the Internet to give any business useful analytics and decision-making power. increases the accuracy of planning, makes it easier to track and monitor items, and increases communication transparency. In supply chain management, "IoT" refers to tying together numerous data points (devicesutilised in the supply chain) to produce a desired result, such as improved operational efficiency or more accurate demand forecasting for products. It is simple to maintain inventory and keep an eye on the production process thanks to the connectivity of several production-related devices. By preventing duplication, theft, and any variation in quality and quantity, it eliminates supply chain management inconsistencies.

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