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Thesis Title

The role of Internet of Things into improving the Supply Chain Case study: Walmart

A Thesis Submitted to the Department of Commerce Sciences as Partial Fulfilment for the Master's Degree in Commerce Sciences. Option; Finance and international Trade

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Abstract:

Since we live in a time of speed and improvement in most areas, finding a way of quickening the pace of trade, particularly in businesses, is inevitable. This is why organizations have profited enormously from the internet. Success presently requires the speed of accomplishing different tasks in record time. This is the fundamental objective of the internet of Things, which is primarily based on the sensors and shrewd gadgets associated to each other and utilized by organizations in their possess, which makes a difference them to move forward the quality of work and moreover win time and decrease costs. With a focus on Walmart and how it has benefited from this technology in its services. This thesis focuses on the comprehensive knowledge of the term Internet of Things and related fields and how it can be used by organizations and how it can contribute to increasing the effectiveness of supply chains for those organizations. The descriptive method was used with the combination of qualitative methods, and information was collected through Walmart's official website. The Internet of Things is a very rich and very important field. It also has a great benefit especially for business companies that rely heavily on technology. The Internet of Things greatly facilitates everyday business and contributes to the profit of time and the reduction of different costs. The integration of the Internet of Things into supply chains helps to increase the efficiency of these chains and helps enterprises to track their full steps at all stages, making it much easier for companies to know if there are any problems during the transfer process. Walmart also uses the Internet of Things in its own stores as well as becoming connected between the company and its customers directly The main conclusions of this thesis are that the field of the Internet of Things is a very complex and huge one where millions of sensors and smart devices connected with each other simultaneously require as much information and require huge speed in their transmission, which confirms the significant technological progress reached by the developed countries. The Internet of Things can also be used in many other tasks such as business and can be used in the lives of individuals and families. This Thesis is based on a proper understanding of the term "Internet of Things" and how it can be used to benefit organizations or even individuals in their lives. Combining them can make it easier for organizations to communicate with customers and understand their requirements as well as for customers as they can benefit from the technologies of the Internet of Things that the organizations offer.

Key words: Internet of Things (IoT), Supply Chains, Industry 4.0, Walmart

Chapter 01: Conceptual framework of Internet of Things & Supply chain

Topic 01: Internet of Things and its current Development

I. Historical background of Internet of Things

The precursor to the Internet of Things is the concept of connected devices that started in the early 1990s at the Auto-ID Centre at MIT. Reportedly, Kevin Ashton, director of the Centre, has coined the term Internet of Things in 1999. In 1997, Ashton considered the possibility of using radio-frequency identification tags to track products through Procter and Gamble's supply chain. Radio-frequency identification tags were used to read and identify objects and then transmit the information wirelessly through a network. Before that, industry adoption of radio-frequency identification tags started in 1980. Then a new concept of sensors and actuators through a wireless sensor network appeared to sense, track, and monitor objects with applications in healthcare and traffic management. Nowadays, these networks are enriched with GPS devices, Smartphone's, social networks, cloud computing, and data analytics to support the modern concept of the Internet of Things.

In Europe, and particularly Germany, the Internet of Things is one of the founding technologies of Industry 4.0 in the manufacturing sector. Industry 4.0 refers to the fourth industrial revolution where the three first industrial revolutions are related to mechanical power (Industry 1.0), mass production (Industry 2.0) and digital revolution (Industry 3.08).

In addition to Internet of Things technology, Industry 4.0 needs cyber–physical systems and cloud manufacturing. Cyber–physical systems are composed of machines, storage systems and production facilities that could autonomously exchange information, trigger actions and monitor each other, a cyber–physical systems links a manufacturing entity virtual (computing) and physical (machines) elements by integrating analogue/digital hardware. Internet of Things provides the needed platform to connect the cyber–physical systems using a network of sensors, actuators and devices. Internet of Things platforms use generally cloud-computing capabilities in external data centers, which led to the concept of cloud manufacturing in the industry 4.0 context. (Ben-Daya, Hassini, & Bahroun, 2019, p. 2)

II. The Definition and importance of Internet of Things

1. The Definition of Internet of Things

The Internet of Things is the connection of millions of smart devices and sensors connected to the Internet. These connected devices and sensors collect and share data for use and evaluation by many organizations. These organizations include businesses, cities, governments, hospitals and individuals. The Internet of Things has been possible, in part, due to the advent of cheap processors and wireless networks. Previously inanimate objects such as doorknobs or light bulbs can now be equipped

with an intelligent sensor that can collect and transfer data to a network.
Researchers estimate that over 3 million new devices are connected to the Internet each month. Researchers also estimate that in the next four years, there are going to be over 30 billion connected devices worldwide.
Perhaps a third of connected devices will be computers, smartphones, tablets, and smart TVs. The remaining two-thirds will be other kinds of "things": sensors, actuators, and newly invented intelligent devices that monitor, control, analyze, and optimize our world.
Some examples of intelligent connected sensors are: smart doorbells, garage doors, thermostats, sports wearable's, pacemakers, traffic lights, parking spots, and many others. The limit of different objects that could become intelligent sensors is limited only by our imagination. (DHET, 2020, p. 13)

Internet of Things exists as part of an emerging technology ecosystem with cloud and big data analytics. Interactions occur among and between people and objects in computer aware environments that can avail themselves of new and innovative services delivered through the cloud and supported by an ever more powerful set of analytical tools. Sophisticated data analysis techniques will enable applications to aggregate and act on large amounts of data generated by devices in homes, public spaces, industry, and the natural world. This aggregated data can drive innovation, research, and marketing, as well as optimize the services that generated it. The ecosystem must be considered to be an overlapping continuum where it is impossible to isolate the impacts of one technology from the others. To that end, the policy issues should consider and address the ecosystem impacts. (OECD, 2016, p. 8)

A definition of Internet of Things is not a simple matter. In a previous report (OECD, 2011) the term Internet of Things was said to be mainly associated with applications that involve radio-frequency identification. In that report the term Machine to Machine was used for:

"Devices that are actively communicating using wired and wireless networks, that are not computers in the traditional sense and are using the Internet in some form or another. Machine to Machine communication is only one element of smart meters, cities and lighting. It is when it is combined with the logic of cloud services, remote operation and interaction that these types of applications become "smart". Radio-frequency identification can be another element of a smarter environment that can be used in conjunction with Machine to Machine communication and cloud services."

Since 2011, the term Internet of Things has gained prominence to describe a wider variety of developments where "things" are connected to the Internet. Traditional Machine to Machine solutions typically rely on point-to-point communications performing actions without the manual assistance of human interaction using embedded hardware modules and either cellular or wired networks. In contrast, Internet of Things solutions rely directly or indirectly on IP-based

networks to interface device (object or things) data to a cloud or middleware platform. (OECD, 2016, p. 9)

2. The importance of Internet of Things

With the growing popularity of the Internet of Things in mind, more businesses seek to reap the Importance of the technology in the supply chain to assist the organization.

- **Higher speed**

Smart route-planning tools and Internet of Things tracking technologies increase the overall supply chain speed exponentially. Integrating these technologies in everyday operations, managers shorten the feedback circle, benefit from faster decision-making, proactively mitigate delay risks, and generally improve the efficiency of locating goods within the warehouse.

- **Higher accuracy**

Connected platforms are faster and easier to access than closed systems. By building a cloud-based Internet of Things system, companies ensure all parties involved in the supply chain lifecycle will have access to relevant data and can address issues fast. On top of that, web and mobile tools for different users (employees, managers, operators, customers) help them work with the insights, use collected data to build strategies and different scenarios relevant to user roles and needs.

- **Improved flexibility**

Internet of Things provides managers with detailed insights on the goods turnover, helping retailers and supply chain managers know how many units of every product should be ordered. The Internet of Things reduces the impact of human error as well by adding high precision in asset tracking, shipping and navigation for the drivers on the road.

- **Better segmentation**

Combining Internet of Things and supply chain management is a good way for retailers to learn more about their products, customers and demand and build relevant strategies. Data collected throughout the product cycle helps better understand the market and segment products with the target audience in mind.

- **Increased efficiency**

Internet of Things empowers a wide range of connected platforms geared towards employees. Tools like smart glasses help instruct warehouse workers seamlessly to ensure they spend less time completing a task. Also, Internet of Things captures efficiency-related data and brings more awareness into resource and labor management.

Thanks to the technology, supply chain managers will ensure all the parties involved in the delivery perform to the best of their ability. (DIGITEUM, 2021)

III. Growth of Internet Of Things over past years

The Internet of Things is an extended and expanded system network based on the Internet, and its ultimate goal is to achieve real-time interaction among things, machines and humans through various advanced technological means. The earliest literature on the Internet of Things was published in 2002; Schoenberger (2002) first designed the application of the Internet of Things in stores, and he stated that tiny wireless chips enable stores to have eyes. After nearly 20 years of development, increasing numbers of government officials, corporate executives and researchers tend to believe that the Internet of Things is an important technology for improving our living environment and quality of life. A market research report showed that the global Internet of Things market reached $1.90 billion in 2018, and this number is expected to reach $11.03 billion in 2026 (Panetta, 2016). The European Union, the United States, China and other countries have also formulated Internet of Things -related action plans. These policies and plans mainly include the Internet of Things - An action plan for Europe and Internet of Things development plans 2016-2020. (Wang, Lim, Wang, & Tseng, 2021, p. 3)

After over 20 years of development, Internet of things -related research has been extended to different fields, including smart medical care. The Internet of things concept has been widely recognized and applied in different fields. However, the Internet of things -related research results do not explore the inherent development rules and research trends of the Internet of things. In particular, few studies have been conducted to reveal the origin of the Internet of things, evaluate its mainstream research topics and discuss the challenges that will be faced by the Internet of things in the future based on a bibliometric method. In addition, the progress of Internet of things technology is inseparable from the support of related theories and methods, and increasingly scholars and practitioners are eager to learn more about the development status of the Internet of things by reading publications. Hence, it is time for a systematic review and outlook for Internet of things development over the past 20 years. (Wang, Lim, Wang, & Tseng, 2021, p. 4)

The graph below depicts the growth of Internet of things over the years. In 1992, only 1,00,000 people were using Internet of things as a technology. Till 2003, the number grew to half a billion people. While 2009 marked the Internet of things inception, 2012 witnessed a sudden increase in the usage of Internet of things where the people using Internet of things reached 8.7 billion, and there was no looking back. The number of users has been growing exponentially over the years reaching 28.4 billion in 2017. It is expected that the number will broaden to 50.1 billion by 2020. (Jindal, Jamar, & Churi, 2018, p. 15)

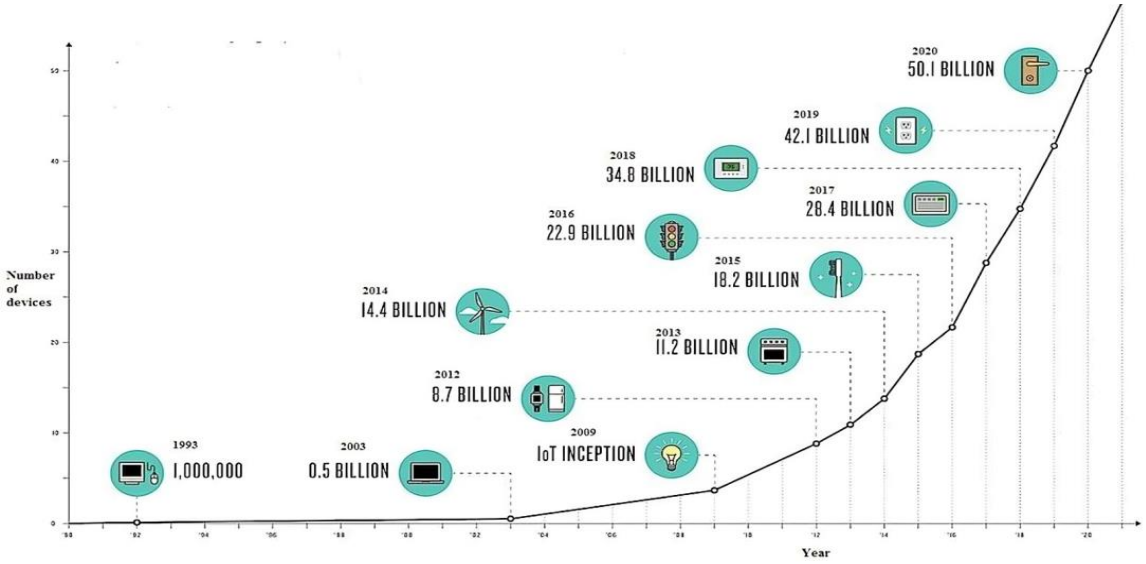

Fig. 1 Survey of Growth of Internet of Things over past years

IV. The Challenges and The objectives of Internet of Things

1. The Challenges of Internet of Things

Behind every success story is a hidden chain of problems. Same is the case of Internet of Things, It experiences three major challenges:

• Technological challenges

• Business challenges

• Societal problems

a. Technology:

Internet of Things components are implemented using divergent protocols and technologies. As a result, these components have intricate configurations and poor design.

Technological challenges can be a reflection of five parameters:

- **Security:** Internet of Things has happened to cause major security issues that have grabbed the attention of various public and private sector companies of the world. Adding such a massive number of new hubs to the systems and the web will provide attackers with a larger platform to invade the system, particularly as many

experience the ill effects of security holes. Indications suggested that the malware captured infinite number of Internet of Things gadgets that are being used in basic applications like smart-home devices and closed-circuit cameras and deployed them against their own servers. A further critical move in security will develop from the way Internet of Things turns out to be involved in our lives.

- **Connectivity:** The most significant challenges of the future of Internet of Things would be to connect several devices, this communication will end up resisting the currently existing structure and the technologies associated with it. Presently, a centralized, server/client architecture is being utilized to authenticate, authorize and connect several terminals in a network.

This model is appropriate only for the current situation and is not scalable to cater future needs where billions of devices will be part of a single network. This scenario will transform the current centralized system into a bottleneck. Large amount of investments and expenditure in maintaining the cloud clusters of servers are required which can deal with humongous quantity of information exchange, as unavailability of servers can lead to a total system shutdown.

- **Compatibility and Longevity:** Internet of Things is developing in a widespread manner. It is incorporating many technologies and will soon advance into a convention. This will pose serious challenges and will demand setting up of additional software and hardware in order to establish communication amongst the devices.

Unavailability of standardized Machine to Machine protocols, Non-unified cloud services, and varieties in firmware and operating systems among Internet of Things devices are some of the other compatibility issues. Devices working on these technologies will become purposeless in future as these technologies are going to become outdated very soon.

- **Standards:** Technology conventions incorporating network and communication protocols, and data-aggregation conventions, are the collection for activities that handle process and store information obtained from several sensors. These enhance the data by increasing the scale, scope, and frequency of data available for analysis
- **Intelligent Analysis & Actions:** The final step in the implementation of Internet of Things is the revelation about the data for analysis. The analysis procedure is based on cognitive technologies and models. There are certain parameters that cause intelligent actions to be incorporated in Internet of Things, some of them being lesser device cost, enhanced device functionality, the machine "influencing" human actions through behavioral-science rationale, deep learning tools, machines' actions in unusual scenarios, information security and privacy and device interoperability.

b. Business:

The main issue is a major inspiration for beginning, putting resources into, and managing any venture, without a full proof plan of action for Internet of Things we will have another bubble, this model should fulfill every one of the prerequisites for all kinds of e-commerce; vertical markets, horizontal markets, and consumer markets. Be that as it may, this class is always a sufferer of administrative and lawful inspection. Usage of Internet of Things technologies plays a significant role to create a source of additional income to reduce the burden on the existing communication infrastructure. (Jindal, Jamar, & Churi, 2018, p. 21)

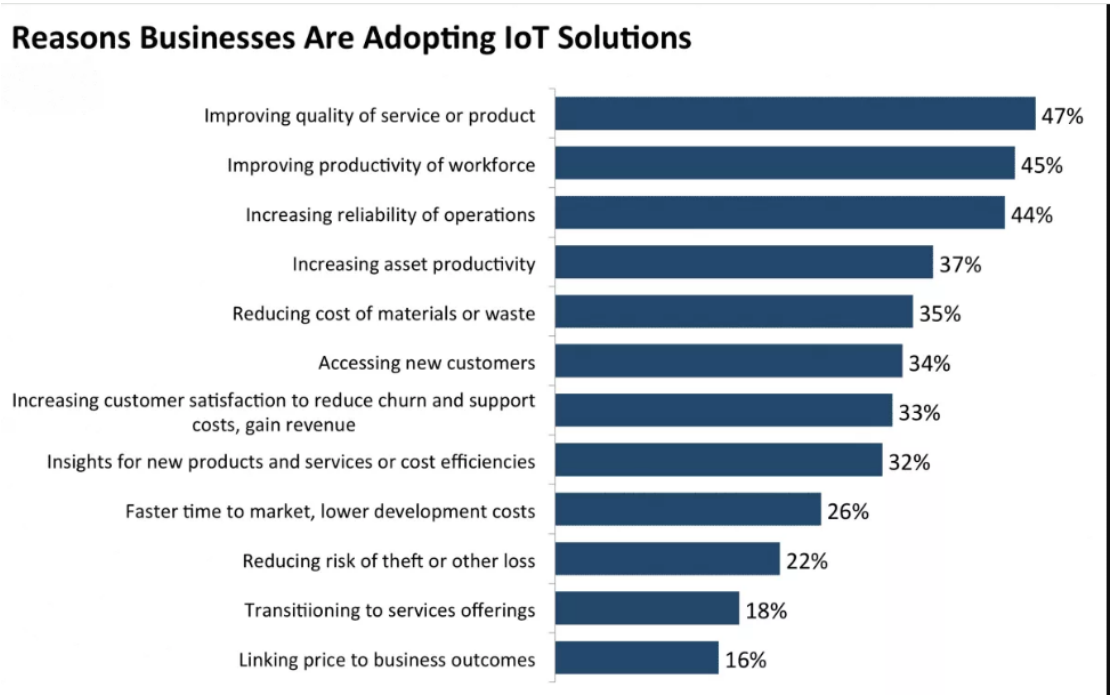

Fig. 2 Reasons Businessman are adapting Internet of Things Solutions

c. Society:

Understanding Internet of Things from the clients and regulators point of view isn't a simple errand for the following reasons:

- Customer requests and requirements change regularly.

- New uses for devices—and also new devices—grow and develop dangerously fast.

- Inventing and reintegrating have features and capabilities that are costly and require significant investment and assets.

- The uses for an Internet of Things technology are growing and changing—regularly in uncharted waters.

• Consumer Confidence: Each of these issues could put a dent in buyers' want to buy associated items, which would keep the Internet of Things from satisfying its real potential.

Internet of things data is a very sensitive data which if leaked can give the control of the system in the attack's hands. Hence we have to have the strong and reliable technology to secure how Internet of things data is being used. Business policies and procedures pose some social challenges to Internet of things and government laws, and rules pose legal challenges to its use Internet of things data is a very sensitive data which if leaked can give the control of the system in the attack's hands. Hence we have to have the strong and reliable technology to secure how Internet of things data is being used. Business policies and procedures pose some social challenges to Internet of things and government laws, and rules pose legal challenges to its use. (Jindal, Jamar, & Churi, 2018, p. 22)

2. The objectives of Internet of Things

Tracking and monitoring are some of the main objectives for Internet of Things deployment in supply chain. The technology allows warehouse and fleet managers to keep track of their cargo and inventory.

However, there's more to the Internet of Things than its asset management potential.

- **Real-time location-tracking**
  Internet of Things provides managers with a coherent stream of real-time data regarding the location of the product and the transportation environment. You will be alerted if the product is shipped in the wrong direction and will be able to monitor the delivery of ready goods and raw materials.

- **Storage condition monitoring**

Thanks to environmental sensors, managers can track shipment conditions and proactively respond to changes. For instance, one of the most common Internet of Things supply chain solutions gathers data on the temperature inside vehicles, pressure, humidity, and other factors that could compromise the product's integrity and triggers automatic condition adjustment.

- **Forecast the movement and the arrival of the product**

Managers use Internet of Things devices and data analytics systems to improve the quality of decision-making and increase the precision of delivery forecasts. Thanks to real-time tracking, companies are able to monitor goods during shipment and predict the delivery as well as forecast and mitigate risks associated with delays.

- **Locate goods in the warehouse**

Integration of Internet of Things-based supply chain management systems is among the top warehouse technology trends. The benefits are numerous from the increased efficiency of warehouse processes to better inventory management and employee safety. Thanks to real-time location trackers, for instance, employees on-site can easily locate goods and get quick to the exact aisle for a specific product. In this case, Internet of Things enables seamless workflow and performance that is impossible to achieve otherwise. Moreover, combined with artificial intelligence, Internet of Things becomes a stepping stone for full-on warehouse automation with little to no human supervision.

- **Improve contingency planning**

Internet of Things and data analytics help supply chain managers plan routes, taking into account traffic, weather, possible accidents or other delay-inducing occurrences that happen on the way. The Internet of Things curates all data needed to develop flexible contingency plans and get to the cause of existing delays. The technology offers supply chain managers real-time alerts that increase the speed of risk mitigation. (DIGITEUM, 2021)

V. The Benefits of Internet of Things and its applications

In present time, the Internet of Things is found everywhere. The major goal of the Internet of Things is to enable all entities living or non-living, to act smart.

Smartness is the key criterion for any object to work with the Internet of Things. Things that can sense, actuate some motion, and send data further while doing some basic computation at their own level can be termed smart things. Currently, there is a massive gradation of common objects into smart objects, as a result of which the Internet of Things has taken over the technological world as well as the real world. As now as the real world.

Internet of Things can be found in every domain of life, its applicability has increased drastically to every nook and corner of the physical world. A number of scientists, academicians, and other stakeholders have suggested many possible domains suitable for Internet of Things applications. (Ahmed, Shilpi, & Amjad, 2018, p. 7)

We have curated the list and subsumed the major domains of Internet of Things applicability into twelve categories, Smart Cities, Smart environment, Smart-metering, Security & Emergencies, Retail, Logistics, Industrial control, Agriculture, Smart-Animal- farming, Home Automation, Smart- Education and Smart Health Care, Smart Industry, Smart Environment, Smart City, Smart Wearable and Smart Home are the five major categorizations of Internet of Things solutions.

The application of Internet of Things products in its domain forms the basis of this categorization. The Internet of Things, its products, and applied method may vary in every single domain mentioned above the only thing the Internet of Things is tasked with, but its operations are manifold. As per the intended accomplishments and

purposes, in this paper, we are listing the into different categories. These functions can be roughly organized into the following Domestic Societal Environmental, Technological and Emergency and Critical Situations.

•Domestic:

Home Automation rightly falls category. It involves the function of sensing and automating the daily activities of the home. An example may be the sensor of one's room which lets the LED knows that the user is not in the room, so it may power itself off.

•Societal:

A smart Internet of Things oriented everything is smart from smart traffic control systems, smart transportation services, and smart parking management, to smart healthcare, smart marketing, and similar social services falls in this category.

•Environmental:

A smart environment where basic constituents of the Environment such as Wildlife, Marine life, Flora, and Fauna are driven by Internet of Things technologies befits this category. An instance could be the sensor which can keep a check on the health of aquatics and prompt the authorities in real time if any mis-happening occurs.

•Technological:

Smart Industrialization, automated malls such as Amazon stores, Smart shopping facilities, and also smart security to keep all these running efficiently are the ideal components of this category.

•Emergency and Critical Situations:

Issues that are of global importance and have an impact on the very existence of mankind fall in this category. This is the domain where proper Internet of Things implementation can bring revolutionary changes. Possible instances may include smartly managing natural calamities, keeping real-time eyes on the water level, prompt indicators for any increased radiation, sensing toxic gas generation fast, and discovering depleting agents of ozone layer and indexing into database and augmenting border securities with the integration of Internet of Things into the defense. (Ahmed, Shilpi, & Amjad, 2018, p. 8)

5.2. Benefits of The Internet of Things

Internet of Things techniques support a wide range of innovative businesses. In addition to using Internet of Things approaches to build applications for smart

transportation, health, and other sectors, Internet of Things techniques may also support more responsive business models in which more granular and frequent data reported by Internet of Things services will allow businesses to better assess how their customers use their products. In turn, firms could offer tailored solutions to their customers while contracts between supplier and customer could be dynamically adapted so that the actual functioning of the service is the main focus for any business. While such transformations have been on-going for several decades, Internet of Things techniques can accelerate this process. (OECD, 2016, p. 11)

Businesses have more information about products that they sell and who is purchasing them. Armed with this type of data, they can streamline production and target their marketing and advertising to specific areas or audiences, promotes creation of new business opportunities and marketing ideas.
Manufacturing saves money, improves efficiency, and improves productivity of manufacturing processes and operations. Manufacturers reduce downtime by predicting maintenance requirements and improving scheduling of field service employees. Retailers are able to do more target marketing, reduce losses based on unsold products, and can provide loyalty bonuses for preferred or frequent customers, as well as manage types of in-store products.

Governments monitor environmental issues, target funding for social issues, and have informed control of power output. Cities have the ability to control traffic patterns based on time of day or major events, monitor and control garbage and recycling, monitor health and housing needs, and evaluate future transportation requirements. Individuals can reap improved fitness and health benefits, better home and family security, and reduced costs for energy and heating systems. They can enjoy more varied entertainment, limit the speed a teenage driver can reach, or even monitor the health of an older family member at the wheel of their car. (DHET, 2020, p. 13)

With the growing popularity of the Internet of Things in mind, more businesses seek to reap the benefits of the technology in the supply chain. In case you are wondering how Internet of Things can improve your company's efficiency and reduce operating costs, here's an overview of its benefits in supply chain.

- **Higher speed**

Smart route-planning tools and Internet of Things tracking technologies increase the overall supply chain speed exponentially. Integrating these technologies in everyday operations, managers shorten the feedback circle, benefit from faster decision-making, proactively mitigate delay risks, and generally improve the efficiency of locating goods within the warehouse.

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supply chain lifecycle will have access to relevant data and can address issues fast. On top of that, web and mobile tools for different users (employees, managers, operators, customers) help them work with the insights, use collected data to build strategies and different scenarios relevant to user roles and needs.

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- **Increased efficiency**

Internet of Things empowers a wide range of connected platforms geared towards employees. Tools like smart glasses help instruct warehouse workers seamlessly to ensure they spend less time completing a task. Also, Internet of Things captures efficiency-related data and brings more awareness into resource and labor management. (DIGITEUM, 2021)

VI. Advantages and Disadvantages of Internet of Things Devices

The Internet of Things has emerged as a transformative force, connecting physical devices to the internet and enabling them to communicate, collect data, and perform various tasks autonomously. This interconnected network of smart devices has revolutionized industries, homes, and cities, offering numerous advantages while also presenting certain challenges. In this article, we will explore the advantages and disadvantages of Internet of Things, highlighting its impact on technology, society, and the economy.

1. Advantages of internet of things

- **Enhanced Efficiency and Productivity**

Internet of Things enables the automation and optimization of processes, leading to increased efficiency and productivity. By connecting devices and sensors, businesses can gather real-time data, monitor operations, and make data-driven decisions. These results in streamlined workflows, reduced manual intervention, and improved resource allocation.

- **Improved Convenience and Quality of Life**

Internet of Things devices offer enhanced convenience and improve the quality of life for individuals. Smart home technologies, wearable devices, and connected appliances allow for remote control, monitoring, and automation, simplifying daily tasks and providing personalized experiences. Internet of Things also enables advancements in healthcare, transportation, and energy management, enhancing safety, comfort, and sustainability.

- **Innovation and New Business Opportunities**

Internet of Things fuels innovation by enabling the development of new products, services, and business models. The ability to collect and analyze vast amounts of data from connected devices unlocks insights and opportunities for optimization, predictive maintenance, and tailored customer experiences. Internet of Things ecosystems creates fertile ground for startups and entrepreneurs to explore novel applications and disrupt traditional industries.

- **Environmental Sustainability**

Internet of Things plays a crucial role in promoting environmental sustainability. By monitoring and managing energy consumption, optimizing resource utilization, and enabling smart grid systems, the Internet of Things contributes to reducing waste, conserving energy, and mitigating environmental impact. Smart cities leverage Internet of Things to enhance urban planning, transportation efficiency, and waste management, fostering sustainable living environments.

2. **Disadvantages of Internet of Things**

- **Security and Privacy Risks**

As the number of connected devices grows, so does the potential attack surface for cybercriminals? Internet of Things devices may have vulnerabilities that can be exploited, leading to data breaches, unauthorized access, or even the hijacking of devices. Additionally, the vast amount of personal data collected by Internet of Things devices raises concerns about privacy and data misuse, necessitating robust security measures and stringent data protection regulations.

- **Complexity and Interoperability Challenges**

The complexity of Internet of Things systems presents challenges in terms of interoperability and integration. Various devices, protocols, and platforms must seamlessly work together, requiring standardization efforts and compatibility among different vendors. Ensuring interoperability, managing updates, and maintaining compatibility over time can be resource-intensive and technically demanding.

- **Reliability and Infrastructure Dependencies**

Internet of Things heavily relies on a robust network infrastructure and reliable connectivity. Network outages, latency issues, or disruptions in communication can

hamper the performance and functionality of Internet of Things devices. Additionally, as more devices become interconnected, the scalability and reliability of the underlying infrastructure become critical factors in ensuring smooth operations.

- **Ethical and Social Implications**

The widespread adoption of Internet of Things raises ethical concerns surrounding data privacy, surveillance, and autonomy. The collection of vast amounts of personal data can potentially infringe on individual privacy rights if not appropriately handled. Additionally, Internet of Things -enabled technologies may challenge traditional notions of consent, autonomy, and accountability, necessitating ethical frameworks and regulations to address these complexities.

While the Internet of Things offers numerous advantages, including increased efficiency, enhanced connectivity, and data-driven insights, it also presents challenges such as security concerns, interoperability issues, and complexity in management. As Internet of Things technology continues to evolve, it is essential to address these challenges proactively through robust security measures, standardization efforts, and comprehensive management practices. By mitigating the disadvantages and maximizing the benefits of Internet of Things, we can harness its transformative potential to create a more connected, efficient, and sustainable future. (Sharma, 2023)

Topic 02: The Supply Chain

I. The Concepts of Supply chain

Historically built on Procurement, Operations and Logistics foundations; Supply Chain exceeds these traditional concepts. Supply Chain is involved with integrating three key flows, between the different stages, across the boundaries of the companies:

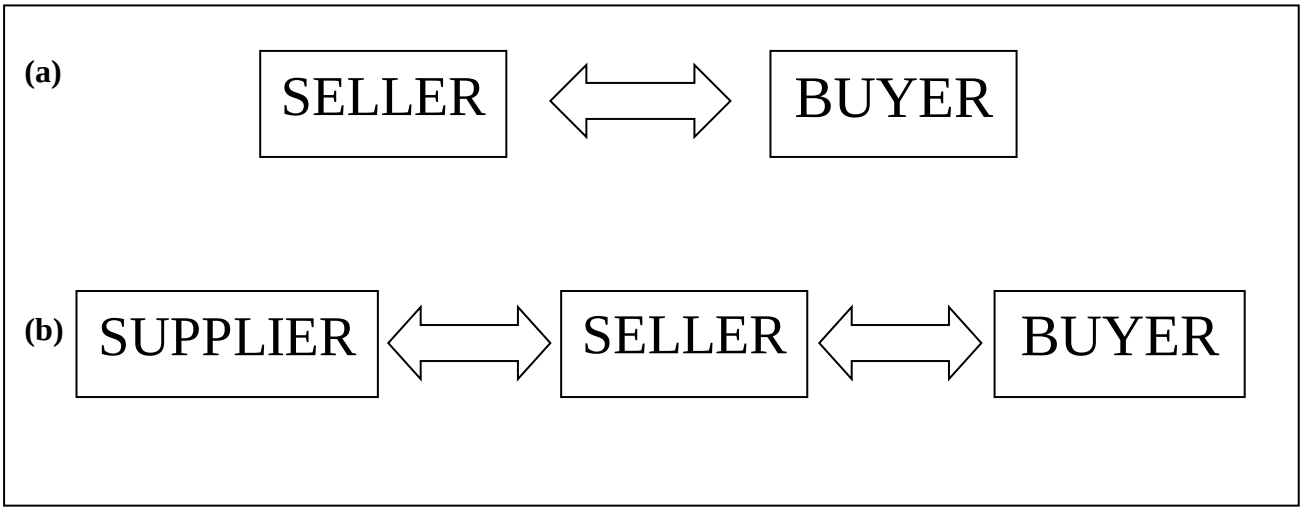
- **Flow of information**
- **Product/materials**
- **Funds**

Members of the supply chain act as partners who are “linked” together through both physical and information flows. It is this that makes an effective supply chain. The flows that involve the transformation, movement, storage of goods and materials and money are called ‘physical flows’. These flows are easily visible.

The physical flows are reinforced by information flows. Information flows are used by the various supply chain partners to coordinate their long-term plans, as well as efficiently control the day-to-day flow of goods and material to the supply chain. In essence, the supply chain enables the flow of products, services, and information goes both up and down the chain. Successful integration or coordination of these three flows produces improved efficiency and effectiveness for business organizations.

‘Supply Chain’ can be defined as 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 and efficient ways possible. There can be various types of supply chains. There is a basic supply chain, and an extended supply chain. The definition of a basic supply chain is: a set of three or more companies directly linked by one or more of the upstream or downstream flows of products, services, finances and information from a source An extended supply chain includes suppliers of the immediate supplier and customers of the to a customer. Immediate customer, all linked by one or more of the upstream and downstream flows of products, services, finances, and information. (Tikoo, 2023, p. 2)

Figure 3: (a) Traditional Supplier-Buyer Relationship, (b) Basis Supply Chain



Source: Upendra Kachru (2010), “Exploring the Supply Chain,” Excel Books

Figure 3 shows a traditional seller-buyer relationship (a) and a basic supply chain (b). An extended supply chain consists of a number of relationships. These are called tiers.

In evaluating the success of the supply chain, the links between the manufacturer and the retailer have to function at a desired level. Even when the performance at earlier stages of the supply chain is outstanding, this is not important – if the product is not available to support retail sales. This is because the end customer is the only source of revenue for the supply chain and the linkage is the ultimate test to the success of the supply chain.

The basic objective of Supply Chain is to maximize the supply chain profitability. A more successful supply chain will, therefore, have higher profitability. The profitability of a supply chain is the difference between what the customer pays for the final product and the costs the supply chain expends in filling the customer’s request. (Tikoo, 2023, p. 5)

II. The objectives of Supply chain

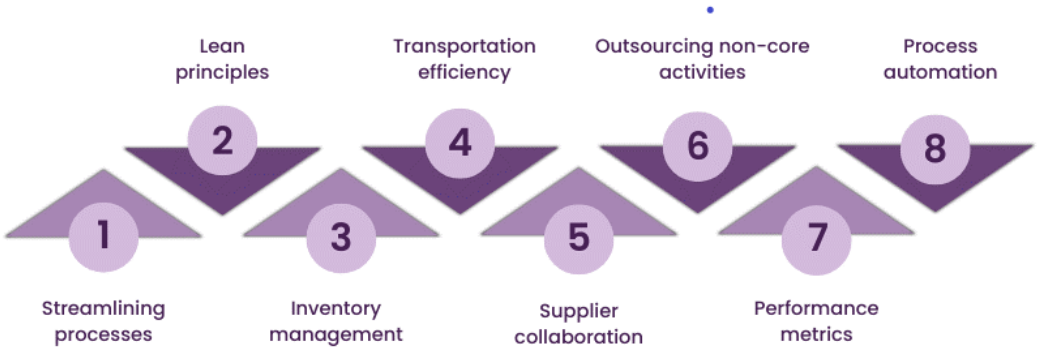
Supply Chain encompasses a set of goals and objectives that organizations, they help optimize their Supply Chain operations and gain a competitive advantage

What are the various Objectives of Supply Chain?

1. Cost reduction and efficiency enhancement

Cost reduction and efficiency enhancement are primary Objectives of Supply Chain that organizations continually strive to achieve. Businesses can maximize output while minimizing expenses by optimizing the **Supply Chain Process**.

Here are key approaches to attain these objectives:



- Analyze and re-engineer existing processes to eliminate inefficiencies and bottlenecks, reducing lead times and improving productivity.
- Apply Lean principles to eliminate waste and improve Supply Chain agility.
- Optimize inventory levels through demand forecasting and just-in-time inventory practices to reduce carrying costs.
- Negotiate favorable contracts with carriers, optimize routing, and explore transportation options to minimize costs while ensuring timely deliveries.
- Collaborate with suppliers on demand forecasting, production preparation, and inventory management to reduce lead times and costs.
- Outsource non-core activities to specialized service providers to focus on core competencies and gain efficiencies.

- Implement performance metrics to monitor Supply Chain effectiveness and identify areas for improvement.

- Integrate technology solutions like robotics and automated systems to reduce errors and increase operational efficiency.

2. Inventory management

Effective management of inventory is a crucial aspect of Supply Chain. It aims to achieve a delicate balance between meeting customer demand and minimizing carrying costs. Let's explore the key approaches to successful inventory management:

- **Demand forecasting:** Accurate forecasting enables optimized inventory levels and prevents stock outs or overstock situations.

- **Just-in-time (JIT) inventory:** Adopting JIT principles reduces holding costs by delivering products as needed.

- **Safety stock:** Maintaining safety stock mitigates the risk of unexpected demand fluctuations or delays from suppliers.

- **Inventory turnover:** Measuring turnover helps assess the efficiency of inventory utilization.

- **ABC analysis**: Categorizing inventory based on value enables prioritization for better management.

- **Vendor-managed inventory (VMI):** Suppliers monitor and manage inventory levels on behalf of the organization, reducing stockouts.

- **Economic order quantity (EOQ)**: Calculating the optimal order quantity minimizes order and holding costs.

- **Inventory audits**: Regular audits ensure accurate inventory records and identify discrepancies.

- **Technology integration**: Implementing inventory management software enhances visibility and control over inventory levels.

3. **Improved customer service**

Improved customer service is a key objective of Supply Chain, as it directly impacts customer satisfaction and loyalty. By focusing on providing exceptional service throughout the Supply Chain, organizations can gain a competitive advantage and foster long-term relationships with their customers. Let's explore the key approaches to achieving improved customer service:

- **Timely deliveries**: Ensuring products reach customers on time, meeting their expectations.
- **Accurate order fulfillment:** Minimizing errors in order processing and shipping.
- **Responsive customer support**: Promptly addressing customer inquiries and issues.
- **Effective communication**: Keeping customers informed about their orders and any potential delays.
- **Efficient returns handling**: Streamlining the process for product returns and exchanges.
- **Personalization**: Tailoring services to individual customer needs and preferences.
- **Customer feedback**: Accumulating and acting on customer feedback to continuously improve service.
- **Supply Chain visibility**: Providing customers with real-time updates on the status of their orders.
- **Collaboration with partners**: Coordinating with suppliers and logistics partners to enhance service levels.

4. **Supplier Relationship Management**

Supplier relationship management is one of the critical Objectives of Supply Chain, focusing on establishing and maintaining positive and collaborative relationships with suppliers. Effective Supplier relationship management enhances the overall efficiency and resilience of the Supply Chain and contributes to the success of the organization.

Let's explore the key approaches to successful supplier relationship management:

Carefully evaluating potential suppliers based on factors such as reliability, quality, and financial stability.

- Building strong, long-term relationships with selected suppliers fosters trust and loyalty.
- Maintaining open lines of communication with suppliers to facilitate timely and effective collaboration.
- Regularly assessing supplier performance based on pre-defined Key Performance Indicators and benchmarks.
- Collaborating with suppliers to improve their capabilities, efficiency, and quality.
- Creating clear and mutually beneficial contracts that outline expectations and responsibilities.
- Recognizing and mitigating potential risks associated with suppliers, such as disruptions or quality issues.
- Encouraging suppliers to adopt continuous improvement practices for mutual benefit.
- Leveraging technology for seamless information exchange and real-time visibility into supplier operations.

5. **Risk mitigation and resilience**

Risk mitigation and resilience are vital to Supply Chain Objectives that address potential risks and disruptions.

Let's explore the key approaches to achieve these objectives:

- **Risk assessment**: Identifying and evaluating potential risks in the Supply Chain like natural disasters or supplier disruptions.
- **Contingency planning**: Developing comprehensive plans to address different risk scenarios and ensure a swift response.
- **Diversification**: Reducing dependency on single suppliers or markets by diversifying sourcing options.
- **Business continuity**: Implementing robust plans to ensure minimal disruptions during crises.
- **Supplier risk management**: Assessing and monitoring risks associated with key suppliers.
- **Real-time monitoring**: Using technology and data analytics to detect potential risks in real time.
- **Flexibility and agility**: Building a flexible and Agile Supply Chain that can adapt quickly.
- **Scenario planning**: Conducting exercises to anticipate and prepare for potential risks.
- **Collaboration**: Collaborating with stakeholders to jointly address risks and find solutions.

A resilient Supply Chain can navigate challenges and disruptions effectively, safeguarding operations in an unpredictable business environment.

6. **Sustainability and social responsibility**

Sustainability and social responsibility are other critical Objectives of Supply Chain Management. Organizations strive to minimize their environmental impact and promote ethical practices using **Green Supply Chain**.

Here is how you can achieve that:

- **Environmental sustainability**: Reducing carbon footprint, promoting eco-friendly practices, and responsible sourcing.

- **Social responsibility**: Ensuring fair labour practices, supporting ethical working conditions, and promoting diversity.

- **Green Supply Chain Management**: Implementing eco-friendly initiatives like energy-efficient operations and recycling.

- **Responsible sourcing**: Sourcing raw materials responsibly to support sustainability goals.

- **Ethical standards**: Adhering to ethical standards throughout the Supply Chain.

- **Consumer appeal**: Attracting environmentally conscious customers through sustainable practices.

- **Brand image**: Enhancing the brand image by demonstrating a commitment to sustainability.

- **Stakeholder engagement**: Collaborating with stakeholders to achieve sustainability objectives.

- **Impact assessment**: Evaluating the environmental and social impact of Supply Chain operations.

7. **Innovation and technology integration**

Innovation and technology integration are crucial Objectives in Supply Chain. Embracing cutting-edge technologies like data analytics, automation, and Internet of Things enables real-time decision-making, enhances efficiency, and drives continuous improvement.

Organizations gain a competitive advantage by leveraging innovation to optimize Supply Chain operations and meet client expectations.

8. **Market expansion and global reach**

Market expansion and global reach make the key Objectives of Supply Chain. Organizations aim to explore new markets and expand their customer base internationally, by establishing efficient global Supply Chain networks, you can tap into international opportunities and gain access to diverse markets. It also helps achieve sustainable growth in the global marketplace.

Supply Chain is a multi-layered discipline that involves pursuing various interconnected objectives. Achieving these Supply Chain goals and objectives leads to efficient and resilient Supply Chains. It also enables organizations to deliver value to customers, gain a competitive advantage and drive business success. (https://www.theknowledgeacademy.com/blog/objectives-of-supply-chain-management/, 2023)

III. Supply chain effectiveness

The effectiveness and value of the supply chain is determined by its ability to align with its partners, whether they are service providers, employees, suppliers or distributors. The processes and systems have to be set to common business goals. It includes the business activity analyses that allow you to optimize processes, both strategic and operational. Supply chain effectiveness is determined by some identified management traits that set them apart from others.
These traits include the following:

1. Strategy

It starts with strategy. Firms with best supply chains have a corporate strategy that drives planning, tactical design, milestones and other steps in strategy development and implementation. The supply chain organization builds on and around this. The supply chain strategy should enable firms to plan tactical operations and to prioritize suppliers, customers and products.
Strategy sets the platform for supply chain execution if the supply chain members understand the process crosses their company and extends beyond the company. The strategy has to be about the flow of products and information, which stretches from suppliers through to store shelves or to customer warehouses. If the company's strategy means a significant shift in markets, products or customers, then the supply chain must change.
The strategy is long-term and has a growth focus. The strategy must be dynamic, and must take into account the resistance to change that can happen within companies. That means the supply chain strategy must be a facilitator of change, be agile and able to recognize, incorporate and adapt to drive toward the changes required.

2. Metrics

Results matter, but the right measures matter more. Performance management often gets lost in the maze of supply chain initiatives.
There are many new initiatives firms are taking in supply chain: (Tikoo, 2023, p. 14)

Radio Frequency Identification, Six-sigma Quality, Lean Manufacturing, Outsourcing, Vendor-managed Inventory, Collaborative Planning, Forecasting and Replenishment, Spend Management and Regulatory Compliance. All these initiatives promise to improve the speed of transactions, streamline processes, optimize

throughput and minimize risk. But the effectiveness of these initiatives should also be evaluated as they relate in overall performance goals.
Financial measures are poor ways to evaluate, direct and manage supply chains. The key performance indicators are orders (if it is delivered complete, on time and accurate), lead-times, reliability, inventory levels, potential out of stock conditions and logistics costs. The metrics for these have to be got right.

3. **Technology**

Technology is a process enabler. Corporations invested trillions of dollars over the past two decades in supply chain management software and systems. Historically, however, their focus has been on improving transaction processing, streamlining processes and optimizing throughput – in short, on improving efficiency. Few firms, if any, have applied resources to supply chain effectiveness and the ability to plan strategically and detect exceptions before they become expensive problems.

Without a strong process, many of the benefits of technology are lost or lessened. Technology is vital for supply chain execution to provide event management, exception management, complete supply chain visibility from purchase orders to delivery orders, and as a tool for collaboration.

4. **Supplier Performance**

Supply chain success depends on supplier performance. Supplier performance, or the lack of, can create havoc on revenue, inventory and profitability. Companies and their supply chains must control suppliers, and gain insight into operational issues through interactions by identifying root causes and understanding the impacts of various actions. It is critical to align performance with demand planning. They should not let suppliers control their business as it will lead to much variability in performance.

5. **Integration and Collaboration**

The supply chain process requires integration throughout the organization and beyond with suppliers and customers Operations managers often make decisions about demand, supply, manufacturing, fulfillment and distribution without clearly understanding the impacts of these decisions on performance targets. This may result in gaps and blind spots in the supply chain that can significantly hinder results. Collaboration with key supply chain participants is important to provide additional focus and resources to the total supply chain.

6. **Risk Mitigation**

A supply chain is effective if the entire supply chain can be assessed to identify critical areas, including suppliers, logistics service providers, ports and other potential risks that could disrupt the company’s supply chain and corrective action taken.

All this factors are critical for supply chain effectiveness. The supply chain, in the ultimate analysis, has to have agility and responsiveness to better adjust to changing market conditions and, to some degree, to control those forces. (Tikoo, 2023, p. 15)

IV.Process view of a Supply Chain

A supply chain is a process and a flow that works in order between and within the different phases of a supply chain so that a company can fulfill the demands of a customer.

Two methods are used in a supply chain to view how the processes are performed these are:

- **Cycle view**
- **Push and pull view**

1. Cycle view of Supply chain process:

The customer can be the real customer or the retailers and the customer order cycle starts when customer interface and this process involves directly receiving and satisfying customers order. Usually customer place order and his specification of the products to the retailer site and this process revolve fulfilling the customers demand.

The customers and the retailer's interaction begin with the customers placing an order to the retailer site and ends at the customer receiving the order. There are further processes involved in the customer order cycles these are:

- Arrival of Customer
- Customer order entity
- Customers order fulfillment
- Customer order receiving

a. Arrival of Customer

Customer arrival means the arrival of a customer to the market to make a purchase of his or her choice. It is the first success of any business that if it is getting enough customers for his or her product so the effort should be made in making the quality product. The only reason behind the exercise is to transform the customer arrival into a customer purchase. A customer can arrive through different means at the marketplace as he can walk into a supermarket for purchases, can call a mail order and he can use a website. Therefore, you should use all possible means for welcoming customers so that the entire door is open for the arrival of customers. (Basodan, 2016, p. 2)

The main effort should be put according to the supply chain perspective. It is the arrival of a customer and the agenda is to make possible contact between a product and a customer and in the telemarketing center, the customers should not have to wait for too long for their orders and the telesales representative can answer customers'

queries in a way, which will turn into customer orders. In addition, the benefit of having a website will be that customers can search and quickly view products that may interest them. All these things should be done for inviting customers.

b. Customer order entity

In this phase, a crucial decision is finalized that the customer arrival successfully turns into a customer order. Customers are informing retailers that they like the product and want to purchase it. In the store markets, customer loads all items that they mean to purchase onto their carts. The main aim of order entry process is to make certain that the order entry is there with the fast pace. It is fast, correct and informed to all other supply chain processes that are affected by it

c. Customers order fulfillment

In this stage, after the customer order entry took place, the next phase is to fulfill the customer order by sending the customer's order to him. At the supermarket this method is simply performed by customer purchasing the item from the retailer, However at the mail order when a customer places the order, this process includes getting the order from the inventory, packaging it and shipping it to the customers and all the information is kept up to date. Therefore, the product is delivered to the customer at the time with the minimum cost

d. Customer order receiving

In this phase, the customer finally gets his order and the payment is made to the seller with the ownership transferring from the seller to the customers. All the information is updated regarding the purchases. When a customer purchases the product at the supermarket, he receives the product at the checkout counter but when he orders through the mail, he receives his order and ultimately it happened as the product approach the customer

2. Replenishment Cycle

In the replenishment cycle stage, mostly, there are many retailers exactly reacted as a customer; the stage is customer order entry according to main features. Distributor and retailer both are involved in replenishment cycle in integrated form. This cycle is made to replenish retailer’s inventory so that the future demands could be met. Whenever an inventory or a supermarket is running out of stock as per its products then the replenishment cycle may be needed to refill inventories at the retailer at the lowest amount of cost so that all the products that are needed should be available at the market. There are four processes of replenishment cycle:

- Retail order trigger
- Retail order receiving
- Retail order fulfillment
- Retail order Inventory

a. Retail order trigger

The main purpose of retail order trigger is to maximize profit because when the customer purchases an item, replenishment of that product is needed in order to meet the needs of the future and by replenishing the product time-by-time economies of scales will be achieved. There will be no shortage of product and balance will be achieved in the availability of the product**.**

b. Retail order receiving

When the customer receives his replenishment order, he must receive it and update all the information from the order placement to the flow of funds from the distributor to the retailer and must update and display all the inventory records.

c. Retail order fulfillment

This process is also similar to the customer order process in which the retailers order are fulfilled by the distributor. But the order of a customer in comparison to the order of a retailer's replenishment order is very small because the replenishment order is very much large .The reason for fulfilling the retailer order too fast is to minimize the cost which could have occurred if the order of a customer wouldn't have been fulfilled.

d. Retail order Inventory

The stage is actually identical to customer order entry, but now, the retailer who places an order of inventory to the distributor through different means whether it being manually or electronically. (Basodan, 2016, p. 3)

3. Manufacturing Cycle

In this process, the main parties that are involved are distributors with the manufacturer and/or retailers with manufacturers. In addition, includes replenishing distributor’s inventory. This process involves-

• Scheduling the production houses.

• Maintaining the manufacturing and shipping placement.

• Orders that arrive from the distributor, retailer or customers.

• Orders receiving at the customer, distributor, and retailer.

a. Order arrival

This manufacturer order arrival is identical to order arrival perspective in no time. In this process, distributors and warehouse set proper replenishment time then convey it to the manufacturer. While it may also happen, customers and the retailers need replenishment and order it directly from the manufacturer. Although, in some cases, there are manufacturers produces to stock a finished product warehouse**.**

b. Production scheduling

In the production scheduling process, the producers allocate orders into the production plan, which they plan about the quantity and quality of the products that should be decided based on the orders, The main purpose of this stage is to determine how to maximize orders and profits while maintaining the minimum cost.

c. Manufacturing and Shipping

in this phase of manufacturing and shipping, the manufacturer produces the product according to the schedule of the production and in the phase of shipment, the product is shipped to its promised customers according to the promised due date with keeping the quality high and low cost. The customer in this phase could be the retailer or the producer etc..

d. Receiving

The products are received by its customers in this phase of the cycle, the inventories are recorded, updated, and the other process is updated.

e. Procurement Cycle

The interface of manufacturer/supplier is necessary for the stage to occur. It included all processes in which it is being insured the mobilization of materials from the availability of manufacturing until the scheduling perspective**.**

The order is placed by the manufacturer to the suppliers for the replenishment of inventories. The above-mentioned entire profitable relationship is effective to the distributor along with the manufacturer with the only difference. Orders are initiated through uncertain customer's demands by the retailers- distributors while the orders of the component can be best with material scheduling without any issue in supply those products that show how it goes with the production. However, the orders of the component decide mainly through schedules of the productions and it is important that the supplier should integrate with the manufacturing perspective by the manufacturer.

f. Push and Pull view of the supplier (Appendix)

It has been discussed earlier that all the process of the supply chain falls into two processes. The first one was the cycle view for modern supply chain process. Now, this one is the push and pulls view of supply chain process highly productive against many perspectives of tactful supply chain process. These supply chain processes are actually believed to give the best as supply chain struggles. In the pull process of supply chain processes, the order is implemented according to the demand of the customers. While in the push process, the order is executed according to the anticipation of the orders of the customers. In other words in the pull process execution, the demand of the customer is known but in the implementation of the push process demand of the customers.

It is actually not known and is forecasted in any perspective immediately in supply things from one chain to another. Pull process is also known as the hasty process

because a response is made according to the customer demand while the push process uses the proactive strategy as they respond to the forecasted demand and not to the actual demand. In addition, this push/pull strategy separates push process from the pull process in a supply chain. It is useful in making a strategic decision that may affect the decision of supply chain in no time. Moreover, the view forces actual perspectives that are globalized paradigm with perfect combination in no time bounded way. These functions are related to the customer order. (Basodan, 2016, p. 4)

IV. Supply Chain Differentiation

Here we consider how firms may proactively differentiate their supply chains based on market needs. The differentiation of supply chains becomes necessary for businesses when they realize that "one-size-fits-all" no longer works, which was highlighted by Fisher (1997) who argued that there were at least two fundamentally different supply chain types: a market-responsive type for innovative products and a cost efficient type for functional products.

There may be multiple reasons necessitating supply chain differentiation: introducing new products (e.g. with new technologies), having a mix of products, and having supply chains at different maturity stages. A strategy for supply chain differentiation is needed in facing such challenges.

The first step in such a strategy is to segment the market and the second step is to establish appropriate supply chains for each segment, i.e. supply chain differentiation follows market segmentation. The more homogeneous the market segment, the higher the possibility to identify the true nature of order winners, qualifiers, preferences, and trends. When a previously homogeneous market segment becomes heterogeneous, the need for supply chain differentiation arises. (MacCarthy, Blome, Olhager, Srai, & Zhao, 2016, p. 15)

Two early examples of companies differentiating their supply chains were Dell and Zara. In 2008, when Dell entered the retail channel, it tried to use the same supply chain as its earlier responsive online configure-to-order business. However, Dell realized that it needed a low cost strategy to better serve the retail channel. They identified four different segments and created supply chains that fitted each customer segment: online/low volume configurations, online/popular configurations, retail, and corporate clients. Zara utilizes two very different approaches for simple conventional products versus time-sensitive complicated products. They outsource the simple and predictable products with a focus on reducing production and transportation costs and keep the problematic ones in-house to support quick-response replenishment.

Customer segment and product type are two of many possible segmentation logics that may be used. The different types of logic can be broadly classified as: product-related, customer-related, supply-related, and geography-related. Product-related logics include product life cycle stage, physical, demand uncertainty and forecast accuracy, and value versus premium products, as well as integral versus modular

product architectures. Customer-related logics include customer segment customer collaboration capabilities and customer buying behavior and buyer personality types. The supply side can also exhibit a variety of uncertainties, which warrant a differentiated view on supply networks. The geographical logic implies a regionalization of the market into specific market segments that have clear geographical boundaries. It is possible to combine logics to create a multi-factor segmentation. The introduction of Omni-channel distribution of consumer goods adds new supply chain challenges to companies that offer web-based sales as a complement to sales through traditional and physical distribution systems. These companies need to design new supply chains with direct distribution capable of managing (large) return flows of goods. Similarly, companies that utilize new product technologies such as additive manufacturing or that move from conventionally powered automotive engines to batteries, may find they require a fundamentally different supply chain design. Such new technologies may even lead to new business models. (MacCarthy, Blome, Olhager, Srai, & Zhao, 2016, p. 16)

Different supply chains should be designed to fit each respective segment, but what are the potential dimensions that can affect supply chain differentiation decisions? Below we identify some of the dimensions that can be used to tailor supply chains to each respective segment identified in a segmentation analysis. However, we acknowledge that there may be other dimensions in particular cases. Also, decisions on these dimensions are interrelated and cannot be made in isolation. Firms that seek to proactively differentiate their supply chains to supply different segments need to consider their options under each dimension as options have different implications on time and cost.

- Supply network configuration: Should production be centralized to one location with global distribution or dispersed to local markets with local distribution? Should sourcing be local and/or global?
- Product delivery strategy: How does the product reach the customer: direct delivery from plant, from a stock-point in the distribution network, from a retailer, or from some other location?
- Customer-order decoupling point positioning: whether the producer uses engineer-to-order, make-to-order, assemble-to-order, or make-to-stock, or some combination of these approaches.
- Strategic inventory positioning: the customer-order decoupling point is by definition the last stock-point along the material flow to the customer, but strategic inventory positions can be added upstream from the decoupling point.
- Strategic capacity positioning: The stages after the customer-order decoupling point may require some excess capacity to maintain stable delivery lead times when demand rate fluctuates.

- Transportation mode (at each stage in the supply chain): With respect to geography, customer lead-time requirements, costs, and environmental concerns need to be considered.
- Process choice: Internal production technologies and lot sizes typically depend on the level of product customization and standardization.
- Supply chain relationships: Aspects concerning information sharing, supply contracts, governance modes, etc., with suppliers and customers, affect supply chain design decisions. (MacCarthy, Blome, Olhager, Srai, & Zhao, 2016, p. 17)

Topic 03: The impact of Internet of Things on supply chains

I. Adoption of Internet of Things in Supply Chain

Hidalgo et al. (2020) said that Internet of Things has been the fundamental pillar for digitalization in various fields of industry and in society for data storage, availability, transmission, and analytics of information. Internet of Things along with Wireless Sensor Networks is being used in consumer as well as industrial applications, including transportation, healthcare, energy, and so on. With the use of Internet of Things, asset tracking and logistics have gained importance as the deployment costs have reduced for connected devices and improved performance for decision making in real-time. For an Internet of Things ecosystem, connectivity is a major challenge with increase in communication standards. Some of the communication standards are: Wireless Fidelity (Wi-Fi), Long Term Evolution (LTE), Bluetooth Low Energy, Radio Frequency Identification, and Low Power Wide Area Network, which enable long-range communication. These communication standards are being developed to reduce energy consumption for achieving efficient transmission as per application requirements.

The rise of innovation and transformation in organizations has resulted in the adoption of Internet of Things in various industries. After careful cost-benefit analysis, the adoption of Internet of Things can result in the smooth and effortless working of the supply chain. (Kamat & Dalpati, Use of Internet of Things (IOT) in Supply Chain, 2021, p. 2)

Talib et al. (2020) highlight that a supply chain network always needs to be connected and continuously monitored, which can be easily achieved by using Internet of Things, as the devices capture data that can be analyzed and monitored remotely at any time. It helps to increase visibility of supply chain network, thus increasing confidence of the personnel. This helps a supply chain to face sudden disruptions and increase its working capabilities. It can be used to restructure traditional supply chain models to eliminate various error-generating or bottleneck operations.

Ku (2018) mentions that wide acceptance of Internet of Things in supply chain has resulted in a huge requirement of storage devices, as the large amount of collected information is required to be saved before further analysis. This increasing demand for storage devices will affect various supply chains linked to them. According to Ali

et al. (2020), use of Internet of Things in construction supply chain can be beneficial for its proper management.

Tu (2018) mentions that Internet of Things -enabled supply chains provide a virtual connection among various organizations, and independent or common interface for information access, which can be processed for further decision making.

Lin et al. (2016) conducted a survey-based research to identify acceptance of Internet of Things for supply chain by creating a survey of technical factors in different variables. The study suggests that Internet of Things can be adopted for a supply chain but requires efficient planning before implementation.

Birkel and Hartmann (2016) proposed a conceptual model based on literature review by combining various intra-organizational factors in 2 major categories of perceived usefulness and perceived ease of use, cross-referenced to external environmental factors.

Gill et al. (2016) highlighted the connectivity modes like Wi-Fi, Bluetooth, mobile network, and any other app (Resalert suggested by author) between the originator and the end user.

Daya et al. (2019) highlighted the role and impact of Internet of Things on various supply chain processes through their literature review. The supply chain processes mentioned by the authors are sourcing, making, delivering, and returning. According to the author, use of Internet of Things in a supply chain leads to: an improvement in visibility implementation.

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Omitolaa and Willsb (2018) highlighted the security features required for Internet of Things ecosystem in a supply chain. The authors examined direct and indirect

relationships across IPhone supply chain. The endpoints are required to be secure for smooth and safe functioning of supply chain. (Kamat & Dalpati, Use of Internet of Things (IOT) in Supply Chain, 2021, p. 6)

II. The Challenges of using Internet of Things on Supply Chains

Thanks to the widely interconnected Internet of Things, Vast amounts of information and more advanced, smarter services are readily available. Significant corporate, political, and technological issues have arisen in the Internet of Things infrastructure, which must be replicated before these systems can be widely used.

Determining how knowledge is accessed is one of the issues facing the Internet of Things in supply chains.

To improve the efficacy and efficiency of the supply chains, Internet of Things applications must be assessed in terms of the value created across the supply chain. In contrast, the Internet is currently a vast and untapped resource for unstructured data. Collecting and analyzing valuable data for reuse and improvement is critical to fully leveraging Internet of Things in supply chains.

Another set of difficulties and challenges of Internet of Things in supply chains identified by numerous professors is the security and privacy concerns raised by Bi et al. The challenge of data dependency has been raised due to the massive rise of data in the supply chain. Congestion has been identified as a stumbling block for scaling, extending, planning, research, and storing. These facts, such as noise buildup, misleading information, measurement inaccuracy, and other flaws, may have a gradual impact on the users and these facts may even compromise information and manufacturing security during the supply chain process. Furthermore, as information technology advances, the amount of cybercrime increases, potentially increasing the possibility of information leaks and jeopardizing the privacy of businesses and individuals.

All of the above issues and challenges are related to information. Aside from this, some organizational issues and challenges are considered. Because of the high labor costs and severe working circumstances in these sectors, the Internet of Things may readily be utilized to optimize production and distribution in mechanical engineering, automotive and discrete manufacturing, power generation, oil and gas, and mining. To maintain production safety, stability, and efficiency, these manufacturing and heavy industries require the use of Internet of Things in their supply chain. However, the use of Internet of Things in the supply chain of light industry and service industries such as taxis and hairdressers has encountered obstacles. This is due to the high demand for personalization and humanistic care in these industries, which makes the replacement of machines and sensors difficult. Furthermore, technical advancements in Internet of Things and artificial intelligence are still insufficient to entirely replace people in these light industry and service industries. (Du, 2022, p. 4)

Another reason is that national regulatory restrictions and traditional perceptions of people are also key barriers to the implementation of Internet of Things in light industry and service supply chains.

Another organizational difficulty is that various organizations store different types of data and utilize different operating systems, making the exchange of information across industries problematic.. Meanwhile, to maintain security, some companies maintain tight information loops within their industries. Once an information exchange platform is in place, it can easily create uncertainty and risk throughout their industry. On the other hand, restrictions on data access stifle the development of Internet of Things in the supply chain. (Du, 2022, p. 5)

1. Challenges for Internet of Things Adoption in Supply Chain

The principal obstacle to Internet of Things adoption cited by 11 retailers was investment cost: "The cost is obviously the real big obstacle" [Retailer]. Three participants highlighted the lack of long-term investments: "Any such investment is seen as a liability, rather than seeing it to improve the business in the long term" [Retailer A]. However, eight retailers explicitly asserted that Internet of Things implementation is a sound investment, while nobody spoke pessimistically: "The cost is always an issue, but it will pretty much offset in about three years into operations" [Retailer E]; "Obviously the Internet of Things technology is not a loss-making. It is profitable if you use it correctly" [Retailer J]. Retailers B and I argued that it was not fair that upstream suppliers and manufacturers bear the cost of technology, such as Radio Frequency Identification, yet downstream partners benefit more. Retailer I called for collective investment: "It is a space where retailers and brand owners need to invest together to impart improvements".

The next recurrent obstacles reported were internal leadership issues. One (cited by 7 participants) was that the technology was not well understood within organizations: "If you don't see the benefit, you only see the cost. It is not the cost that is the biggest issue; it is the knowledge", [Retailer F]. Six managers also discussed a perceived lack of management vision in Internet of Things adoption: "I think there seems to be a certain level of the reluctance of investing in this (Internet of Things) space. Decision-makers find the cost to service and operations a little bit too abstract" [Retailer A]. Also, 4 participants felt that senior managers lacked a clear understanding of the demands of Supply chain. Retailer I went so far as asserting that "managers don't want to know up the value chain, it is easy to disguise what is happening upstream". The issues above were exacerbated by not having good examples cited by three retailers: "When we made the transition, we didn't have a proper example to look at, saying these guys were here, this is what they did, and this is where they are now. We were a bit cynical about moving forward with Internet of Things investments" (Vass, Shee, & Miah, 2021, p. 8)

2. Challenges in Implementing Internet of Things in Supply Chains

In this section, we turn our attention to the formidable challenges that organizations en-counter when seeking to integrate Internet of Things technologies into their supply chains. By identifying and dissecting these obstacles, we aim to provide a comprehensive understanding of the practical roadblocks and issues that must be navigated in order to harness the full potential of Internet of Things within the supply chain landscape.

a. Data Security and Privacy Challenges

The integration of Internet of Things devices into Supply chain has introduced a host of data security and privacy challenges that organizations must navigate carefully. As Internet of Things devices continuously collect and transmit sensitive data, ranging from inventory levels and shipment details to equipment status and environmental conditions, they become attractive targets for cyber attacks. Data breaches in supply chain Internet of Things systems can lead to severe consequences, including compromised intellectual property, financial losses, and damage to a company's reputation.

One of the primary challenges lies in securing the data generated by Internet of Things devices at each stage of its journey. This encompasses data encryption, secure transmission, and secure storage. Encryption ensures that data is protected from unauthorized access during transmission and storage, reducing the risk of interception or tampering. However, encryption alone is not sufficient; organizations must also implement strong authentication mechanisms to control access to Internet of Things devices and data. Additionally, data security measures should extend to the Internet of Things platform or cloud service where data is processed and stored. Adequate access controls, regular security audits, and vulnerability assessments are crucial to maintaining the integrity and confidentiality of Internet of Things -generated data. Furthermore, organizations need to stay vigilant against emerging threats and continually update their security protocols to adapt to evolving attack vectors. Balancing the imperative of data security with the need for data availability and real-time insights is a delicate but essential aspect of Internet of Things implementation in supply chains. (Sallam, Mohamed, & Mohamed, 2023, p. 11)

b. Interoperability Issues

Interoperability, or the seamless integration and communication of diverse Internet of Things devices and systems, stands as a formidable challenge in the landscape of Supply chain. This challenge stems from the proliferation of Internet of Things solutions from various manufacturers, each with its own proprietary protocols, data formats, and communication standards. The consequence is often a fragmented Internet of Things ecosystem where devices and systems struggle to exchange data and collaborate effectively. This lack of interoperability can lead to data silos,

increased complexity, reduced efficiency, and higher operational costs for organizations seeking to leverage Internet of Things transformative potential.

c. Scalability Concerns

The successful integration of Internet of Things technology into supply chain operations necessitates not only technological readiness but also a thoughtful approach to change management and work- force development. Implementing Internet of Things solutions often involves a significant shift in how work is done, how data is collected and analyzed, and how decisions are made within an organization. Resistance to change, coupled with a lack of necessary skills and understanding among employees, can pose substantial challenges to the adoption and effective utilization of Internet of Things in supply chains. (Sallam, Mohamed, & Mohamed, 2023, p. 12)

Change management plays a pivotal role in easing the transition to an Internet of Things -enabled supply chain. It involves clear communication of the reasons for change, its benefits, and the roadmap for implementation. Employees need to understand the advantages of Internet of Things, including improved efficiency, reduced operational costs, and enhanced data-driven decision-making. Moreover, a culture of innovation and adaptability should be fostered, where employees are encouraged to embrace new technologies and processes. Leadership buy-in is critical, as it sets the tone for the entire organization. Additionally, change management should incorporate training and development programs to equip employees with the necessary skills to work with Internet of Things systems. This includes not only technical skills for device management and data analysis but also the ability to interpret Internet of Things -driven insights and apply them to daily operations.

d. Costs and Return on investment Considerations

The adoption of Internet of Things technology in supply chains represents a significant investment, and organizations must carefully consider the costs and return on investment associated with these initiatives. While Internet of Things offers the potential for substantial benefits, such as improved efficiency, enhanced visibility, and cost savings, it is essential to evaluate the financial aspects comprehensively. The costs of implementing Internet of Things in supply chains encompass various elements, including the purchase of Internet of Things devices and sensors, network infrastructure upgrades, software development, data storage, and ongoing maintenance and support. Additionally, organizations need to factor in the costs associated with workforce training and change management efforts to ensure that employees can effectively operate and utilize Internet of Things systems. (Sallam, Mohamed, & Mohamed, 2023, p. 13)

e. Data Management and Analytics Complexity

The influx of data generated by Internet of Things devices in supply chains presents a double-edged sword: the potential for actionable insights and improved decision-making, but also the challenge of managing and deriving value from massive and diverse data sets. Internet of Things deployments lead to a proliferation of data points, including real-time sensor data, location information, environmental conditions, and equipment status, among others. As a result, organizations must grapple with the complexities of data collection, storage, integration, and analysis. Effective data management is pivotal to extracting meaningful insights and making informed decisions that drive supply chain efficiency and competitiveness.

One of the foremost challenges in data management within Internet of Things -enabled supply chains is the sheer volume and velocity of data. Internet of Things sensors continuously stream data points, generating terabytes or even petabytes of information daily. Managing this high-speed data influx requires scalable and robust data infrastructure capable of handling the data deluge. Additionally, organizations must devise efficient data collection strategies to filter out noise and focus on relevant information. Data integration becomes paramount, as Internet of Things data often originates from diverse sources and systems. Ensuring data consistency and quality across the supply chain is a complex endeavor, as data may flow through multiple touch points, including manufacturing, transportation, and warehousing. Data governance practices, data cleansing, and data lineage tracking are crucial components of managing data complexity in Internet of Things -driven supply chains. (Sallam, Mohamed, & Mohamed, 2023, p. 14)

f. Change Management and Workforce Skills

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g. Regulatory and Compliance Hurdles

The integration of Internet of Things technology into supply chains brings with it a complex web of regulatory and compliance challenges. These challenges arise from the need to adhere to a myriad of local, national, and international regulations governing data privacy, security, and product tracking. In many industries, such as pharmaceuticals, food, and healthcare, stringent regulations dictate how data is handled, how products are transported and stored, and how customer privacy is maintained. The multifaceted nature of Internet of Things deployments in supply chains requires organizations to navigate these regulatory landscapes diligently.

One of the primary regulatory concerns is data privacy and protection. Internet of Things systems collect and transmit vast amounts of data, including sensitive information related to products, customers, and partners. Compliance with data protection regulations, such as the General Data Protection Regulation in Europe or the Health Insurance Portability and Accountability Act in healthcare, is essential. Organizations must establish robust data governance frame- works, implement encryption and access controls, and ensures data is collected and used in accordance with regulatory requirements. Additionally, data residency and cross-border data transfer issues can complicate Internet of Things implementations, as data may traverse international boundaries. Organizations need to be cognizant of these challenges and establish protocols for data sovereignty compliance. (Sallam, Mohamed, & Mohamed, 2023, p. 15)

h. Sustainability and Environmental Considerations

The integration of Internet of Things technology into Supply chain not only offers opportunities for efficiency and cost savings but also presents an avenue for organizations to address sustainability and environmental concerns. As global awareness of climate change and resource scarcity grows, supply chain sustainability has become a crucial focus area. Internet of Things plays a pivotal role in this pursuit by enabling organizations to monitor and optimize their operations in ways that reduce their environmental footprint.

One of the fundamental ways Internet of Things contributes to sustainability is through resource efficiency. By continuously monitoring energy consumption, water usage, and other resources at various stages of the supply chain, organizations can identify inefficiencies and implement measures to reduce waste. For example, Internet of Things sensors can help optimize transportation routes reducing fuel consumption and greenhouse gas emissions. Additionally, smart facilities equipped with Internet of

Things technology can adjust lighting, heating, and cooling systems based on occupancy and environmental conditions, minimizing energy consumption. These resource-saving initiatives not only contribute to cost reduction but also align with environmental sustainability goals, demonstrating a commitment to responsible resource management**.** (Sallam, Mohamed, & Mohamed, 2023, p. 16)

III. Internet of Things enhanced supply chains

1. Internet of Things enhanced supply chain capabilities

After looking into the challenges of Supply Chain and Internet of Things technology's enablements, this part introduces the capabilities of Supply Chain that can be affected by deploying Internet of Things in Supply Chain. Deploying Internet of Things in Supply chain improves capabilities for the chain that can genuinely bring advantage for the firm (Ben-Daya, 2022).

Li et al. (2006) claims that price/cost, quality, delivery dependability, product innovation, and time to market are the dimensions of advantages that an optimized and efficient Supply chain can offer. However, Ben-Daya et al (2022) proposed a new list of possible advantages in a modern supply chain management and considering the new advancements of technology and new challenges that supply chain faces. The list is based on reviewing that each proposed a single new capability. The mentioned capabilities are resilience, velocity, traceability, and reliability. Fredrico (2021) views the matter in a different way. He argues Internet of Things generates improvements on performance attributes such as efficiency, responsiveness, flexibility, reliability, transparency, visibility, resilience and traceability that can potentially offer competitive advantage for a firm. By merging the input from different authors, the following attributes are presented as competitive advantages that are enhanced by Internet of Things. (Zand, 2023, p. 24)

a. Cost effectiveness

Cost reduction is one of the most cited objectives when it comes to supply chain management. Cost reduction is an inevitable factor that companies need to consider in today's global supply chain competitive market. With rising supply chain costs, savings in transportation, inventory carrying costs and overall management of the supply chain are vital to achieve chain efficiency. Cost of a supply chain is a double sided factor; having a low cost in logistics, transportation and maintenance of the chain can lead to competitive advantage, where on the other hand not having cost cutting solutions results in more expensive products which is the opposite of what satisfies the consumers. Internet of Things plays a major role in transportation optimization. Smart Internet of Things sensors from different sections of the chain enable the firms to run simulations to find out the most efficient alternative in terms of time, cost and resources introduce a simple linear cost model to analyze the impact of the cost of sensors and alerts on the unit purchase cost. Mentions cost of implementing Internet of Things as a factor that needs to be considered, however the potential of Internet of Things systems with correct integration can provide a firm

huge competitive advantage as it creates a lower cost supply chain that enables it to provide cheaper products maintaining its profit margin. (Zand, 2023, p. 24.25)

b. Velocity

Like physics, velocity in Supply chain refers to the speed of motion, action and operation. The entire supply chain performance would be boosted by Internet of Things applications and monitoring systems. Faster decision making process, minimizing the incidents and dangers and increase of overall productivity is easily achievable via the internet of things. In general, supply chain velocity measures the speed of completing tasks and activities within the supply chain as well as the order in which tasks are done through the supply chain, from the very first step to the delivery of the final product or service. Torng (2004) defines supply chain velocity as the ability to complete an activity as quickly as possible. Juan et al., (2021) found that response speed of a firm is a key to measure the performance of supply chain and it leads to gaining lead advantages in production, gains advantages in marketing and improves customer service. other than the speed of completing a task or activity, introduced velocity as the recovery speed of Supply chain disruptions in a resilience point of view. Ben-Daya et al., (2022) recognized decreasing time in Supply chain equals higher velocity and it can be identified in four different dimensions: supply chain empowerment, supply chain adaptability, supply chain speed, and supply chain innovations. Internet of Things enables the smart route planning tools to increase the speed of Supply chain and ensure faster decision making and faster movement of goods within the chain.

In addition by minimizing human interaction, the human errors are reduced which results in avoiding delays caused by the errors. For instance in the traditional ways, managers needed to be dependent on human data entry to keep track of all the assets; but with Internet of Things a software can do it all automatically. This can provide managers a very quick access to important information about each delivery such as contents of each package or storage instructions. (Zand, 2023, p. 25)

c. Transparency

Transparency of supply chain refers to being able to locate entities of the chain and to communicate the information with the stakeholders. Achieving transparency requires two interconnected attributes of traceability and visibility. Traceability of shipments in the supply chain is often introduced in the downstream manner where the shipment gets tracked by the customer. However it is also concerned with upstream events to figure out the source and properties of a product. Traceability of supply chain as a factor that benefits the managers to gain visibility of the chain in order to make deliberate decisions. (Zand, 2023, p. 26)

d. Resilience

Resilience in general refers to the ability of a supply chain to keep operating regardless of disruptions. In the literature, resilience is defined from different

perspectives. Hollnagel et al. (2009) defines resilience as the ability of steady reconstruction to achieve a better state. In supply chain perspective, Christopher and Peck (2004) defines it as “the ability of a system to return to its original state or move to a new, more desirable state after being disturbed”; Ponomarov and Holcomb (2009) mentions “Supply chain resilience is the adaptive capability of the supply chain to prepare for unexpected events, respond to disruptions, and recover from them by maintaining continuity of operations at the desired level of connectedness and control over structure and function”.

Flexibility and resilience of a supply chain are interlaced and it takes into account the ability of the chain to reconfigure as required by customers or by unforeseen disruption. The Internet of things can provide environmental sensors to allow managers to monitor and react to any unusual changes in each part of the chain. For example in transportation, an Internet of Things supply chain system can gather data on temperature, pressure, humidity, and other conditions of the vehicle that might affect the products and immediately apply automated condition modification. Deploying Internet of Things enables the chain with increased and simplified connectivity of entities of the chain -objects (things) and decision makers- to take steps towards resilience. (Zand, 2023, p. 27.28)

2. Enhancing the visualization of supply chain

One of the main goals of Internet of things is to improve human perception ability and intelligent processing ability. Internet of things is able to provide the connection of various objects at any time and any place, and also the status and related information of any object at any time and any location. The perception layer, as the foundation of Inter of Things, is also the basis of Internet of things -based Supply chain system in Internet of things context. For the agricultural supply chain, the introduction of Internet of things technology intellectual brings new opportunities and changes to intelligent agriculture.

The adoption of Radio Frequency Identification tags, wireless sensors, and transmission equipment enables the tracing and visual digital management of single or packaged agricultural products and food. Throughout the entire process, from the production of agricultural products and food to sales, in detail, from the production site to warehouses, from warehouses to tables, intelligent management is able to monitor and realize the digitized and visualized logistics and management of agricultural products and food, improving their quality. In terms of retail supply chain, the application of Radio Frequency Identification technology and wireless sensors can provide accurate information regarding the variety, quantity, customer, location, and other related details of products to decision makers in supply chain, enhancing the level of transparency, and visualization throughout the entire process, and more importantly, the whole supply chain (see Figure 2). Decision-making entities are able to be aware of the real-time operation progress and make better

coordination; accordingly, the efficiency of supply chain is raised to a great extent. (Cui, Supply Chain Innovation with IoT Chapter 8, 2018, p. 5)

Application Layer	Real -time visible monitor	Production whole-process tracking	Information centralized management	Design materials on spot	Electronic Commerce Platform	Spatial Mapping
Interconnected layer	Data Center		Information Center		Internal Network	
	Cloud computing platform					
Sensing Layer	RFID Tags		Access Gateway		Intelligent Terminal	
	RFID Sensor		Intelligent Device		Motion Sensing Device	

Table 01: Layer architecture of supply chain system in Internet of Things context.

3. Enhancing the robustness of supply chains

Enhancing the robustness of supply chains and lessening the uncertainty of supply chain is one of the important factors to be considered in the establishment of supply chain system. The advent and the development of Internet of things technology assist in enhancing the robustness of supply chain and lessening its uncertainty. Based on Internet of things technology, decision-making entities in supply chain can dig and gather data with more accuracy and obtain more precise information, shortening the lead time of expected demand for products or inventory.

At the same time, the application of Internet of things technology also provides information sharing mechanism to decision-making entities in supply chain, thereby minimizing the bullwhip effect and uncertainty of supply chain, enhancing the robustness of supply chains. In the Internet of things context, applying Internet of things technology can make real-time monitoring and decision-making of the whole supply chain throughout the process of supply chains, meanwhile, precise management of the quantity, variety, quality, and batch information of raw materials can be also realized, with accurate information regarding the storage location of raw materials or spare parts being provided. Accordingly, timely replenishment of inventory is performed; hence, shortening of production cycle, decrease of cost, inventory, capital occupation, and eventually supply chain uncertainty can be realized.

Warehouse management plays an important role in supply chains. With the application of Internet of Things technology, the management process of warehouse is simplified. The collection process of information including warehousing, storage location, and quantity is prompt, accurate, and complete, reflecting the real-time inventory status. Furthermore, with the correspondent improvement of space utilization and decrease of cost, management efficiency is raised; thereby the robustness of supply chains is enhanced. (Cui, Supply Chain Innovation with IoT Chapter 8, 2018, p. 6)

4. Realizing supply chain intelligent management

The realization of supply chain intelligent management is an important subject of the supply chain system based on Internet of Things and one of the major changes in supply chain function. To realize the intelligent management of Internet of Things, intelligent platform, which is based on Internet of Things, is significant. The development of Internet of Things technology provides technical support for intelligent management of supply chain. Perception layer is the foundation of Internet of Things. Through the sensor devices of perception layer, the Internet of Things - based supply chain system can continuously obtain information of nodes in supply chain, and dig, classify, integrate, and store relevant data with Internet of Things data processing technology. Eventually, extract useful knowledge and provide timely information regarding supply chain operation status and tendency, and hence realize intelligent decision-making.

First of all, through the installation and application of a variety of sensing devices (such as Radio Frequency Identification, sensors, etc.), real-time supply chain operation status can be sensed; when the environment changes, sensed information can be provided to supply chain system timely. Second, the development of wired and wireless network technologies and their integration with internet technologies link the various modules in supply chain system, laying the foundation for prompt and secure transmission of information. Third, the further development of mass data storage technology, data fusion technology, and data mining technology of Internet of Things creates favor-able conditions for the development of intelligent decision-making and intelligent control technology, and has turned into an effective guarantee for intelligent management of supply chain. Enhancing the visualization and robustness of supply chain and realizing the intelligent management of supply chain are significant improvements that differentiate supply chain system based on the Internet of Things from traditional supply chain system. (Cui, Supply Chain Innovation with IoT Chapter 8, 2018, p. 7)

IV. Internet of Things Applications in supply chains

1. Internet of Things-Based Supply Chain System

The journey of a smart supply chain system ranges from the provisioning of raw materials from suppliers, intelligent production of products at the manufacturing site, and secure and intelligent carriage of products under a strict monitory system. These products are transported to a retail store to provide to end-users, as demonstrated in Figure 4. Customers are further tracked down through a fully connected Internet of Things system to monitor their behavior.

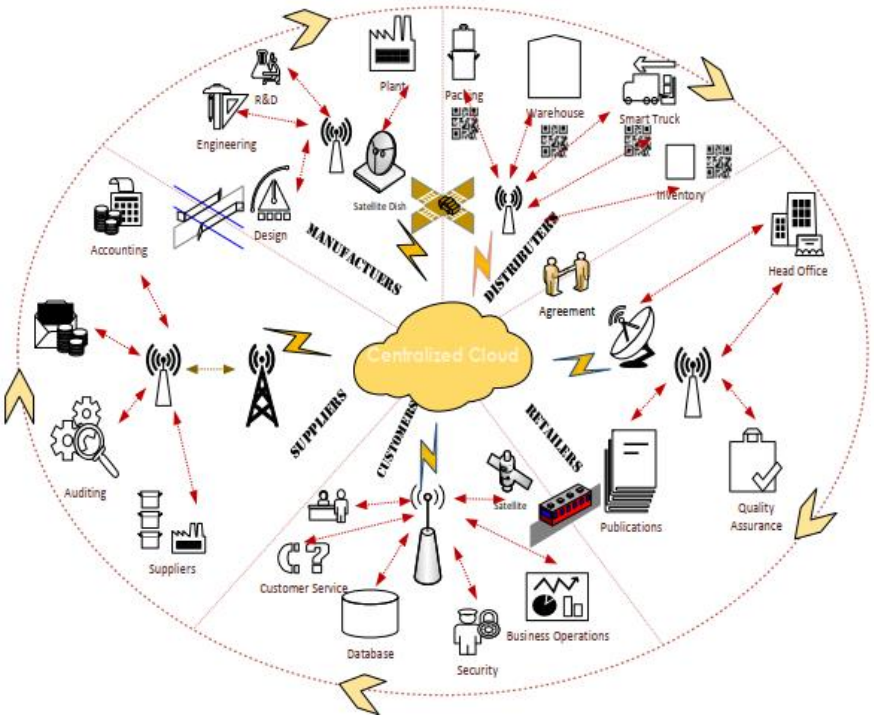


Fig (4): Smart Internet of Things application in supply chain.

1.1. Internet of Things-Enabled Manufacturers

The modern world economy has been revolutionized by the occurrence of two important phenomena, regionalization and globalization. In this connection, major changes have been observed, not only on the economic side but also on the cultural, social, and political spectrum of society. Additionally, complexity, unpredictability, and competition also appeared to increase. The market is strongly involved in reshaping traditional products and services. It must produce high-quality products in the shortest period with low costs and environmental protection. This is not possible without bringing about changes in the production process to make it efficient, flexible, and transparent, shortening the process cycle, and increasing innovation. In this context, industries have to be updated on Internet of Things, artificial intelligence, distributed databases, 3D printing, cloud computing, advanced robots, augmented reality, and autonomous vehicles. The Internet of Things virtual network is created with the help of integrating products, processes, objects, workers, and systems that ensure communication in real-time. The industrial environment is properly maintained based on the collection, processing, and dissemination of information and achieves the benefits shown in Figure 4. (Khan, Su'ud, Alam, Ahmad, Ahmad, & Khan, 2023, p. 5.6)

In addition, other benefits are planning and monitoring of the production process, saving of raw material and human labor, a decline in downtime, manufacturing process efficiency, availability of real-time system information, improvement of transportation and logistics, the introduction of quasi closed loop production, production of refined products, implementation of an innovative ecosystem, and enhancement of attractiveness of jobs and activities. RFID and sensors are mandatory

components of modern technologies in the implementation of smart factories. Several automation processes related to factories ranging from inbound and outbound management to identification of tools and parts are critical activities performed on the mentioned technology. Primarily, the application of the technology was to identify and track the items in the logistics and retail sector of the supply chain; however, maximum benefits can be obtained in the manufacturing sector as well. Similarly, cloud computing is providing on-demand service to furnish flexibility, reduce costs, and increase efficiency and revenue to smart factories. Cloud platforms extend computational and storage capabilities that can be enhanced on demand. In this context, a huge amount of data generated during the operation of sensing devices of Internet of Things is transported to cyberspace for conversion into useful information. (Khan, Su'ud, Alam, Ahmad, Ahmad, & Khan, 2023, p. 6.7)

a. Internet of Things-Enabled Distributors and Retailing

- **Smart Transportation**

The efficiency of transportation can be improved by the strict monitoring of vehicles, cargo, and safe driving. Further added advantages are reduction of costs and cargo loss. In the context of vehicle monitoring, it is necessary on the part of the company to trace its location in a real-time scenario. Additionally, the speed of a vehicle, fuel consumption, and tire pressure are remotely observed. A full-fledge vehicle-tracking system was used to monitor the location (global positioning system) based on geographical coordinates, and the status of the vehicle has been updated in the database system. By implementing a data analysis system, tracking the density of the vehicles and traffic congestion with the help of Bluetooth technology have been proposed. Another attempt was made to develop intelligent logistics systems through the integration of AI, Internet of Things, and 5G technology. The status and location of cargo can be monitored in real-time with the incorporation of 3G, Geographic Information Systems, Radio-frequency identification, AI, and middleware for data communication, signal acquisition, and processing of information. Furthermore, data about the cargo rerouting, localization, and monitoring of its conditions are automated without the intervention of human beings. In addition, the systems are capable of communicating with each other and the centralized location. Another application of Internet of Things in the context of smart transportation is to monitor the driver's health and behaviors. The physiological condition of the driver was remotely tracked through low-power wearable Wireless Sensor Network which has significantly helped to reduce roadside accidents by taking certain preventive parameters.

- **Smart Warehousing**

With the emergence of continuous changes in technology and business operation practices, warehousing is becoming complex and critical, while considering the optimization of space, observing the warehouse environment, and bringing improvements in the process of product management. The logistic control system is optimized based on ZigBee technology that has taken the structure of star control. The warehouse is properly managed by the Internet o Things-based system with the

application of data analytics and computational techniques. Strong management tools of the enterprise resource planning system help in dynamic inventory, quick in and out warehousing, and better management of products. The integration within the smart house is mainly possible with a short-range communication system, and ZigBee is considered the technology of the choice.

- **Smart Loading and Unloading**

For the distribution of items, the loading and unloading process, storage, and stacking are required to be smart for efficiency enhancement, a speedy operation, and lower costs. Automation of forklifts with the smart technology of a RFID reader can greatly help to determine the exact position and further delivery of goods inside the warehouse without human intervention. Similarly, robots are programmed and connected to the Internet to work as a bridge for warehouse keepers. Autonomous robots are supervised by the operator by giving sketch or speed commands from handheld devices.

- **Smart Carriage**

High efficiency and low costs are possible by including Automated Guided Vehicle's in the internal and external transport of packages in the warehouse. Numerous wireless technologies are utilized for communication among Automated Guided Vehicle's in the smart factory. The precision and accuracy of Automated Guided Vehicle's are ensured by implementing key impact factors, such as circular magnetic field and contour in the automatic logistic workshop. (Khan, Su'ud, Alam, Ahmad, Ahmad, & Khan, 2023, p. 8)

- **Smart Packaging**

The traditional approach to packaging has significantly changed to intelligent, interactive, and aware packaging with the emergence of Internet of Things technology. Tracking and tracing of packages have improved incredibly on the introduction of smart packages that make decisions on the fly. This approach has further mitigated the menace of product recalls. Smart labels fixed on packages are machine readable with sensors attached to the system using Bluetooth, RFID, and NFC. To take full advantage of smart packing product design and automate the packaging system, a wireless sensing device of Internet of Things is implanted on it. High flexibility, velocity, and real-time exchange of information are ensured with the help of an advanced robotic system. This is further interlinked with cyber networks and shaped in the form of the automated e-fulfillment system. The same technology and implementation of NFC has been adopted to categorize the products based on temperature sensitivity. Package design is incomplete without utilizing an appropriate application, for example, to determine the condition and effective monitoring of packaged food items. Particularly, storage and transportation is controlled by a customized platform. Like- wise, iMedPack is an intelligent pharmaceutical packaging system fitted with passive Radio-frequency identification suggesting a promising solution for the safe delivery of medicine. The system is installed with a built-in automatic reminder system that gives an alert in case of non-compliance with

pre-set conditions. Short-range wireless technology of Internet of Things systems is the technology of choice to determine its recognition and readability. Presently, NFC and Radio-frequency identification are mainly utilized in Internet of Things; however, with the advent of new techniques and procedures, real-time monitoring will greatly improve packaging quality.

- **Smart Distribution Processing**

This refers to a set of processing performed at a logistics center or warehouse before the shipment of products. To create ease and enhance added value, the products have to pass through sorting (arrangement of products into sets) and labeling (affixing labels). Products are divided based on their types and invoices to improve delivery support. Sorting is accomplished through an autonomous-wheeled robot to perform a roving survey in offices, manufacturing units, and libraries that travel in a close spacing of 6 cm. For efficient management of warehousing logistics and the meticulous process of picking with the assistance of fast localization of storage items, the system utilizes minimum cost of maintenance technology and long-range application. The label is incorporated with the required information about the product to make it more traceable and enhance the value-added service in the logistics sector. In the food industry, for cold chain monitoring and real-time traceability, the smart labeling tags are connected with a microcontroller that can be extended to humidity, light, and temperature sensors and can be used as an antenna assembly for Radio-frequency identification communication to track food items. In the context of the product distribution process, the use of Radio-frequency identification is frequently extended to long-range technology to remotely conduct sorting and labeling.

Internet of Things has a strong involvement in the distribution sector of supply chain management to add value for intelligent management of the center. The distribution of products can be made smart with the inclusion of networking, flexibility, intelligence, digitization, and intelligence. In this context, smart distribution centers are erected with automation and intelligence features for handling and sorting equipment. An Internet of Things -based integrated route planning system is comprised of genetic algorithms and planning techniques to route food distribution at multi-temperature. As far as the intelligent delivery of goods is concerned, the health of goods and time precision approach for delivery cannot be guaranteed without implementing the emerging technology of unmanned aerial vehicles, autonomous vehicles, and intelligent containers. The latter item consists of a wireless sensory and communication network to disseminate information about the autonomous process. Necessary information regarding environmental conditions, type of loaded items, and transaction information, such as costs, order transport, and impact of traffic situation, are provided to the end-user remotely. This results in a more comprehensive, easy-to- use, and up-to-mark supervisory system being developed. (Khan, Su'ud, Alam, Ahmad, Ahmad, & Khan, 2023, p. 9)

b. Internet of Things Technology and Supply Chain Applications

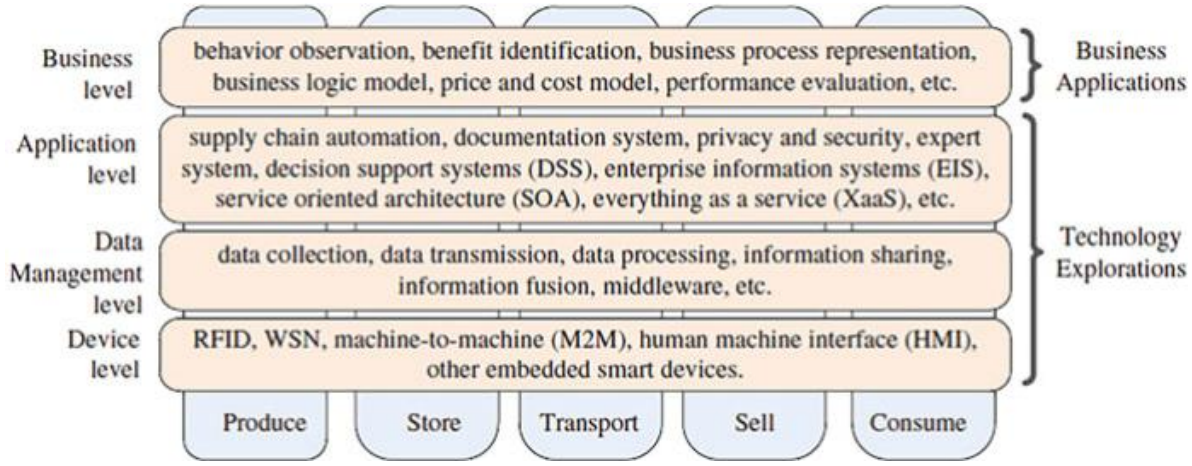
Internet of Things is a global network of many connected devices that rely on sensory, communication, networking, and information processing technologies that use Radio Frequency Identification readers to identify, track, and monitor objects embedded with Radio Frequency Identification tags automatically. It is often termed as **"ambient intelligence," "ubiquitous network," "ubiquitous computing," "pervasive computing,"** and **"cyber physical systems".** With many applications across all sectors of economy, the innovative technology include Radio Frequency Identification tags, wireless sensor networks, machine-to-machine communication, human-to-machine interaction, middleware, web services, and information's.

Table 02: Smart logistics functionalities and related technologies

N	Smart logistics functionalities	Related technologies	Suitable applications
1	Identification	Barcode, Radio-frequency identification, wireless sensors, retina scanner	Ensure a secured identification of objects at all stages of the supply chain
2	Location services	Global positioning systems (GPS)	Satellite navigation used to determine ground location of objects/people in real time
3	Condition monitoring	Internet of Things sensors (cooling unit, missing parts/cargo, tire pressure, vehicle brake)	Allows to view the current state of products/vehicles to ensure good condition, error detection, missing parts and so on
4	Connectivity	4G, 5G network	Communication network supports Internet of Things-enabled objects connected to cloud
5	Visibility	GPS	Real-time tracking and tracing of movement of goods/vehicles
6	Environmental scanning	Internet of Things wireless sensors	Able to interact with environment and communicates data at granular level (temperature, pollutants)
7	Autonomous	Embedded Internet of Things sensors and actuators	Allows human to delegate activities to smart products and machines
8	Compatible	Middleware between warehouse management systems and enterprise resource planning	Integrate existing technologies with new technologies
9	Data analytics	warehouse management and enterprise resource planning systems	Analyze data and generate reports for business intelligence
10	Safety and security	Internet of Things wireless sensors	Real-time data help in safety of objects, reliability and also security (e.g.,food items and dangerous goods)

Internet of Things network has four essential layers:

- A sensing layer that integrates different types of "things" like RFID tags, sensors, actuators to sense/control physical world and capture data
- A networking layer that supports data transfer through wired/wireless network (i.e., WSN)
- A service layer that integrates services and applications through a middleware technology
- An interface layer allows interaction methods to users and other applications. (Himanshu, 2023, p. 5)



Fig(5): IoT taxonomy for technology exploration and business applications. (Source: Pang et al., 2015, p. 292)

Internet of Things presents taxonomy for a food supply chain (Fig. 5) that possibly could be extended to other supply chains as well. In a supply chain –produce to consume – there are four levels including device, data management, application, and business levels. **Radio Frequency Identification** tags are embedded (i.e., device level) to collect, transmit, and share data to all supply chain partners using middleware (i.e., data management level). The application level offers supply chain automation with decision support systems for everything as a service. The business level includes user behavior, benefits of Internet of Things, and overall performance of the technology. Internet of Things applications have been categorized into four major domains.: Industry, Healthcare, Smart environments, and Personal and Social domains. In the industry domain – such as retailers, distribution centers, transporters – accurate and timely information related to products can help organizations to rapidly respond to market changes. **Radio-frequency identification** and near field communication (NFC) technologies can keep track of products from design to distribution and then delivery to the end users. Similarly, sensors fitted into a truck driver cabins can monitor tire pressure, fuel consumption, location, and speed, and then the data can be shared with control room by global positioning systems (GPS). (Himanshu, 2023, p. 6)

V. Industry 4.0 and Supply chain 4.0: The Role of Internet of Things

The emerging Internet of Things is expected to play a leading role in the Industry 4.0 era, where the integration of Internet of Things into logistic digitalization is becoming

more and more relevant. Thus, Internet of Things is perceived to facilitate a technological shift in supply chain management. Supply chain information systems based on Internet of Things are capable to coordinate and integrate internal and external activities of enterprises. Correspondingly, Supply Chain Information system is reported to be greatly enhanced with the proliferation of Internet of Things. (Vass, Shee, & Miah, Internet of Things for improving Supply Chain Performance:A Qualitative Study of Australian Retailers, 2018, p. 3)

Industry 4.0 is the fourth industrial revolution that envisions cyber-physical systems, which allow machines to interface with each other with minimal human interaction. This technology creates a manufacturing environment where smart machines not only communicate with one another but also analyze and understand production issues to fix them as the need arises. This progressive thinking is labelled as a move toward smart factory or advanced manufacturing or Industrial Internet of Things. (Shee, 2023, p. 8)

This factory of the future concept intends to use innovative digital technology like Internet of Things among other technologies such as advanced robotics, artificial intelligence, hi-tech sensors, cloud computing, and 3D printing to manage manufacturing activities in an interoperable global value chain. Cyber-physical systems are composed of broadly four interconnected technologies: automation of knowledge work, Internet of Things, advanced robotics, and autonomous/near-autonomous vehicles. Kamble et al. (2018) propose a framework where Industry 4.0 will likely to facilitate business processes through the cyber-physical interaction of connected elements making the manufacturing system more flexible, economical, and environmentally friendly. (Shee, 2023, p. 8.9)

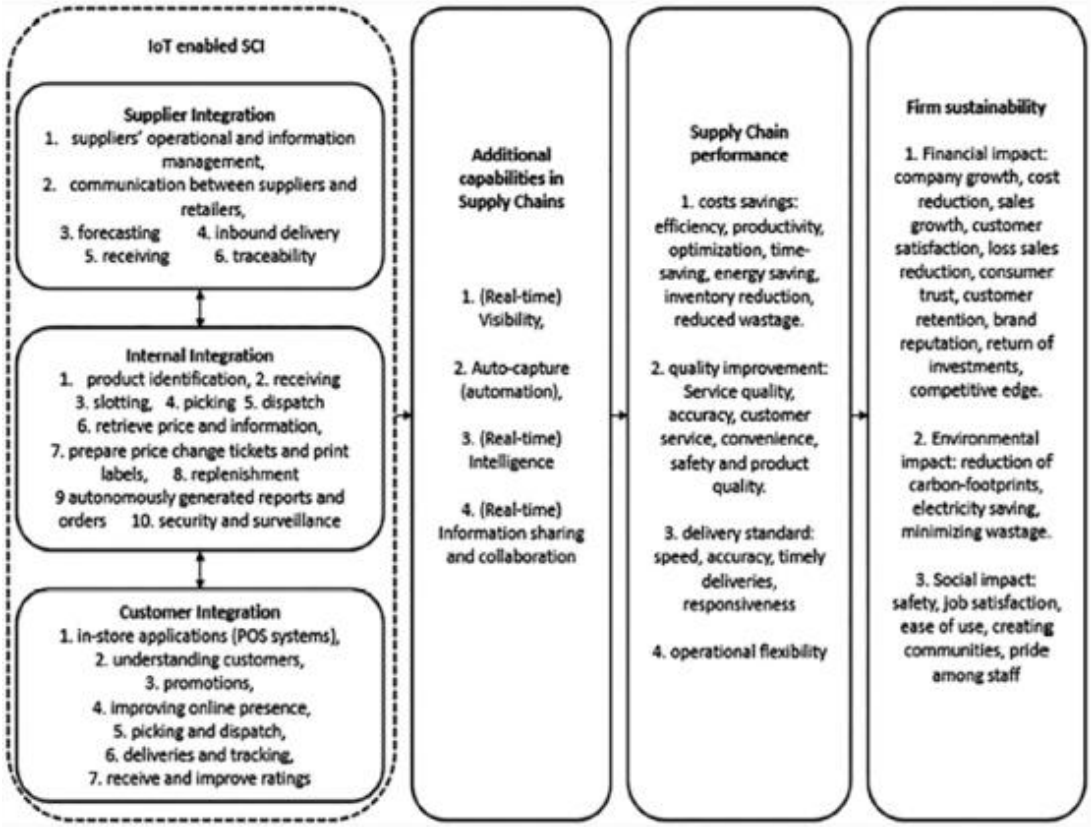


Table 3: Internet of Things enables firm sustainability in retails

Prior to Industry 4.0, earlier versions focused on water and steam power to mechanize production (Industry 1.0); electric power to create mass production (Industry 2.0); and electronics and information technology to automate production (Industry 3.0), respectively. Now, it is the time that cyber physical systems in Industry 4.0 integrate information and communications technologies (i.e., Internet of Things) with industrial technology. With devices including cameras and sensors that remain handy, man-machine interaction is likely to be enhanced. Cyber-physical systems thus support autonomous information exchange between machines by connecting them in a production environment. Embedded with sensors and actuators, these smart machines will have the potential to connect through the Internet. In other words, it is not just an amalgamation of technological gadgets into the existing industries and practices, but it is a space where the products, processes, technologies, and employees are intertwined for higher efficiency. (Shee, 2023, p. 9)

Industry 4.0 has significant impact on Supply Chain 4.0. Supply Chain 4.0 proposes performance improvement by means of digitalization of logistics processes which lead to a faster, flexible, granular, accurate, and efficient next generation supply chain. Previously, Supply Chain 2.0 leveraged in low level of digitization with "mainly paper-based" business decisions. Later, Supply Chain 3.0 was characterized by "basic digital components in place". Even today, digital capabilities remain an ongoing agenda for many with basic algorithms used for planning/forecasting to improve digitalization in business decisions. Recently with Supply Chain 4.0, the highest

maturity level, supply chains are intended to leverage the available data (even big data), for improved, faster, and more granular level of decision-making. The potential impact of Supply Chain 4.0 is huge claiming 30% lower operational costs, 75% reduction in lost sales, and 75% reduction in inventory.

As collaboration between suppliers, manufacturers, transporters, and customers is critical to increase transparency and visibility of goods flow, digitalization, and automation of logistics processes using Internet of Things will likely help capture, store, and share data across the supply chain. The objective is to integrate supply chain processes – supply chain integration – using various technologies deployed at various nodes as suitable. DeVass et al. (2018, p. 4) define supply chain integration as "collaborative inter- and intra-organizational management on the strategic, tactical and operational business processes to achieve effective and efficient flows of products, information and funds to provide the maximum value to the end customer at the lowest cost and the greatest speed."

The increased benefits of flexibility, improved quality, higher efficiency, and productivity enable mass customization, meets customer demands, and creates value through new products and services to the market. All these benefits can be achieved through Industry 4.0 technologies.)Tjahjono et al. (2017) find that implementation of Industry 4.0 technologies such as virtual and augmented realities, 3D-Printing and simulation each result in opportunities to support various key performance indicators – including product availability, customer experience, response time, time to market. Further, they find that Big Data Analytics, cloud technology, cyber security, Internet of Things, miniaturization of electronics, Radio-frequency identification, robotics, drones, and nanotechnology could be opportunities or threats on supply chain. Not realizing its benefits will be a threat for survival in the market.

Although several technologies are disrupting the traditional ways of working, and mostly appearing as standalone technologies having their own merits and advantages, they are highly interconnected. Internet of Things in the form of sensors and actuators is getting increasingly powerful due to its decreasing cost that makes its use ubiquitous. For example, in a cyber-physical systems environment within Industry 4.0, Internet of Things is the foundation technology that automates data capture, storage, and sharing using the Internet. It integrates multitude of physical devices equipped with sensing, identification, processing, communication, and networking capabilities. Egwuonwu et al. (2022) suggest that blockchain technology and Internet of Things together can improve trust among value chain partners in many areas, for example, technical challenges confidentiality, authenticity, and privacy) and security challenges (i.e., counterfeiting, physical tampering, and data theft). (Shee, 2023, p. 10)

Conclusion

In this chapter the Internet of Things has been touched upon in detail with trying to cover most important aspects, The concept of IoT technology and how it works have been addressed and supply chains have also been addressed by mentioning the main points attached to it, as well as the direct relationship between the Internet of Things and between supply chains and how the Internet of things can improve the efficiency of these supply chains.

Chapter 02: Empirical framework

Topic 01: Introducing the "Walmart"organization and how it operates

I. Overview of Walmart Organization:

Walmart, Inc. is an American multinational discount store operator and one of the largest corporations in the global retail industry. Its company headquarters is located in Bentonville, Arkansas. Walmart's business strategy sprung from the late 19th century five-and-dime retail model, but it added a potent combination of operational efficiency, cutting-edge technological approaches, and"elbows-out" competitiveness reminiscent of Gilded Age capitalism. (Britannica, 2024)

Walmart, founded by Sam Walton in 1962, has evolved from a small discount store in Arkansas. With a presence in multiple countries and diverse products, Walmart has redefined convenience and affordability for consumers worldwide. The company's commitment to low prices and efficient operations has propelled it to the summit of the global retail landscape.

In large-scale retail, the significance of a well-defined Walmart Organizational Structure cannot be overstated. The sheer magnitude of Walmart's operations necessitates a meticulously crafted framework. This section explores why a robust Walmart org chart is paramount for a retail giant, delving into its specific challenges and advantages in navigating the industry's complexities. (Jones, 2024)

II. Historical background of Walmart Organization

1. 1962–1970: The early years

In the early 1960s, Sam Walton, the visionary behind what was to become one of the world's most prominent retailers, began his journey by opening discount stores in rural areas. His objective was to pursue growth by targeting customers who were underserved by retailing giants including Sears and Kmart, while avoiding direct competition with them and other dominant department stores.

Walton opened up his first Walmart store in 1962 in Rogers, Arkansas, called Wal-Mart Discount City. This new venture came after a decade of experience running a discount store in Bentonville, Arkansas, called Walton's 5&10 (a Ben Franklin five-

and-dime franchise). That first store's grand opening flier listed 22 departments, including shoes, all types of apparel, house wares, small appliances, gifts, hair care, and sporting goods.

Walmart's early growth was largely fueled by small retail acquisitions and aggressive pricing tactics. From the very beginning, the company constantly pursued the elimination of inefficiencies—from new technologies such as computerized payroll and sales report systems to negotiating favorable supplier contracts—to streamline its supply chain and protect its bottom line.

Walmart's growth due to its heightened efficiency is an accomplishment that has long divided supporters and detractors:

- Although reports of low employee wages didn't surface until the 1990s, the company's critics assume that this "aggressive pricing tactic" and its anti-union stance played a role in bolstering Walmart's bottom line.

- Walmart's "cookie-cutter" saturation strategy (as Sam Walton called it) was to create a hub of stores near a warehouse, reduce advertising spend, overwhelm a local area with market presence, and repeat the process in the next town and state. By the close of the 1960s, Sam Walton had established 18 Walmart stores and had accumulated 17 Ben Franklin stores across four states—all of which generated a total of $30.8 million in annual sales (equal to $257 million in 2023 dollars).

2. 1970-1980: A decade of expansion

The 1970s was a decade of transformation for Walmart—a time of rapid expansion and innovation that laid the foundation for Walmart's forthcoming dominance in the retail industry.

Walmart took a major leap into the public investment space when it became a publicly traded corporation in 1970. This was also the year the company established its first distribution center in Bentonville, Arkansas.

The next financial milestone took place in 1972, when shares of Walmart had quadrupled in value and began trading on the New York Stock Exchange. By this time, Walmart's stock had undergone two 2-for-1 stock splits.

As the company's expansion into other states gained momentum, Walmart continued its practice of adopting advanced computer technologies, including the IBM System/370 that pioneered virtual memory, and the widespread implementation of electronic cash registers.

Walmart also began acquiring companies, starting with 16 Mohr Value stores followed by the Hutcheson Shoe Company. By this time, Walmart began expanding

its in-store offerings, launching pharmacies, auto-service centers, and jewelry departments. By the end of the 1970s, Walmart had 276 stores with annual sales of $1.24 billion (equal to $10.35 billion in 2023 dollars).

3. 1980–1990: From discount store to supercenter

The 1980s marked a decade of near-exponential growth for Walmart's store offerings and share price. The company attained new heights through creating expanded retail formats, technological adoption, and geographical presence.

Walmart's innovation in retail format began with the debut of Sam's Club in Midwest City, Oklahoma in 1983. Sam's Club is a membership-based, warehouse-style superstore where customers can buy products in bulk. In the latter half of the decade, Walmart introduced its first Walmart Supercenter in Washington, Missouri. The supercenter's size, up to 200,000 square feet (versus Walmart's 100,000 square feet) allowed the store to offer a much wider range of merchandise and services.

Walmart was an early adopter of universal product codes (UPCs) at checkout counters and replaced archaic cash registers with point-of-sale (POS) systems that would track inventory and other data in addition to record sales and make change. The company also completed its Walmart Satellite Network, a communications network that linked all its units to the home office by voice, data, and video.

In terms of geographical expansion, Walmart entered 15 states in the American South, Midwest, and East Coast. Its business acquisitions included Kuhn's Big K (1981), Woolco (1983), Grand Central Shoes (1985), and Super Saver (1988) stores.

By the end of the decade, the company had a footprint in 27 states with 1,528 stores. Its annual sales increased to nearly $26 billion (equal to $217 billion in 2023 dollars).

4. 1990–2000: From supercenter to global retail giant

At the beginning of the 1990s, Walmart had already established itself as one of the largest retailers in the United States by annual sales. Its heightened level of operational efficiency via economies of scale and cost controls gave it a significant advantage over many, if not most, of its industry competitors. Nevertheless, the company would continue to expand and evolve, venturing into international retail markets and the then-emerging realm of e-commerce.

Walmart moved into international markets with the opening of a store in Mexico, and growth continued, either through new stores or the acquisition of established retailers, in countries such as Canada, China, Germany, and the United Kingdom. Facing increased competition from emerging retail rivals Target Corporation and Costco Wholesale in addition to other factors such as a huge debt-financing load and a U.S. economic recession, Walmart's sales and profitability began experiencing a decline in

the early 1990s. This period of decline also coincided with Sam Walton's death in 1992, at which time his son, S. Robson "Rob" Walton, took over as chair.

The company began rebounding in 1993, partly due to the success of its private label brand Great Value, whose affordability and variety made it appealing to cash-strapped consumers, and partly due to the upward-turning tides of the economic recovery. Also, its debt-financing strategy to build additional Walmart Supercenters finally paid off in 1995, when Walmart saw its sales double. By 1999, the company had become the world's largest private-sector employer, with a workforce of around 1.14 million.

In addition to acquisition and expansion efforts, Walmart and Sam's Club debuted online stores in 1996—a critical and timely step toward reinforcing the company's brick-and-mortar position while establishing new online markets. By the end of the 1990s, Walmart had 3,996 stores in the U.S. and 1,004 stores across the globe. Its annual sales had reached $165 billion.

5. 2000–present: Digitalization and continual growth

In 2001, Walmart's total sales surpassed those of Exxon Mobil, ranking it as the largest corporation in the world. It remained a global leader in the ensuing years, and in the 2010s it began to acquire several e-commerce businesses, including Jet.com (2016) and Moosejaw (2017). In 2018 the company changed its name from Wal-Mart Stores, Inc. to Walmart, Inc.

As of January 2023, Walmart is the largest retailer in the world, with 10,623 stores and 380 distribution facilities in 27 countries. Its revenues since 2022 have exceeded $600 billion a year. More than 58% of its revenue comes from in-store grocery purchases.

Although Walmart's e-commerce business has seen steady growth, generating up to $73.2 billion in 2022 across all store segments, it's a mere 14% of Amazon's (AMZN) net revenue of $513.98 in 2022 (Amazon being the leading e-commerce retailer worldwide). This figure speaks less to Walmart's challenges in the e-commerce space and more to its roots and essence: a brick-and-mortar variety store offering a variety of goods at competitive prices with groceries at the heart of its offerings.

Walmart has become a corporate icon representing the double-edged sword of capitalist competition. Walmart's presence has benefited countless customers from small American towns to large cities across the U.S. and the globe. However, critics would argue that its rapid and outsize growth has come at the expense of smaller competitors in local communities. While some studies have shown that Walmart's presence has shifted retail employment in local areas, with one Walmart employee replacing 1.4 other retail employees, there's no conclusive evidence of Walmart's negative effects on the overall economic conditions within a local economy. Other

factors, such as the effect of wages, benefits to consumers, and impacts on consumption and other socioeconomic factors have yet to be explored. (Britannica, 2024)

III. Products and Services of Walmart Organization

Emerging from the "five-and-dime store" business environment, Walmart transformed itself into the global retailing behemoth it is today by expanding and innovating on the strategies and principles that defined its industry.

These recastings of common business practices became Walmart's **competitive advantages**:

- **Geographical "soft" monopolies.** Walmart's strategy of placing stores in rural areas to avoid big retail competition was key to its early success. But it went step further and saturated areas near its major distribution centers with stores, establishing concentrated yet expansive hubs of market exposure. This approach has also become a point of criticism and contention, as it has arguably led to the closure of local small businesses that were unable to compete.

- **Aggressive pursuit of efficiency.** Walmart focused on streamlining supply chains, adopting new technologies, reducing waste, and collaborating closely with suppliers. The company expanded primarily in rural areas, initially to avoid large retail competitors. Critics say this strategy dealt a punishing blow to smaller competitors who were unable or unwilling to match Walmart's prices or efficiency.

- **Price competition.** A trait stemming from its five-and-dime origins, Walmart capitalized on its local competitive positioning, efficiency model, expansive product selection, and brand to pass savings on to its customers. Notably, Walmart was also one of the first companies in the retail industry to achieve economies of scale—the ability to significantly reduce production costs by increasing output.

- **Private labels.** Walmart offers several private label products, including Great Value, Sam's Choice, and Equate. These private labels allow Walmart to offer store-branded products at lower prices than name-brand competitors.

What kinds of products and services does Walmart provide?

1. Retail Goods

Walmart offers retail goods in a variety of categories. Customers can buy electronic products such as MP3 players, digital cameras, printers, laptops and computers. Walmart offers music downloads movies, books and jewelry. In addition to home furnishings, the retailer also offers baby products, sporting goods and grocery items.

2. Photo Services

Walmart offers photo lab services inside stores and online. Customers can drop off their photographs for developing via a store kiosk. They can also upload their digital photos via the corporate website. Pick up photos at a store location or have them sent to a home address. The photo lab offers customers the option to develop the prints in an hour.

3. Pharmacy

In 2006, Walmart began offering customers prescriptions for a mere $4. This practice was significant, with many retailers following suit. The company estimates savings to customers total $3 billion since the program's inception. Walmart offers monthly prescriptions for pickup in-store or mail order services for long-term medications. The savings are due in large part to Walmart's catalog of over 300 generic medications available for $4 in-store or $10 for a 90-day supply.

4. Financial services

Walmart offers several financial services. These include:

- **Credit cards**
- **debit cards**
- **Bill payment**
- **Money transfers**
- **check cashing**
- **check printing**

Walmart offers a store credit card without an annual fee. Obtain a debit card in-store or online. Walmart offers money transfer services through Moneygram, starting at $4.75. Customers can also purchase money orders and gift cards, send bill payments, order printed checks and cash checks for fees starting at $3.

5. Wireless Services

Walmart partnered with service provider T-mobile to offer wireless phone service. The Walmart Family Talk Wireless service provides customers with a family plan for unlimited text and voice calls. The service requires no traditional yearly contract and plans start at $45.) McGew(2017 ،

IV. Organizational Structure of Walmart Organization

1. Evolution of Walmart's Organizational Structure

Walmart's organizational structure has evolved in parallel with the company's rapid growth over the past five decades:

1960s – Early structure focused decision-making with a few key executives around Sam Walton.

1970s – Regional VPs appointed as store count grew beyond Arkansas.

1980s – Further delegation of authority to store, district and regional managers.

1990s – International expansion led to country-level divisions and hierarchies.

2000s – Increasing responsibility to ecommerce and other new divisions.

While growing in complexity, Walmart has maintained its fundamental hierarchical structure that empowers localization through geographical units while executing centralized strategy. (Williams, 2023)

The hierarchical structure of Walmart is, like most other structures, a top-down chain of command. There are many levels of responsibility, with the CEO at the top of the chain. Then there are executive-level officers, senior management, and junior management, etc. The main purpose of the hierarchical structure is to ensure a division of labor and to ensure that everyone knows their job role and what they are supposed to be doing. This also means that it will ensure that everything runs smoothly as long as everybody does as expected. Another purpose of the hierarchical structure is that decisions can be made more easily. Because everyone has a clear line to their immediate superior, when a decision needs to be made quickly, there is no need to consult the whole company; it can be passed down the ranks. This should ensure that the best decisions for the company are made faster. Decisions can be made by a few key individuals who have a clear and defined knowledge of the industry and business. This will lead to good decisions for the company and also ones that meet the company's aims and objectives. However, Walmart operates a job culture approach, which means that the development and performance of the managers through training will be achieved if they are involved, and they also motivate their employees to be involved as well. This means that Walmart, despite having a hierarchical structure, offers opportunities for employees to suggest ideas and to get involved in the decision-making process, which is different from other hierarchically structured companies. (Brodowicz, 2024)

2. Walmart Organizational Structure Presentation

- Wal-Mart is constructed into three divisions: Wal-Mart Stores (US) and Sam's Club (US) and Wal-Mart International.
- Wal-Mart is arranged into regions led by a Regional Vice President.
- Each region is made up of Districts run by a District Manager.
- Each District is made up of stores.
- Each Store is divided into two categories: Support and Managerial.

- The highest ranked manager is Department Manager, Support Manager, Assistant Manager, management trainee, and Co-Manager.
- The top store position is Store Manager, called General Manager in Sam's Clubs.
- The stores contain 40-50 different departments.

Sam's Club is a chain of warehouse clubs which sell groceries and general merchandise, often in large quantities.

There are a total of 41 Wal-Mart regions, each with its own Regional Vice-President who works out of Bentonville.

Each region, in turn, contains approximately eleven districts; each district contains approximately six to eight stores. Each district is run by a District Manager.

At Sam's Club, district managers are called Directors of Operations, but the job responsibilities are identical.

District Managers work in conjunction with Regional Personnel Managers on personnel matters.

3. Structure of Walmart's business model

Walmart has a hybrid hierarchical-functional organizational structure, otherwise referred to as a matrix structure that combines multiple approaches. On the one hand, Walmart follows a hierarchical structure, where the current CEO Doug McMillon is the only employee without a direct superior, and directives are sent from top-level management. On the other hand, the function-based structure of Walmart's business model is used to categorize employees according to their particular skills and experience. (Cuofano, 2024)

Table 04: the structure of Walmart's business model

Department	Type of Structure	Structure Details	Advantages	Drawbacks
Corporate Leadership	Hierarchy	Walmart's corporate leadership operates within a hierarchical structure, with clear levels of authority and responsibility. The structure includes executive leadership, senior management, and various divisions and departments, such as finance, legal, and corporate affairs.	Clear lines of authority and accountability. Efficient decision-making process. Well-defined roles and responsibilities	Potential slow decision-making due to multiple levels of approval. Limited flexibility in responding to rapid changes in the retail industry.

Retail Operations	Divisional Structure	Walmart's marketing and sales operations follow a divisional structure, with divisions responsible for different regions or store formats. Marketing teams develop strategies tailored to specific markets. Sales divisions oversee retail operations and customer experience. Walmart also has an e-commerce division focused on online sales.	Tailored approach to different markets and regions. Quick adaptation to local market conditions. Specialization in retail operations.	Potential coordination challenges between divisions. May result in variations in retail strategies across regions.
Supply Chain Management	Functional Structure	Walmart's technology and innovation functions combine elements of both functional and divisional structures. There is a centralized technology team responsible for global IT initiatives and infrastructure. However, innovation teams within different divisions also focus on technology solutions tailored to their specific needs, such as e-commerce or supply chain innovation.	Efficient management of the supply chain. Specialized expertise in logistics and inventory management.	Potential challenges in cross-functional collaboration between supply chain and other business units. May not align with specific business divisions.
Finance and Accounting	Functional Structure	The Human Resources function operates with a functional structure, focusing on HR-related functions such as talent acquisition, talent development, and employee relations. Teams handle HR matters across the organization, including recruitment, training, and performance management.	Efficient financial management and reporting. Specialized expertise in financial matters.	Potential challenges in cross-functional collaboration with other business units. May not align with specific business divisions.
Marketing and Sales	Divisional Structure	Walmart's marketing and sales operations follow a divisional structure, with divisions responsible for different regions or store formats. Marketing teams develop strategies tailored to specific markets. Sales divisions oversee retail operations and customer experience. Walmart also has an e-commerce division focused on online sales.	Customized marketing and sales strategies for different regions and customer segments. Quick adaptation to regional market conditions. Specialization in retail marketing.	Potential coordination challenges between regional divisions. May lead to variations in marketing and sales strategies across regions.

Technology and Innovation	Hybrid Structure	Walmart’s technology and innovation functions combine elements of both functional and divisional structures. There is a centralized technology team responsible for global IT initiatives and infrastructure. However, innovation teams within different divisions also focus on technology solutions tailored to their specific needs, such as e-commerce or supply chain innovation.	Efficient management of global IT infrastructure. Specialized technology solutions for division-specific needs. Flexibility to innovate at the divisional level.	Potential challenges in balancing centralized and divisional technology initiatives. May require effective coordination between central IT and divisional innovation teams
Human Resources	Functional Structure	The Human Resources function operates with a functional structure, focusing on HR-related functions such as talent acquisition, talent development, and employee relations. Teams handle HR matters across the organization, including recruitment, training, and performance management.	Efficient management of human resources and talent-related activities. Specialized expertise in HR functions.	Potential challenges in cross-functional collaboration with business units. May not align with specific business divisions.
Sustainability and CSR	Cross-Functional	Walmart’s sustainability and corporate social responsibility efforts involve cross-functional collaboration. While there is a dedicated sustainability team, sustainability initiatives require collaboration across various departments, including supply chain, marketing, and corporate affairs. The company’s sustainability goals are integrated into its overall business strategy.	Holistic approach to sustainability and CSR, integrating it into business operations. Collaboration across functions for a shared purpose.	Potential challenges in ensuring consistent sustainability practices across the organization. Requires effective cross-functional coordination and alignment with corporate strategy.

Source: from FourWeekMBA website by Gennaro Cuofano

- **Key Features of Walmart's Organizational Structure**

Walmart's key features of organizational structure are centralization, diversification, and equity. In the case of Walmart, the geographic division is used in the organizational structure of the company. Each region around the world has a senior manager who is responsible for that particular region. This type of organizational structure is one of the main factors that enable Walmart to maintain its high employee satisfaction levels. This is because the company employs a large number of people, and thus, in the case of any issues in the company, the employees can easily air their views to the management. Through the effective use of this type of organizational structure, Walmart is in a position to respond to market trends in a pretty quick manner. This is because there is a top governing body as well as several international advisory groups that give directions in terms of expansion and growth strategy. Centralization is whereby key decisions in the organization are made by the top

management, and the information flows from the top. On the other hand, decentralization provides the opportunity for lower employees to make key decisions and exercise authority, which is not the case in centralization. Walmart employs a diversified strategy to continue growing and expanding. This type of organizational structure, where there is a top governing body, is called centralization. Centralization helps the top management to make the key decisions as the information flows from the top. Decentralization is the dispersal of decision-making governance. In Walmart, top-level management and high-level management take advantage of centralized decision-making. On the other side, the divisional organizational structure at Walmart helps the company to create strategies that can effectively apply in satisfying needs in different markets. When the company adopts a strategy that is mainly focused on a single market, they always organize and manage operations that are specifically targeting that single market. Through this, employees can be more specialized, and it makes it standard. This kind of specialization enables division of work and also avails chances of management experience. The company had both functional and divisional structure at one point, and the divisions were supposed to help in the management of different markets. A functional organization is one which includes the organizational structure in which the main decisions are taken at the top, and the information is then passed down through different levels. On the other side, a divisional organization is an organizational design or a corporate structure that groups each organizational task into a division. Walmart utilizes a divisional organization structure. With this type of structure, the company divides its operations according to the different needs of the customers, such as the home users, corporate customers, and on-the-go users. Each organizational function will be done in marketing, finance, IT department, and printers.

a. Centralization vs. Decentralization

Another key feature of Walmart's organizational structure is the use of a mix of centralization and decentralization. Centralization is the process by which the activities of an organization, particularly those regarding planning and decision-making become concentrated within a particular geographical location and especially in the corporate head office. By contrast, decentralization is the process by which the activities of an organization, particularly those regarding planning and decision-making are distributed and diffused away from a central location or authority. Centralization can result in a power struggle within the organization. That is because when there are a number of different imperial powers competing for overall control, conflict for territory can arise. Power and control are in the hands of a few, and communication and expansion can become a real issue. Decentralization has the effect of dispersing or spreading of functions and powers. It also allows junior staff to develop their own strengths and make the most of them. Decentralization usually results in a greater degree of customer focus and a quicker response to changes in the market. By empowering employees to make their own decisions and become more involved in the running of their area of the business, the organization's leadership is able to devote more time on strategic issues. Don't forget to mention what this second

speaker has said and eventually provide an overview. Two experts, Jaydeep and Chris, will be speaking on the alternative between centralization and decentralization and the effect of power distribution and organizational change. Next up is Chris. Finally, talk a little about the importance of understanding the centralization, decentralization and make links with what imagine in Walmart as a result of the organizational structure of the company. Well, centralization can lead to a bottleneck in the operation which in turn creates an environment that becomes more susceptible for errors to occur. As Walmart's purpose is to save people money so they can live better, therefore, significantly reducing operational worth and optimizing inventory flow, it would indicate to a more efficient distribution operation. Also, by allowing properties of successful decentralization to become part of his plans, Walmart can look forward to empower associates and creating a bigger, better service for customers. Chris explains that the main advantage of centralization is that consistency can be maintained. However, the main advantage of decentralization is that it will allow consistency where necessary but there is still the ability to take advantage of more regionals and local tastes. The opportunity for the sharing of power with employees and the possibility of arising quicker decisions will help organizations stay more in tune with local environments. We were lucky sufficient to have an extemporary from Mr Humin who is the senior vice president of operation for North deal. He outlined that Walmart performs good application of both practices. For example, the distribution operation is much more centralized, where there is a single distribution centre responsible for a number of stores. Over on the store area, managers obtain a certain level of autonomy. However, requests must be made to the main office if further resources are needed. His explains that the authority rests at the top of the structure with narrow span of control at the upper levels of the hierarchy - a typical characteristic of a centralized structure. On the other hand, narrow spans of control are great at middle management levels in a company that is organized with decentralization in mind. His final comment was that the establishment of an effectively manage combination of both centralization and decentralization will lead to more successful reorganization of Walmart.

b. Functional vs. Divisional Structure

After discussing whether Walmart is a centralized or decentralized organization, the speakers moved on to consider whether Walmart uses a functional or a divisional structure - or whether it uses some combination of these two structures. At this point, it can be useful to show and discuss the definition of each type of structure. For example, a functional structure is a structure that organizes the activities of a business around specific job functions, such as operations, marketing or sales. Managers will group together people who have the same skills and perform similar tasks. In contrast, a divisional structure is a structure that groups together activities that are focused on a particular product or market; in other words, this type of structure decentralizes business operations to specific parts of the group. The text emphasized that Walmart uses a mix of divisional and functional structures. So the audience was shown the definition of a matrix structure and the presenters explained how and why this would

be appropriate for Walmart - a large and complex business that needs to manage relationships in a variety of directions. Some of the audience would need to make a note on the fact that a matrix structure is a structure that creates project teams, with each team drawing members from different departments, who are then assigned to projects based on their expertise. This structure is a combination of two or more different forms of departmentalization, with the ultimate aim being that the resulting information networks are both vertical and horizontal. The talk then moved on to consider how business functions within the Walmart's organizational structure. This can form the basis of a good discussion on how organizational structure can impact on the ways in which the business meets its objectives. For example, one of the goals of a functional structure is to ensure that people with the same skills - who might be spread out all over the business - can share their expertise and help to create and develop good ideas. Another way to put this is to say that a functional structure can help to promote innovation in a business. Speakers can also discuss how a functional structure can limit the amount of information and individual expertise that might be shared between different areas of the business. The examples used in the presentation constantly referred back to Walmart. This is something that students need to do in any form of assessed work. By doing this, the students confirmed to the examiner that they have in-depth knowledge, not just of business theory, but also of real business practices. It also demonstrates to the examiner that the student can think critically about how business theory can be applied to complex, multinational organizations.

c. Impact on Decision-Making and Communication

When it comes to decision making, Walmart's organizational structure has a significant impact. Being a big corporation, Walmart has a tall organizational structure. This kind of structure has many levels of management, with most decisions and processes going through each level and ultimately getting to the top. Moreover, the organizational structure provides a system to make the company's strategies and objectives done. The power of making decisions relies on how the company wants a strategy or decision to be made. In Walmart, the critical decisions are made by the top level management. These are decisions that have a long lasting effect on the growth of the company. On the other hand, the middle level management makes tactical decisions. These are decisions that direct the standard day to day operations of the company. With the way the company has been set up, each decision making process is defined by the levels of authority, the type of decision and the established company's objectives to be achieved. For any company to run its operations smoothly, there has to be a good communication protocol. Walmart has a very good communication system. A company's organizational structure also has a role in the level of communication. In Walmart, the top level management will get the first type of information, taking advantage of being high in the chain of command. However, the middle level and the low level managements will have to receive the information from the top level, up to the ground employees. The well established communication modes in Walmart are of great help and efficiency because it determines how fast a decision

is accepted and executed, how information is passed from one point of the company to another, and how the company's policies and strategies are received and implemented. From the above discussion, it is clear that Walmart has a well designed organizational structure that greatly stipulates how the company runs its operations. The decision making processes are well defined. The formulation of strategies is made easier, and the objectives of the company are realized efficiently. The established well communication modes and protocol provide a very good ground for different types of information and orders to flow efficiently and effectively. It promotes transparency and accountability in the organization, and hence fostering a trust and a good working environment among the employees. (Brodowicz, https://aithor.com/essay-examples/walmart-organizational-structure-presentation#3-key-features-of-walmarts-organizational-structure, 2024)

Topic 02: the application of IoT in Walmart

Walmart has leveraged IoT devices to improve inventory management and enhance the in-store shopping experience. IoT sensors track product availability, monitor temperature-sensitive items, and help optimize restocking processes. Moreover, IoT-enabled shopping carts and smart shelves provide real-time product information, enabling customers to make informed purchasing decisions.

1. **Managing Food Safety through the Internet of Things**

Food quality is an important part of Walmart's customer experience. Our customers depend on our stores to maintain food at the proper temperature, like keeping ice cream frozen and milk cold. Global Tech is helping our Real Estate team to ensure proper food quality through monitoring our refrigeration units with IoT systems. Our IoT application not only monitors the temperature of the individual unit to ensure proper food safety standards, but also looks at how the equipment is performing and takes proactive steps towards maintenance repairs to reduce the cost and down time caused by equipment failure.

If the signal received requires additional information, it is sent to the maintenance team through a cloud application where the team will triage the issue and determine the best course of action. That could include leveraging a store associate to take additional steps, repairing an IT connection issue, submitting a work order and getting a technician on-site to look at the unit or by making changes remotely to the equipment. (Walmart, 2021)

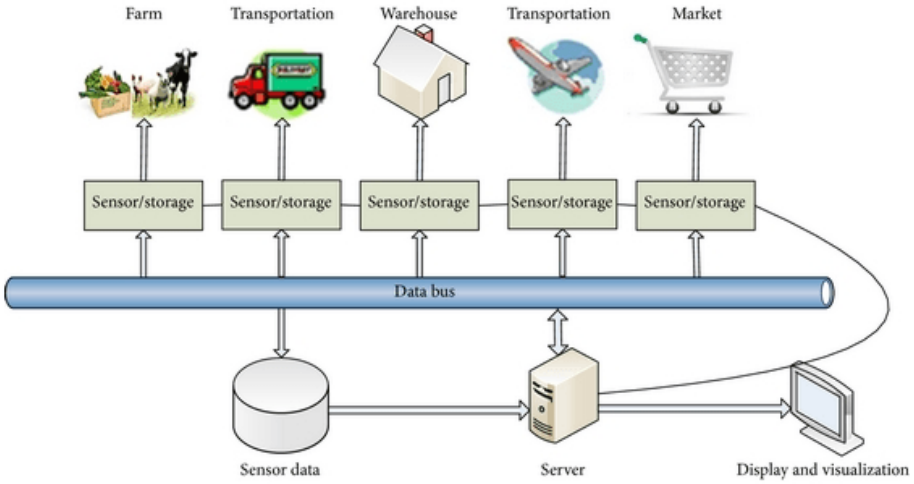


Fig (06): IoT in the Food Supply Chain

In the short term, Walmart has invested in IoT to improve food safety and traceability. In 2016, Walmart started collaborating with IBM and Tsinghua University to "improve the way food is tracked, transported, and sold" in China as an alternative to paper and manual processes. Walmart installed IoT sensors with near field communication technology (NFC) allowing the company to track product and production attributes throughout the supply chain. Replicating this success, Walmart launched a similar 2017 initiative to track mangoes in the US.

In the medium term, Walmart plans to leverage IoT data to own the "last mile" of delivery: getting groceries directly into a customer's refrigerator. Through communication with other home sensors, Walmart can grant delivery drivers access to fill your refrigerator. Walmart has already identified key hurdles of grocery delivery including perish ability, demand planning, expiry, product recalls, and automatic re-ordering, and filed for key patents. (Calvin, 2017)

2. Responsible Energy Consumption

Efficiently and effectively managing energy consumption in response to internal and external factors requires constant monitoring to make adjustments without impacting the customer experience. We're able to use IoT sensors on our stores' HVAC and energy systems to remotely monitor and respond to community energy consumption needs quickly and with minimal impact to our customers' shopping experience. Through the use of a solution called Demand Response we can reduce energy consumption to any of our U.S. stores for a set amount of time and then have systems in place to automatically return our equipment back to the normal operating standards. What this means is that we can lower energy use anywhere in the U.S. by region or an individual store. This allows us to reduce energy consumption and lower utility costs all without impacting the customer experience. Another benefit of this application of IoT is the sustainability implications, where in partnership with local communities,

we can lower our use of the energy grid in response to high demand needs like blackouts and brownouts. (Walmart, 2021)

3. Using IoT to improve food quality

As part of its digital transformation, Walmart is using IoT at a scale unmatched across retail to improve food quality, lower energy consumption and keep costs low for its customers, according to vice president Sanjay Radhakrishnan.

Walmart manages more than seven million unique IoT data points across its US stores. Every day, this network of connected devices sends almost 1.5 billion messages regarding temperature, operating functions and energy use. To help manage this massive volume, the IoT team within Walmart Global Tech has built proprietary software that uses algorithms to detect anomalous events in real time and take action to fix issues quickly.

"**IoT has been a topic in the tech industry for a few years**," said Radhakrishnan. "**Many consumers have heard of it when they are thinking about how different pieces of technology within their home talk to another. If you've ever told one of your devices – let's say your phone – to turn on another device in your home – let's say your TV – then you've leveraged IoT in your home. Walmart has done the same thing in our own home – all of our 4600 plus US stores – to better serve our customers and lower costs**."

Food quality is an important part of Walmart's customer experience. Its customers depend on its stores to maintain food at the proper temperature, such as keeping ice cream frozen and milk cold.

Global Tech is helping its real estate team ensure proper food quality through monitoring refrigeration units with IoT systems. The IoT application not only monitors the temperature of the individual unit to ensure proper food safety standards, but also looks at how the equipment is performing and takes proactive steps towards maintenance repairs to reduce the cost and down time caused by equipment failure. If the signal received requires additional information, it is sent to the maintenance team through a cloud application where the team will triage the issue and determine the best course of action. That could include leveraging a store associate to take additional steps, repairing an IT connection issue, submitting a work order and getting a technician on-site to look at the unit, or making changes remotely to the equipment. Efficiently and effectively managing energy consumption in response to internal and external factors requires constant monitoring to make adjustments without impacting the customer experience.

"**We're able to use IoT sensors on our stores' HVAC and energy systems to remotely monitor and respond to community energy consumption needs quickly and with minimal impact to our customers' shopping experience**," said Radhakrishnan.

"**This allows us to reduce energy consumption and lower utility costs all without impacting the customer experience**," said Radhakrishnan. "**Another benefit of this application of IoT is the sustainability implications where, in partnership with local communities, we can lower our use of the energy grid in response to high demand needs like blackouts and brownouts**." (Rogerson, 2021)

4. **improving inventory management and enhancing the in-store shopping experience**

IoT sensors track product availability, monitor temperature-sensitive items, and help optimize restocking processes. Moreover, IoT-enabled shopping carts and smart shelves provide real-time product information, enabling customers to make informed purchasing decisions. (Blogger, 2023)

Lauren Desegur, VP of customer experience engineering at WalmartLabs said, "**We're essentially creating a bridge where we are enhancing the shopping experience through machine learning. We want to make sure there is a seamless experience between what customers do online and what they do in our stores.**"

While its arch nemesis in business may be Amazon.com, Walmart has the advantage of using the best of both worlds—with over 11,000 brick-and-mortar stores and its online experience—in its laboratory to develop retail tech that catapults sales and customer satisfaction. Walmart was an early adopter of RFID to track inventory and has a tech incubator called Store No. 8 in Silicon Valley to"incubate, invest in, and work with other startups, venture capitalists and academics to develop its own proprietary robotics, virtual and augmented reality, machine learning and artificial intelligence technology."

Recently, Walmart launched Pick-up Towers in some of its stores that are 16 x 8-foot self-service kiosks conveniently located at the entrance to the store that retrieves online orders for customers. Customers can just scan a barcode on their online receipt and within 45 seconds the products they purchased will appear on a conveyor belt. So far, customers give these Pick-up Towers positive reviews as an improvement over the store's traditional pickup process.

Another way Walmart hopes to improve the customer experience with new retail tech is through Scan and Go Shopping. Customers in the pharmacy and money services areas will be able to use the Walmart app for some aspects of the checkout process instead of waiting until they reach the counter and then will be able to bypass the main queue to get in and out of the store more quickly. This is a step in the direction of being able to bypass the checkout process entirely with the use of computer vision, sensors and machine learning as used at the Amazon Go concept store. Walmart already uses machine learning to optimize the delivery routes of their associate home deliveries. (Marr, 2017)

Conclusion

In this chapter, an attempt was made to drop the information extracted from the theoretical chapter on Walmart, First of all, Walmart was introduced in general with a look at its organizational structure, It was also concluded that Walmart uses Internet of Things in its company, especially in its stores in the world, which makes it easier for it to communicate indirectly with its customers. The Internet of Things is used to reduce the energy consumed and protect customers by monitoring the quality of food and maintaining the food safety of products as well as sophisticated storage technologies and others.

ملحق بالقرار رقم ....1082.... المؤرخ في 27 2020

الذي يحدد القواعد المتعلقة بالوقاية من السرقة العلمية ومكافحتها

الجمهورية الجزائرية الديمقراطية الشعبية

وزارة التعليم العالي والبحث العلمي

مؤسسة التعليم العالي والبحث العلمي:

نموذج التصريح الشرفي

الخاص بالالتزام بقواعد النزاهة العلمية لإنجاز بحث

أنا الممضي أسفله،

السيد(ة): إبراهيم خابتي الصفة: طالب، أستاذ، باحث طالب

الحامل(ة) لبطاقة التعريف الوطنية رقم: 402013631 والصادرة بتاريخ 2022-06-05

المسجل(ة) بكلية / معهد العلوم الاقتصادية والتجارية قسم العلوم التجارية

والمكلف(ة) بإنجاز أعمال بحث (مذكرة التخرج، مذكرة ماستر، مذكرة ماجستير، أطروحة دكتوراه).

عنوانها: The Role of Internet of Things into Improving Supply Chain, Case Study: Walmart

أصرح بشرفي أني ألتزم بمراعاة المعايير العلمية والمنهجية ومعايير الأخلاقيات المهنية والنزاهة الأكاديمية المطلوبة في إنجاز البحث المذكور أعلاه .

التاريخ: 2024/06/04

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جامعة محمد خيضر–بسكرة بسكرة في:30-05-2024

كلية العلوم الاقتصادية والتجارية وعلوم التسيير

قسم العلوم التجارية

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بعنــوان:

The role of Internet of Things into improving the Supply Chain

Case study: Walmart

ارخص بطبع المذكرة المذكورة.

الاستاذ المشرف **رئيس القسم**