

Review on Smart Supply Chain Management using IoT and Machine Learning

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ABSTRACT: SCM includes the integrated process planning and implementation needed to optimize the flow of resources, data and financial capital. There is a delay in the transmission of data in traditional supply chain management mode that seriously affects the effectiveness of supply chain management. Each company's objective is to minimize costs for each process, so by using automation maximum efficiency is achieved. Supply chain management is the backbone of global trade. This paper presents a framework of real-time monitoring of smart supply chains and predicting the quality of goods in real-time. It is based on enabling a set of Internet-of-Things (IoT) and Machine Learning based functions across the supply chain. IoT-based mechanisms such as RFID technology can improve transportation and distribution efficiency. By taking real-time data and using different models of Machine Learning we can improve the productivity of every process.

KEYWORDS: Supply Chain, Internet Of Things (IoT), Machine Learning.

I. INTRODUCTION

The idea of supply chain management emerged in the late 90's which was widely used by industrialists for maintaining and tracking goods. Supply chain management helps in maintaining the supply of the goods from manufacturer to the final destination in an efficient way and also helps in maintaining the inventory.

Previously, producers were the supply chain drivers - dealing with the pace at which items were produced and appropriated. Today, clients are calling the shots, and makers are scrambling to meet client requests for choices/styles/highlights, speedy request satisfaction, and quick conveyance. Supply chain management is an essential and significant component of the organisation to boost the organisations profit. Effective supply chain management has become a possibly efficient way to secure competitive advantage and improve the efficiency of organizations. Companies learning how to enhance their supply chain management will become the fresh success stories on the global marketplace.

In this rapidly growing world, food requirements have become one of the main concerns. Food and Agriculture Organization estimates that by 2050 the world's population will be around 9.1 billion. So, controlling food waste have become very important. At the end of the 20th century, Kantor et al. (1997) researched the loss of food in the United States of America. He found the food supply is around 355,883 million pounds, and 27% of that food supply loses around 96,088,41 million pounds when calculated as numerical values [7]. The principal causes of damage to food products during transportation are microbial illnesses, biological alterations, physical harm due to inadequate circumstances and mechanical harm caused by maltreatment [4].

There are various technologies used for efficient supply chain management which are Machine Learning, IoT and Block-chain. Machine learning helps in predicting the requirement of the goods, IoT helps in tracking the goods and block-chain helps in maintaining the goods. The Internet of Things is a technology of interconnected computer systems, machines, individuals that have distinctive recognizable information and transmit information over a network. In IoT, RFID system i.e. Radio Frequency Identification is used which helps in identifying the goods. So, by combining these technologies a supply chain network is formed which is smart and reliable.

IoT based Supply Chain

One of the main reasons which affect supply chain systems is our ability to know about sudden changes in real-time. Here Internet of Things (IoT) comes to power in order to make supply chain management system more efficient. By sensing changes in real-time we have the ability to take necessary action towards it and remove the time gaps that are formed [1].

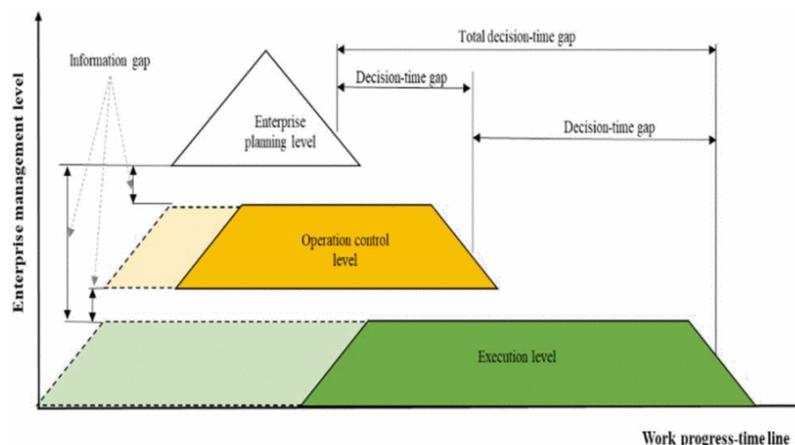


Figure 1: Gaps in supply chain [1]

As shown in **Fig 1**, in every supply chain the time gaps are formed which means information obtained from source is delayed and this directly affects the decision-making ability of the system. Also, the decision made at any instance takes time to implement which is decision-time gap. Therefore, to overcome these gaps in any supply chain management system IoT is used. As an automatic terminal for collecting data, the RFID scheme is also the entry of the Internet of Things information.

Application of IoT in Supply Chain

1) Authenticate the Location of Goods at Any Time

Specific storage containers, materials to be transported or products can be linked to sensors. The IoT device will communicate its place that GPS satellites pick up and use to monitor goods location in real-time.

2) Track Speed of Movement and When Goods Will Arrive

Tracking motion flow and traffic flow makes predicting how goods move through the supply chain much easier. Manufacturers, Suppliers, and warehouses can prepare to receive products, reducing handling times and ensuring products are processed efficiently.

3) Monitor Storage Conditions of Raw Materials and Products

It is necessary to store certain products such as food in optimal conditions. Sensors can monitor temperature, atmospheric exposure, light levels, humidity and other variables in the environment. If certain limits are exceeded, these sensors trigger an alarm to the company.

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4) Streamline the Problematic Movement of Goods

By tracking the goods and route planning over it, we can recognize where and when goods are in delayed through IoT devices. This helps the supply chain to be accelerated by strategic planning and appropriate paths.

5) Locate Goods in Storage

Goods are tagged with sensors when they are in a warehouse, which makes it much easier to locate particular products in a big warehouse and ensuring precise identification and goods distribution.

RFID system

RFID is an automatic non-contact identification technology called "radio frequency identification" that can automatically identify the remaining or moving entities. The RFID system comprises primarily of 3 components reader, tags and antennas [2].

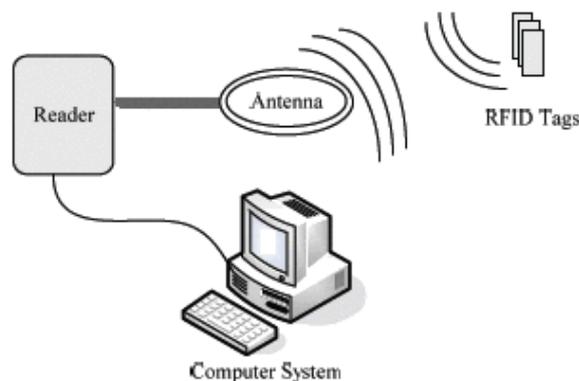


Figure 2: Working of RFID system [2]

Tags: Tags are applied to all product quantities, from individual parts to shipping labels. The RFID tag itself is a power-free microchip. Each product contains unique product code. When a product passes through the RFID scanners, data from the tag is read that can contain any quantity of data, such as:

- Shipment Identity
- Order status
- Serial number
- Product Location logs

Reader: RFID reader is a gadget used to collect data from an RFID tag, which is used to monitor individual objects. Radio waves are used to move information from the tag to a reader.

Antenna: An antenna provides the tags with data and commands

Supply Chain for Agricultural Products

According to a Billerud AB, study, about 10% of the new fruits and vegetables coming into European markets from various parts of the continent are affected in the transport process. It is a major loss not only to the safety of food but also economically of about 10 billion euros annually. By enhancing the transport method, damages can be reduced. The principal causes of damage to food products during transportation are microbial illnesses, biological alterations, physical harm due to inadequate circumstances and mechanical harm caused by maltreatment [3] [4]. To overcome such problem following should be used:

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- Smart Thermostats for Better Quality Assurance

Once an industry sends products for shipment, some temperature-sensitive products can become too hot, leading to a despicable foodborne disorder that puts the public in danger. Temperature-controlled packaging may assist with investment.

- Smart Consumer Appliances for Food Alerts and Inventory Reminders

Nearly every food item the customer brings home can be monitored by new intelligent products like refrigerators. Smart appliances can also sense the temperature of the product and control it to maintain quality.

- Enhanced Precision Farming

Precision farming is a fresh concept embraced by farmers to define and establish the precise parameters required to boost productivity using digital tools. These digital tools are used by farmers to collect data and other variables which influence crop productivity. The information collected helps farmers to determine trends that assist to plan and predict.

Application of Machine Learning in Supply Chain

Machine learning is a sub-area of Artificial Intelligence that allows systems to learn and help improve from experience automatically. By using different machine learning models we can predict the probability if the product will arrive on time, if not then it calculates delay time depending on the situations, the probability of customer returning the goods, and much more. By many machine learning prediction models we are now able to predict and overcome the loss by taking action towards it [6][10].

- We can predict if the shipment likely to be delivered on time by using real-time data.
- If there are many returns from a specific area or for a specific product then we can find out the reason through data analysis.
- Predicting the quality of product on arrival by sensing the temperature and weather conditions on the way by using RFID sensors.
- By analyzing the patterns of customer demand for a product in a particular region we can ship the product directly to customer eliminating the cost of the warehouse.

Next Generation Supply Chain

Today, nearly all sectors and most businesses are facing a more competitive climate – that is, increased demand uncertainty, smaller product life cycles, increased demand for mass customization, higher competitive intensity, fewer warehouses, more third-party service, globalization, etc [8]. The next generation of SCM should possess flexibility to satisfy all the terms listed above. Robotics is revolutionizing all regions which operate in materials handling. It offers great support to companies related to distribution such as Amazon or Ali Baba with unique positions same as supply chain providers [5]. Jobs are a big and essential factor in any supply chain. So by increasing use of robotics, the amount of human interaction decreases, which results in more cost effective supply chain system. A research by the Information Services Group discovered that by 2019, 72 percent of companies would use robotic process automation to decrease expenses, enhance productivity, and enhance compliance.

II. LITERATURE REVIEW

Marwa Chamekh et. Al [1] explain IoT based Tracking System For Supply Chain Management.

This paper describes the use in the business sector of IoT-based supply chain management. It presents an IoT based traceability model and illustrates the distinct supply chain needs such as IoT data history, integrity, accuracy,

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originality, optimal updating, and scalability by storing and querying information on IoT networks such as product locations, sensor system communications, and camera manufacturing.

Bo Yan et. Al [2] introduced RFID and the IoT in the supply chain and discussed RFID, which can uniquely identify an entity compared with other automatic identification technologies. The EPC technique is used to integrate product data effectively with a general network dependent on the assimilation of the RFID scheme and network appliance system. Data for the products stored in tags can be read by readers mounted on various supply chain circumstances. Supply chain members are therefore able to request, update or share data on time through the network.

Yu Gu Et. Al [3] presented research in SCM for Fresh Agricultural Products using IoT. This paper describes how the management of the SCM of fresh agricultural products is crucial to improving fresh produce companies' competitiveness, and the appearance of items offers a new ability to handle the fresh agricultural supply chain.

Zhibo Pang et. Al [4] proposed the Tracking Service for Supply Chain by WAN and Sensors. This paper creates a fresh system solution that is based on the global deployment of our wireless sensor system and RFID methods. It is concerned with the coherent architecture WAN-SAN that helps offer the practical solution with low energy use, reasonable prices and significantly better tolerance of communications in the sector.

Dr. Sini V Nair Et. Al [5] presented Supply Chain Management System of Amazon. This paper states that supply chains in reaction to product life cycles or experience with a new industry can and should develop over time. Amazon follows a customer-centered flywheel-business model that is particularly defined by focusing on selection, comfort and cost and that the new customer-centered supply chain world will involve supply chain executives to adopt the shift, drive it within their organisations, and learn how to handle it with their clients rather than concentrating exclusively on expenses.

Rahul Agrawal Et. Al [6] explains how Machine Learning transforms Supply Chain Management. He recommended architecture for Machine Learning Models in Supply Chain Management. By using different machine learning models we can predict the future state of every product. By Machine Learning about 90 percent cases of delays and returns were predicted correctly.

Linda Scott Kantor Et. Al [7] explained the wastage of food in the food supply chain on each and every level. Initially it starts from farm itself, then during processing and transport, finally during retail and after consumer purchases it. Many different techniques are given in this paper to reduce and overcome food wastage by recycling it or using its byproduct. Field gleaning, Perishable food rescue or sal, Food rescue, Non-perishable food collection are the types of efforts to reduce waste of food.

Vikas Misra Et. Al [8] explains how prerequisites have been proposed for the upcoming age of SCM frameworks and how SCM operator based methods are a solitary answer for the organization of the upcoming age of SCM in a global environment. The requirements for the next generation of SCM systems is described based on every characteristic. Distributed Information Management System (DIMS) is one of the main factors as it manages information over such big network.

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Table 1: Summary of Literature Review Table

Sr. No.	Author	Title	Source	Technology Used	Findings
1	Marwa Chamekh, Sadok El Asmi, Mohamed Hamdi, Tai-Hoon Kim	IoT Based Tracking System For Supply Chain Management	IEEE-2018	IoT	IoT based traceability model for Supply Chain Management.
2	Bo Yan, Guangwen Huang	Supply chain information transmission based on RFID and internet of things	IEEE-2009	IoT	Introduces a model which can efficiently fix information asymmetry in the supply chain, and create a network for supply chain transmission data.
3	Yu Gu, Tiaobin Jing	The IOT research in supply chain management of fresh agricultural products	IEEE-2011	IoT	How IoT has a beneficial function in the future development of the supply chain for new agricultural products.
4	Zhibo Pang, Jun Chen, Zhi Zhang, Qiang Chen, Lirong Zheng	Global fresh food tracking service enabled by wide area wireless sensor network	IEEE-2010	IOT and Machine Learning	Introduces system solution based on our worldwide deployable wireless sensor system and RFID technologies by using WAN-SAN coherent architecture.
5	Sharanya, Dr. Sini V Nair	Supply Chain Management System of Amazon	ILTEMAS-2018	IoT and Machine Learning	Study of Supply Chain architecture of Amazon and suggestions to improve it.
6	Rahul Agrawal, Avneet Saxena	Using Machine Learning to Transform Supply Chain Management	White Paper, TCS-2018	Machine Learning	Suggest architecture to improve Supply Chain efficiency using Machine Learning

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7	Linda Scott Kantor, Kathryn Lipton, Alden Manchester, and Victor Oliveira	Estimating and Addressing America's Food Losses	Econ papers-2011		Analysis of wastage in American Food Supply Chain and suggested solutions to overcome it.
8	Vikas Misra, M.I.Khan , U.K.Singh	Supply Chain Management Systems: Architecture, Design and Vision	Journal of Strategic Innovation and Sustainability -2010		Study of Supply Chain Management system and proposing the next generation of SCM - Distributed Information Management System.

III. CONCLUSION

In this modern world we require new technologies with Supply Chain Management to meet with the growing demand of the consumers. This paper presents the concept of Smart Supply Chain based on Internet-of-Things and Machine Learning along with traditional supply chain architecture. It is now time to include more automation in the business world. Various attempts on this path are found in the literature which helps supply chain management and transportation in an efficient way. By technology mentioned in this literature we can monitor goods or raw materials as well as update server data. The gathered information will be used to analyze the work for future reference. Initially, this will benefit the company by saving them funds and allowing for wider product diversification, thus allowing for higher productivity.

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