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Real-Time Visibility and Tracking for Supply Chain Systems: Improving Inventory Management and Reducing Operational Costs Through Technology

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Abstract
Global supply chain systems are growing increasingly complex, and lately, the need for real-time visibility and tracking systems has intensified. This demonstrates the necessity of solutions that can help in managing inventory, reducing operational costs, and improved decision-making. The basis of this paper focuses on the role played by real-time tracking systems, that is, GPS, RFID, and IoT technologies, in enhancing supply chain visibility and efficiency. These technologies integrate to help the firms to react in advance to disruptions, track the goods in transit, and optimize supply chain operations. The paper also discusses the benefits, difficulties, and future prospects of real-time tracking by the firms in the modern supply chains while relevantly underlining the necessity of technological integration to meet the varying demands of the supply chain systems in this generation.

1. Introduction

A Supply chain system is defined as the network of people, organizations, and activities involved in the production and delivery of a product or service. Supply chain management systems globally have become very complex, these systems are complex not just because they operate in different regions and time zones but also involved and coupled with various industries, stakeholders, and whatnot. One of the most important aspects of managing a global supply chain is being able to track the movement of goods in real time. This has emerged as an important factor to enhance operational effectiveness and risk management. Real-time tracking Technologies like Global Positioning System (GPS), Radio-Frequency Identification (RFID), and Internet of Things (IoT) have changed the Global SCM as they can track and monitor the exact position of goods in real time; this allows constant tracing of goods, optimizes routes, manages delays, and enhances decision-making processes at large. In this paper, the effects of real-time tracking systems on supply chain operations are discussed and reasons why most reliance is placed on these technologies in modern SCM. This paper focuses on how such technologically enhanced inventories help reduce inefficiency, enhance operational transparency, prevent disruptions and delays, and protection against occurrences of unexpected events.

2. Supply Chain Visibility and Its Importance

Supply chain visibility can be defined as the ability of supply chain stakeholders to access information/data about the products/ goods in real-time across the system, including their location, status, and condition. The higher the visibility on an organizational level, the better the decision-making

will be. Higher Visibility keeps the systems free from disruptions, ensures on-time deliveries, and contributes towards the primary goal of enhanced customer satisfaction and operational efficiency.

2.1 Role of Visibility in Modern Supply Chains

Globalization of supply chain systems necessitates that firms maintain real-time information regarding the movement of goods across borders and at various points in supply chains. Lack of visibility has sometimes led to problems such as bad inventory management, shipment delays, and inaccurate demand forecasting, all factors damaging business performance. Real-time tracking systems help overcome such challenges by providing end-to-end visibility of all the stages of the supply chain-from sourcing raw materials to the delivery of the final products at the end-user level (Caridi et al., 2014).

2.2 Advantages of Real-Time Visibility

Some of the main advantages of real-time supply chain visibility are as follows:

Proactive Decision-Making: By gaining access to real-time information, companies will be able to make faster decisions that are based on accurate data and can minimize risks with disruptions.

Cost Reduction: Real-time visibility helps to streamline logistical cost by focusing on inefficiencies such as over-inventories or late transportation and eventually allows for reduction in the operational cost (Wamba et al., 2013).

I**mproved Customer Satisfaction**: SCM systems with visibility can provide more exact delivery times and can reduce potential stockouts and, therefore, improve customer satisfaction (Wang et al., 2016).

3. Technologies Employed for Real-Time Tracking

Technological advancements have been the driving force behind real-time tracking and visibility in SCM. Key technologies that enable real-time tracking include GPS, RFID, and IoT.

3.1 GPS (Global Positioning System)

The availability of GPS technology in logistics is used in guiding vehicles and tracking shipments in real time. In this context, accurate location information enables firms to track the movement status of their commodities in transit, optimize delivery routes, and foresee incidents such as traffic congestion or other untimely setbacks (Jin et al., 2012). Furthermore, the integration of GPS with sophisticated software systems assists businesses in developing more efficient routes and utilizing their fleet without unnecessary fuel wastage and transportation expenses.

3.2 RFID (Radio-Frequency Identification)

The utilization of radio waves in RFID technology automatically identifies and tracks goods by sending real-time information from RFID tags attached to goods or containers to RFID readers. This, in turn, ensures that the locations, product conditions, and level of inventory are up to date. The RFID system differs from the traditional barcode scanning system due to the fact that no specific line-of-sight scanning is required, and it is extremely efficient in tracing goods along the supply chain at various stages, such as warehouses, distribution centers, and retail outlets.

RFID has helped significantly in improving the accuracy of records while reducing direct labour costs associated with scanning. For instance, RFID makes it possible to track at real-time levels, thus making impossible the chances of stockouts or overstocking scenarios (Attaran, 2012).

3.3 Internet of Things (IoT)

IoT is changing the dynamics of supply chain management since it enables the real-time exchange of information from interlinked devices and systems. IoT sensors implanted in cars, containers, and products can provide real-time information about location, temperature, humidity, and other vital

parameters. This monitoring involves constant tracking of the good in transit; such that the environmental conditions are within acceptable ranges, especially in temperature-sensitive products such as pharmaceuticals or perishable commodities (Zhong et al., 2017).

Apart from this, IoT-enabled systems can predict possible risks or delay and help prevent the same from companies employing IoT. The level of granularity is significantly enhanced and thus improves the overall visibility of the supply chain and directs the way to greater operational efficiency (Wang et al., 2016).

4. Supply Chain Efficiency through Real-Time Tracking Systems

The integration of the real-time tracking systems to the SCM significantly influences the overall efficiency in the supply chain. Among the most important gains of these technologies are:

4.1 Improved Inventory Management

Real-time tracking provides companies with clear details on the number of units of supply items in various places. Therefore, the ability to fine-tune its policies regarding the management of stock translates to a company minimizing holding costs without suffering from overstock or understock situations (Wang et al., 2016). For example, companies can enable automatic replenishment of stock by utilizing real-time tracking data once the amount of products hits the specified levels to trigger replenishment.

4.2 Lead times and Delays Minimized

Real-time tracking of the shipment process helps organizations identify delays in transportation and therefore act in real-time. Coupled with the alert system, which gives the company real-time information about possible disruptions or constraints, mainly traffic and weather-related (natural) such companies can adjust the routes for shipment or even delivery schedules (Jin et al., 2012). This results in a lower lead time and, subsequently, a reduction in the adverse impacts due to the unforeseeable.

4.3 Optimized Transportation and Logistics

Real-time visibility into the movement of goods will not only enable companies to optimize routes, reduce waiting times, and reduce fuel consumption but also enable advanced analytics from tracking systems in identifying cost-efficient and time-effective routes (Wang et al., 2016). This has implications for lowering the total transportation and logistics costs.

4.4 Risk Mitigation

Disruptions in the supply chain, due to events such as natural calamities, geopolitical tensions, or pandemics, can have unseen fallouts on businesses. Real-time tracking systems help one assess risks early and take corrective actions such as altering the supply route and adjusting the inventory distribution. This intervention sets limits on the disruptions affecting the overall supply chain (Christopher & Peck, 2004).

5. Challenges in Implementing Real-Time Tracking Systems

Despite numerous advantages of real-time tracking systems, some problems still need to be overcome:

5.1 Data Privacy and Security

The volume of data that is generated by real-time tracking systems is quite high, and this has raised a huge question with regard to the privacy and security of such data. Therefore, organizations must take stiff cyber security measures so that hackers do not steal their sensitive information (Zhang et al., 2019).

5.2 High Installation Costs

One of the negative aspects of applying real-time tracking systems is extremely high initial investments in IoT and RFID technologies implementation. Subject Matter Experts may face hardship in absorbing these technologies due to lack of finance. This factor reduces the chance of its adoption among SMEs (Attaran, 2012).

5.3 Integration with Existing Systems

The integration of real-time tracking technologies with the existing ERP and supply chain management systems is complex and expensive. It demands ensuring the smooth integration and data interoperability among different systems for the full realization of benefits from real-time tracking solutions (Wamba et al., 2013).

6. Future Prospects

The future prospects of real-time tracking in Supply Chain Management are very promising. By employing emerging technologies like blockchain and Artificial Intelligence, visibility and operational efficiency in SCM systems can be increased further. For example, blockchain technology will bring secure, transparent, and immutable transactions records throughout the various processes defining the supply chain. At the same time, AI enables the analysis of data streams generated by IoT devices, making it possible to determine demand and contribute towards more logical decision-making (Tjahjono et al., 2017).

As these technologies become more mature and easier to access, more of these real-time tracking applications will be adopted in the supply chain life cycle.

7. Conclusion

Real-time tracking and visibility technologies are revolutionizing supply chain management by coming up with transparent, continuous, and accurate information regarding location, condition, and status of goods along the entire process of Inbound to Outbound in a supply chain making them stronger, efficient, and agile. All the three technologies - GPS, RFID, and IoT have been instrumental in enhancing operational efficiency, increasing transparency, and mitigating risks. While opportunities like privacy & security, implementation cost, and system integration exist, the aggregate benefits through real-time monitoring and tracking outweigh them. In particular, given growing demand for agile, resilient systems of supply chains, the adoption of real-time tracking technologies will be absolutely crucial for remaining competitive in global markets.

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