

# Supply chain management using IoT- A comprehensive review

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## Abstract

This paper mainly focuses on supply chain management and application of Internet of things through an extensive literature review. Important features of Internet of things in Supply chain management are covered including definition of IoT, Technology involved in IoT, SCM definition, various Supply chain process and applications. We presented several application of IoT in SCM with extensive literature. We identified that most of the studies are on various level of applications of IoT's in SCM and various technology conceptualized to simplify the SCM process using IoT. Most of the Studies are concentrated on food supply chains, delivery supply chains, manufacturing supply chains and the scope of IoT in various Supply chain management system.

**Keywords:** Supply chain Management; Internet of Things; Delivery supply chain; Food supply chain.

## 1. INTRODUCTION

[31]The present business management, Individual business cannot do business as independent but rather as an active member of wider supply chain involving a network of multiple business and relationship. [32]Product customization, price of product and level of service are the mostly demands of customers in present days. [33]The rapid change in technology and continues introduction of new products to the market increased the products complexity. A part from this, the economic, social and natural factors are highly dynamic. The companies need to build risk management system and rapid response to these challenges In order to survive in such a complex environment. Companies must have a effective collaboration with suppliers and customers in order to balance and reach the complex environment. [32]The Responsiveness, reliability, resilience and relationship are called as '4Rs' which are the principles of supply chain management.

[34]The IoT has become the essential tool to enable the supply chain management to the next level. The Internet of things has created many solutions to the changing demands of customer through SCM. [35]IoT has become a great tool to deal with complexities in SC M and uplifted to the next level.

This paper focuses on IoT and its impact of supply chain management through a detailed literature review. The important aspects of Internet of things in SCM including definition of IoT, definition of SCM, and the technology elements needed to implement IoT, applications of SCM.

## 2. About SCM:

Network between a firm and its suppliers to produce and distribute the product to the final buyer is known as Supply chain. [4]Supply chain system includes different people, activities, entities, information and resources.

To manage the flow of goods, information, data, raw material to final product is called as Supply chain management (SCM) system.

[2]The contribution of logistics in the supply chain and, at the same time, researchers and practitioners has recognized a new trend of supply chain integration and collaboration over the past two decades. This philosophy is known as supply chain management and has attracted extensive attention in logistics Development. [1]In the existing method Deep Learning and Neural network for Logistics Supply Chain Information Collaboration. In the existing method large complexity of structure and Hard to maintain version control. So in the proposed method FPGA (Field-Programmable Gate Array) and IOT (Internet of Things) for Logistics Supply Chain Information Collaboration.

The logistics Cooperation based on supply chain management reduces overall costs while improving services to end customers in the supply chain. [3]Global progress, rapid innovation and growing regional influence have made the Supply Chain (SC) an indispensable part. Competition is now changing from the company level to the industry level. The data not only destroys the organization, but it also affects the industry as a whole supply unit. [4]The industrial sector supports more than half of the population, and the automotive sector is the fastest-growing sector. Supply chain cooperation reduces the performance of different industries and different regions. The below table gives detailed report of literature summary on Supply chain management (SCM).

Table 1. *Literature relating to specific application in the supply chain*

S.No.	Application area	Sources
1.	Information sharing	Chen (2017), Bibi e al. (2017), Lrite et a. (2017), Yan et al. (2016), Grunow and Piramuthu(2013).

2.	Virtual supply chains	Verdouw et al. (2016), Verdouw, Beulens, and Van der Vorst(2013).
3.	Condition monitoring	Bowman et al. (2019), Jedermann et al. (2014), Badia-Melis et al.(2015), Shih and Wang(2016)
4.	Food safety	Liu et al. (2016), Gautam et al.. (2017), Wang and Yue (2017).

The table .1 covers the literature that focused on specific food supply chain. In specific, many papers identified the dealing with IoT application in Supply chains. [5]The implications for supply chain risk management (SCRM) by applying internet of things (IoT) have made the business more easy and profitable. The implementation of IoT in SCM reduced the man power requirement and increased the process speed and minimized the time wastage.

### 3. About IoT:

[5]IoT provides the needed platform to connect the CPS using a network of sensors, actuators and devices. IoT generally use cloud –computing capabilities in external data cebtres, which led to the concept of cloud manufacturing (CM) I the industry 4.0 context.

The IoT is composed of two words: ‘Internet’ and ‘Things’ and so we have two main visions. [36]The first vision is focused on Internet or the network component and the second one is focused on the ‘Things’ component. [5]The empirical findings of this study provide some guidelines for logistics and supply chain managers to evaluate IoT adoption in their firms. Likewise, IoT solution providers can also benefit from this study by improving their solutions to mitigate the IoT adoption concerns addressed herein. [6]The below table gives detailed report of literature summary on Internet of Things (IoT).

Table 2. *Representative List of IoT platforms (M&S Consulting 2017)*

S.No:	IoT platform	Connectivity(more than Internet)	Security	Event monitoring	Machine learning
1.	Amazon Web Services (AWS)	Yes(Y)	Y	Y	Y
2.	Carriots	Y	Y	Y	
3.	Cisco IoT Cloud Connect	Y	Y	Y	
4.	GE Predix	Y	Y	Y	Y
5.	IBM Watson	Y	Y	Y	Y
6.	Microsoft Azure	Y	Y	Y	Y
7.	Kaa	Y	Y	Y	Y
8.	Oracle IoT	Y	Y	Y	Y
9.	Sales force IoT platform	Y	Y	Y	
10.	SAP Leonardo	Y	Y	Y	Y
11.	Thigworx	Y	Y	Y	Y

The most common IoT platforms and their key characteristics are included in table 2. [7]The categories of features classified in the table are connectivity, security, and event monitoring and advanced analytics. An efficient alternative to own and manage data centers is cloud computing services (Bonomi et al. 2014). [8]Amazon Web Services uses advanced analytics i.e. Machine Learning feature to run the business in effective mode. Carriots, Cisco IoT Cloud Connect and Sales force IoT platform are not using advanced analytics like machine learning technologies. [9]The fog computing concept mixes local and cloud-computing services and consists in a highly virtualized platform that provides storage, and networking services, compute between end devices and traditional cloud computing data centers' (Bonomi et al. 2012).

[10] The empirical analysis identified key research trends in big data analytics and IoT divided over two time-periods, in which research demonstrated steady growth by 2015 and the rapid growth was shown afterwards. The key finding of this review is that the main interest in recent big data is toward overlapping customer service, support and supply chain network, systems and performance. [11]Major research themes in IoT moved from general

supply chain and business information management to more specific context including supply chain design, model and performance.

#### 4. IoT application in SCM:

The willingness to invest in Internet of Things (IoT) and Big Data Analytics (BDA) seems not to depend on supply nor demand of technological innovations. [8]The required sensing and communication technologies have already matured and became affordable for most organizations. [12]Businesses on the other hand require more operational data to address the dynamic and stochastic nature of supply chains. So why should we wait for the actual implementation of tracking and monitoring devices within the supply chain itself?

The main aim is to find examples of academic literature that explain how organizations can incorporate real-time data of physically operating objects into their decision making. [12]The resulting health/condition monitoring systems seem to benefit production environments in terms of dependability and quality, while logistics operations are becoming more flexible and faster due to the stronger emphasis on prescriptive analytics (e.g., association and clustering). Further research

should extend the IoT's perception layer with more context aware devices to promote autonomous decision making, invest in wireless communication networks to stimulate distributed data processing, bridge the gap in

between predictive and prescriptive analytics by enriching the spectrum of pattern recognition models used, and validate the benefits of the monitoring systems developed.

Table 3. *Impact of IoT on supply delivery process.*

S.No.	Delivery function	IoT Impact	IoT technology	Source
1.	Warehousing	Time savings in the order of 80 to 99% by enabling of Joint Ordering.	Smart things RFID tags	Choy, Ho, and Lee (2017), Yan et al. (2014), Chen et al. (2013b), Cheng, and Huang (2013a). Lou et al. (2011).
		Warehouse and yard management	Smart things	Alyahya, Wang, and Benett(2016), tadejko (2015).
		Safety and security	Smart things and multi-agents	Trab et al. (2015)
2.	Inventory Management	Enabler of VMI through real time visibility	Smart things	Lou et al. (2011)
		Inventory shrinkage, misplacement, accuracy and out – of-stocks.	RFID tags	Mathaba et al. (2017), Qu et al. (2017), Fan et al. (2015,2014), Deeker et al (2008).
3.	Order management	Information sharing	EPC global	Lou et al.(2011), Bowman eta al.(2015).
4.	Transportation	Rerouting based n quality level	Sensors, Information fusion and cloud computing.	Pang et al. (2015).

The table. 3 represent impact of IoT on supply chain delivery process in detailed literature with respect to delivery function. Warehousing, inventory management, Order management and transportation are the four main delivery functions of SCM delivery process that are presented on the table. [13]RFID tags, Smart things, EPC global, Sensors, Information and cloud computing are the mostly used IoT technologies in Supply chain delivery process.

## 5. Discussions:

In this section, we present different observations regarding the application of IoT in supply chain management. [14]The challenges on Supply chain with IoT application are still in their early stage because of its huge potential and disruptive nature. The IoT unprecedented visibility into all aspects of the supply chain, It gives early warning of internal and external situations that require remediation.

Based on the literature by supply chain process, we identified that studies are still confirmed to isolated areas of the supply chain.

[15] Make and delivery are the two supply chain processes and most of the research activities are done on these two processes. The roots of IoT are not new to SCM but the improvements brought by IoT to the logistics function can be viewed as a continuation to previous developments. [16] Lot of research have been found on the IoT technology which is main source of development and implementation of IoT in SCM. some of the reviews and surveys that appeared in the literature (Ng and Wakenshaw 2017, Mishra et al. 2016, Dey et al. 2016, Agarwal, and Xu 2015, Li, Xu, and Zhao 2015, Xu, He and Li 2014, Miorandi et al 2012, Atzor, Iera, and Iorabito 2010).

The Supply chain Management is found more effective by using Internet of Things technology. [17] The literature shows that time optimization and effective usage of resources in SCM are possible. It results in firm development in positive direction by improving profits yearly. [24] Accuracy and quick supply is increased after using IoT technology in SCM. In future the IoT brings many more developments in Supply chain management domain.

## 6. Conclusions:

In this paper, we provided an outline of the latest trends in the application of IoT to various supply chain processes. We explored IoT in an SCM context, presented its main technology enablers and provided an IoT definition, SCM definition and application of IoT in SCM. We found the main gaps in the literature with respect to the potential of IoT role in helping address supply chain management challenges. The interest of both researchers and practitioners are to provide an information overview of the latest development in this emerging and growing area.

We conclude this paper by listing out the several possible venues for future research. The main possible venues identified are maintenance, Virtual network flow, Design and optimization, costing, vehicle routing. The routing and scheduling will be a daily reality in the IoT age for real time tracking and re-

optimization (Pang et al 2015). The costing of IoT technology is another important question for firms. For an example, how to determine the economic and ecological value of sensor information (Bowman et al. 2009). What is the optimal placement of sensors and alert initiation?, What is the optimal scheduling of autonomous repair operations? These two are the main questions related to the maintenance found from the literature (Bowman et al. 2009). Another major challenge is to optimize flow in virtual supply networks that dynamically change their configuration depending on the state of the physical supply chain system (e.g. Verdouw et al. 2013).

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