ISSN: 0976-3031

Available Online at http://www.recentscientific.com

CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 10, Issue, 01(D), pp. 30446-30449, January, 2019

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

A MODEL FOR INDUSTRY 4.0 SUPPLY CHAIN ARCHITECTURE: AN INTERNET-BASED LOGISTICAL AND INVENTORY MANAGEMENT APPROACH FOR OPTIMIZATION OF THE SUPPLY CHAIN FOR THE RETAIL INDUSTRY

Sunil Koul

Engineering @ Restoration Hardware, California, US

DOI: http://dx.doi.org/10.24327/ijrsr.2019.1001.3061

ARTICLE INFO

Article History:

Received 12th October, 2018
Received in revised form 23rd November, 2018
Accepted 7th December, 2018
Published online 28th January, 2019

Key Words:

Supply chain, RFID, demand forecasting, order processing, logistical operations.

ABSTRACT

The current paper describes an industry 4.0 supply chain architecture for applicability in the retail industry. Essentially, the main objective of the study is to integrate order tracking technologies (e.g. RFIDs), order processing technologies, and warehouse management technologies (e.g. AI and industrial robots) in order to form a holistic supply chain technology model for the retail industry. The study employs a meta-analysis approach in which, various literatures on the subject are reviewed and supply chain technology trends discovered. A supply chain architecture model that integrates the various SC technologies is then developed. Finally, a conclusion and recommendations for effective implementation are provided.

INTRODUCTION

The main purpose of this article is to pull together the various technologies used in supply chain optimization in order to develop efficient industry 4.0 architecture for supply chain optimization for the retail industry.

Motivation for this study is based on two major facts. First, existing studies have mainly focused on developing small-scale solutions that partially solve the various challenges inherent in contemporary supply chain networks. For instance, a majority of studies focus on the integration of emerging technologies such as Internet of Things (IoT), RFID device tracking technologies, and use of artificial intelligence in supply chain analysis. However, very few studies have focused on the development of a supply chain management architecture that is based on contemporary technologies. Second, the few existing studies that attempt to develop an industry 4.0 architecture for optimal supply chain efficiency have hardly focused on the retail industry. Some of the studies focus on the manufacturing sector, while others are too specific hence their proposed models cannot be applied to the supply chain of the enter retail industry.

The internet offers great opportunities for business development. Such opportunities have revolutionized the retail sector as more retail companies are offering free home delivery services. Even though such services are good for motivating and attracting customers, they pose a significant burden to the retail industry – the burden of overcoming all supply chain inefficiencies in order to satisfy their clients. However, it is contended that the overall benefits of implementing a technology-driven supply chain outweigh the costs incurred during the implementation of such. The current study aims at designing a supply chain technology architecture for an online retail shop, considering that most contemporary retail organizations allow online ordering and order fulfillment processes. Retail businesses typically operate by sourcing goods from external suppliers and distributing these goods and services through other distribution channels until they reach the final consumer (Zheng and Li, 2018). This necessitates the implementation of inventory management technology. This technology that estimates future customer demands, hence facilitate Just-in-Time order delivery.

RESEARCH METHOD

The research implemented a meta-analysis research approach in which, a number of studies on the same subject was evaluated in order to determine the overall trend in supply chain technology. Typically, the study conducted a survey of

Corresponding author:* **Sunil Koul
Engineering @ Restoration Hardware, California, US

existing literature on emerging technologies for supply chain management, and proposed a new supply chain technology integration framework based on the omissions and weaknesses of existing studies. These studies were extracted from the IEEE Xplore database. Since the research evaluates inventory management in retail businesses, the key words used in the search for reputable sources were: 'Supply chain AND Technology AND Retail AND inventory' and 'Supply chain AND Technology AND Retail AND Transportation'. The results were further filtered using the following criteria;

- First, the research filtered the results based on the publication dates. Precisely, articles published earlier than 2009 were eliminated.
- Second, the researcher skimmed through the titles of the various articles obtained after the initial keyword search. Only articles related to "supply chain technology in retail inventory management" were selected.
- Third, the articles that passed the second selection criteria were further subjected to another assessment that entailed abstract validation. The abstract provided general information regarding the direction of each article.

RESULTS

After conduction of the initial keyword search, only 56 articles were obtained from the IEEE database for the first keyword string, and 34 articles for the second keyword string. During the second assessment criteria that entailed filtration based on title, only 6 of the 56 articles from the first keyword string, and 4 of the articles from the second keyword string were found to be relevant.

Article Author(s)	Objective	Findings
Chunxia, Weimin, Yingyan and Huiyuan.	Implementation of RFID technology in tracking of vegetable packages in China.	The researchers found that implementation of an RFID facilitated tracking of all packages, hence minimizing costs associated with package losses.
L. Bhadrachalam, S. Chalasani and R. V. Boppana	To find out whether RFID implementation necessitates a change in underlying inventory management architecture.	Researchers argue that changing the underlying inventory management model is the only way that RFID implementation could benefit corporations by making their Supply Chains more visible.
Z. Zhang *et al*	To develop an order/device tracking system for applicability in retail SCM based on wireless sensor networks (IoT)	Order tracking minimizes the losses associated with lost packages.
Y. Zheng and Y. Li	To design a sales forecasting and unmanned distribution strategy for a typical retail business	Unmanned distribution strategy takes many forms e.g. unmanned transport systems (drones, self-driving cars), unmanned vending machines, etc. The process improves supply chain efficiency.
D. Shen, K. K. Lai and L. Liang	Design of a sales forecasting and inventory replenishment framework for applicability in retail inventory management.	Reduced inventory management costs, improved customer satisfaction since they get whatever they need at whatever time they want.
D. A. Efrilianda, Mustafid and R. R. Isnanto	Design of an inventory control system with re-order point approach.	The designed system facilitates accurate automated distribution of goods from the central warehouse to retail warehouses based on customer demand.
D. Gao, N. Wang, Z. He and T. Jia	Investigation of the Bullwhip effect in online and offline inventory systems.	Findings indicate a larger effect for the online retail system as compared to the offline retail system.
C. Goebel and O. Gunther	Investigation of the applicability of RFID in the assessment of inventory level in retail stores.	RFID technology can be used to determine inventory level, hence guide in the formulation of critical decisions associated with under-replenishment and over-replenishment.
S. Paydar, I. R. Endut and A. Lajevardi	Investigation of the environmental determinants of RFID technology adoption.	Findings indicate that social pressures and uncertainty are the main factors in the social environment that motivate the implementation of order tracking via RFID technology.

All the six articles also passed the third validation phase. All the ten articles obtained also passed the third assessment criteria that involved filtration based on the relevance of their abstracts.

The following concept table – which summarizes the main objectives of the various articles reviewed – was developed;

DISCUSSION

Studies explored tend to focus on two main technologies used in logistics and inventory management; RFID order tracking technology, and sales forecasting technologies. These two types of solutions are intended to address common challenges that face the contemporary retail supply chain. First, forecasting technologies are designed to address challenges associated with the Bullwhip effect. On the other hand, tracking technologies are implemented in order to prevent errors and risks associated with order transportation and delivery. For instance, RFID tags contain data on date, stamp, order type and number, and delivery destination. Hence, it is easier to track wrong deliveries by simply comparing RFID data and data stored in the company database (Paydaret al, 2013). It is also easier to track the extract location of a package, hence order a re-shipment to the correct destination in case of a wrong delivery. Other than order tracking, (Goebel & Gunther, 2011) have indicated that RFIDs can also be used in the tracking of inventory level in the warehouse. Even though the concept is feasible, the researchers have not provided simulation models to illustrate its effectiveness.

Some studies such as (Zheng and Li, 2018) have focused on logistical efficiency, particularly via use of unmanned systems. Unmanned systems include self-driving cars, unmanned aerial vehicles (UAVs), and unmanned vending systems. Some studies such as focus on the implementation of a fully-automated outbound logistics. However, full automation of outbound logistics can only be achieved if the distribution channel has no intermediaries between the retail warehouse and

While existing studies effectively design and implement RFID and forecast technologies for applicability in supply chain optimization for the retail industry, there is limited focus on how these technologies can be integrated in order to come up with a holistic technology-based supply chain architecture for

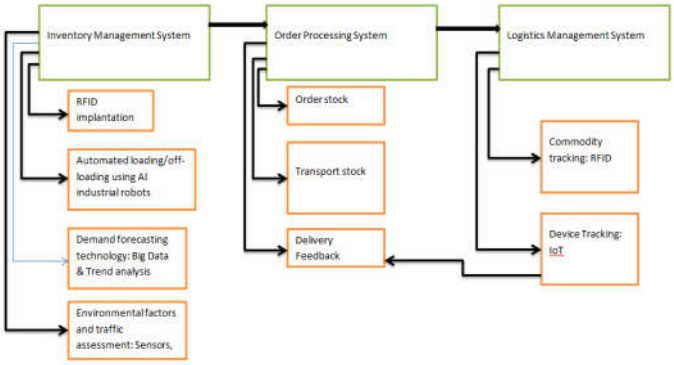
the retail industry. In a nutshell, a majority of existing studies present individual facets of supply chain technology without a clear illustration of how these facets can be integrated together in order to form a holistic supply chain management system for the retail industry. There are potential challenges associated with implementation of such a model across the facets of a typical supply chain; inbound logistics, process applications, and outbound logistics. Essentially, the industry 4.0 model cannot be implemented and managed by a single corporation; instead, implementation of such a model would require collaboration among various corporations (Goebel & Gunther, 2011). However, the model can perfectly be implemented in a vertically integrated supply chain networks, although the ensuing supply chain net or will be sophisticated. The system is well-applicable to retail businesses that offer home delivery because, the supply chain is wholly managed by the corporation; there are no intermediaries between order placement and order consumption.

Proposed Model Diagram

Proposed supply chain technology has following capabilities;

- The technology architecture allows all incoming packages to be implanted with RFIDs. When a special order for RFID implantation on all ordered packages is made, it is the supplier who ensures that all packages delivered are implanted with RFID tags.
- Automatic loading and offloading of goods. Once new stock arrives, automatic offloading and loading systems are deployed.
- Order placement and order processing technology. This is normal software that allows customers to place orders and make payments online. The system should also be capable of managing inbound stock in that suppliers are contacted via the same interface.
- Optimized deliveries. The technology must be able to scan all delivery requests in its outbound logistics in order to define an optimal path. Factors for consideration in the determination of an optimal path include the direction of customer requests and traffic statistics. Regarding customer requests, the system initially subdivides the geographical scope of the supply chain into smaller regions. Crow delivery is then implemented. Precisely, crowd delivery entails the bundling together of requests that come from various regions in order to optimize delivery. The system automatically develops an optimal delivery route based on the number of requests from various regions as well as traffic statistics and road transport network.
- After deployment of delivery mechanisms, there are risks that goods in transit may get lost, get stolen, or get damaged. In order to avoid these risks, there is need for efficient order tracking in order to ascertain order delivery status. This study proposes the implementation of RFID order tracking for individual commodity packages, and IoT infrastructure for the transporting systems such as vehicles and drones. RFID tags

Traffic measurement is conducted by aerial photography. Precisely, an AI software that detects vehicles from the images is implemented. The system counts the number of vehicles, hence determines the traffic density for each road section. Alternatively, daily traffic statistics on different road sections can be used to determine an optimal route for delivering goods to various destinations.



CONCLUSION

This article particularly focuses on the integration of inventory management and device tracking technologies. Precisely, the main aim of the research was to design a supply chain technology architecture for applicability in the supply chain of the retail industry. The direction of the research is influenced by two main factors; scarcity of studies that focus on a holistic supply chain technology architecture, and absence of studies that address supply chain technology architecture within the retail industry. The study employs a meta-analysis method in which systematic literature related to the subject is reviewed. The main purpose of reviewing this literature is to discover the trend in contemporary supply chain technologies in the retail sector. A search for reputable sources in the IEEE Xplore database yields only 9 articles. The few number of articles found can be attributed to the strict filtration criteria implemented. Findings reveal RFIDs and forecasting technologies as the most common in contemporary retail supply chain management. Based on the research gap identified earlier, a new proposed system that integrates various technologies is designed. The system only covers three main sections of supply chain management; logistical operations, warehousing, and order processing. The system begins with the implantation of all packages with RFIDs from the supplier's side. At the retail company's warehouse, AI robots are used for offloading and arranging of packages in the warehouse with automated scanning of RFID contents. The online ordering system allows customers to place orders and pay before deliveries are made. In order to overcome the Bullwhip effect, an automated demand forecasting system is deployed. This system predicts future demand trends and generates the expected number of orders for that should be made for particular packages. Prior to transportation of packages to their destinations, assessment of road congestion statistics is necessary. In areas with limited road networks, drones and UAVs are deployed. While the packages are in transit, there is need for constant tracking in order to get rid of human errors that could lead to wrong deliveries.

Recommendations

The following are recommendations for any retail company that would wish to implement this model;

First, the system should be implemented by corporations that are financially stable because, initial set-up costs are quite high. However, the expected long-term benefits are worth the investment.

Second, corporations wishing to implement the model should have a vertically integrated supply chain in order to reduce supply chain complexity. Having too many independent actors in a single supply chain would limit full-scale implementation of some technologies such as order tracking.

References

Bhadrachalam, L., Chalasani, S., &Boppana, R. V. (2009, March). Impact of RFID technology on economic order quantity models. In *2009 3rd Annual IEEE Systems Conference* (pp. 327-332). IEEE.

Chunxia, W., Weimin, Y., Yingyan, P., &Huiyuan, X. (2009, May). Research on RFID technology adoption of vegetable supply chain in China. In *Information Technology and Applications, 2009. IFITA'09. International Forum on* (Vol. 2, pp. 669-672). IEEE.

Efrilianda, D. A., &Isnanto, R. R. (2018, March). Inventory control systems with safety stock and reorder point approach. In *2018 International Conference on Information and Communications Technology (ICOIACT)* (pp. 844-847). IEEE.

Gao, D., Wang, N., He, Z., &Jia, T. (2017). The bullwhip effect in an online retail supply chain: a perspective of price-sensitive demand based on the price discount in e-commerce. *IEEE Transactions on Engineering Management*, *64*(2), 134-148.

Goebel, C., & Gunther, O. (2011, January). The information value of item-level RFID in retail supply chain operations. In *2011 44th Hawaii International Conference on System Sciences* (pp. 1-10). IEEE.

Paydar, S., Endut, I. R., &Lajevardi, A. (2013, September). Environmental determinants of RFID adoption in retail supply chain, a binary logistic regression analysis. In *RFID-Technologies and Applications (RFID-TA), 2013 IEEE International Conference on* (pp. 1-6). IEEE.

Shen, D., Lai, K. K., & Liang, L. (2009, July). Inventory replenishment model for perishable products in two-level supply chain. In *Business Intelligence and Financial Engineering, 2009. BIFE'09. International Conference on* (pp. 396-400). IEEE.

Zhang, Z., Chen, Q., Bergarp, T., Norman, P., Wikström, M., Yan, X., & Zheng, L. R. (2009, June). Wireless sensor networks for logistics and retail. In *Networked Sensing Systems (INSS), 2009 Sixth International Conference on* (pp. 1-4). IEEE.

Zheng, Y., & Li, Y. (2018, August). Unmanned Retail's Distribution Strategy Based on Sales Forecasting. In *2018 8th International Conference on Logistics, Informatics and Service Sciences (LISS)* (pp. 1-5). IEEE.

How to cite this article:

Sunil Koul. 2019, A Model for Industry 4.0 Supply Chain Architecture: an Internet-Based Logistical and Inventory Management Approach for Optimization of The Supply Chain for The Retail Industry. *Int J Recent Sci Res.* 10(01), pp. 30446-30449.
DOI: http://dx.doi.org/10.24327/ijrsr.2019.1001.3061

****