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THE ROLE OF INTELLIGENT INFORMATION SYSTEM IN E-SUPPLY CHAIN MANAGEMENT PERFORMANCE

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Artificial Intelligence (AI) has shifted supply chain into intelligent supply chains. AI techniques nowadays appears to support supply chain processes, and have showed increased use of commercial AI applications for supply chain representation in many forms. The underlying assumption of this article is that companies along with suppliers and clients are willing to reduce the risk of uncertainty and reduce demand fluctuation which affect the lead time that impact the supply chain performance. Intelligent information system would be used to conduct part of supply chain transactions in the real time, which would reduce the lead time and reduce the uncertainty of demand fluctuation along supply chain parties, reducing the lead time and bullwhip effect would increase the supply chain management efficiency and enhance its performance.

In particular, this article assumes that an agent-based intelligent information system is capable of managing its own activities (e.g., the general reasoning capabilities of AI planning) and its uncertainty in other agents' behaviors that affect its reasoning capabilities. Thus, it may be advantageous for the involving agents to coordinate on the estimates of their task executions so that they could reduce the uncertainties by employing other agents' estimates. Moreover, this article focuses on the way in which an intelligent agent-based system communicates along supply chain parties in SME FMCG retail and distribution industry, and introduce an intelligent information system for supply chain management which suppose an enhancement on supply chain performance in e-supply chain platform.

Keywords: e-supply chain, Intelligent information system, Supply chain performance.

Introduction

The emergence of global information economy; accelerating competition, and high technological advance, have been affecting and shaping the new look of e-business organizations, that consider the "internet of things" as one of the basics competency, that required for success and prosperity. This business dynamic environment has been rapidly transforming e-supply chain management to go beyond information sharing and coordination between buyers and vendors, to the extent of integrating all organizations strategies along distributed supply chain. Supply chain management is a key component of productivity and this has necessitated a paradigm shift in the way it is done. One of the most significant changes is the adoption of latest technologies to enhance efficiency, agility and flexibility in the entire supply chain. e-Supply chain management has revolutionized e-business by allowing for better visibility and tracking. The new technologies allow for real-time information sharing and monitoring of the entire supply chain activities, this of course will enhance the flexibility and enable to better adjustment and increase the responsiveness level for managing risk and uncertainty through the supply chain.

Recently several new artificial intelligent (AI) techniques, in which are using to improve the performance of e-supply chain system, such technologies and techniques are: Multi Agent System (MAS), Artificial Neural Network (ANN), Genetic Algorithms (GA), and Fuzzy Logic (FL) (Al-zubi, 2010). The technologies that underlying in this research are: Agent-based communication, BLE (Bluetooth Low Energy/iBeacon), RFID (Radio-frequency identification), NFC (Near Field Communications), and GPS (Global Positioning System). Moreover, "internet of things" has upgraded a business into e-business, and artificial intelligent system has upgraded e-business into intelligent business. And to gain competitiveness, organizations have to constantly apply latest technology through collaborative efforts of a "network" of supply chain members rather than the efforts of an individual organization.

The emergence of Intelligent Information Systems has inspired many changes in today's business world from basic business procedures, routine tasks and business functions, to management styles and business models, the changes can be seen almost everywhere. The impact of IIS on today's business is obvious in at least two categories: (1) the improvement of business in efficiency, effectiveness and productivity; (2) the transition of business in the way people create, organize, manage and operate an enterprise.

Intelligent information system enhances the performance of the supply chain through the online information sharing along the supply chain parties. This allows process of information flow to be quality (in real time) and customer orders to be tracked and rectified, isolates bottlenecks in the process, so reduce lead times so they can be aligned with available capacity in order to maximize plant utilization. All of this ensures quicker time-to-market for the firm's products.

Importance of the Research

Agent-based Intelligent Information System have a great potential to support electronic supply chain management. This Research attempts to provide a practical-based suggestion for better understanding of managing supply chain and clarify the role of the Intelligent Information System in e-supply chain and its impact on the performance.

The findings of this research will help businesses, academic, and researchers as well in the following aspects:

1. Suggest using agent-based for Intelligent Information Systems.
2. Identify the proposed components of Intelligent Information Systems.
3. Identify the role of using Intelligent Information Systems in enhancing the performance of e-supply chain management.

Background

Supply Chains management considered to be the integration of business processes of all organizations involves from end user through original suppliers that provide products, services and information that add value for customers. While e-Supply chain management concerned of managing a supply chain activities and processes by the support of internet of things, and conducting transactions that could be done by web-based technology.

Measurement of supply chain performance mainly focus on three overlapping and interrelated areas: cost, time and quality (Zhao, Zhang, Yang, Fang, & Huang, 2018).

Lead time measured by the time required for the company to meet its customers' needs, it referred to as "order-to-delivery cycle time". In other words, it is the time needed by the company to plan and stock (inbound logistics), inventory and schedule (operations), cycle time (order-to-delivery time), and invoice a particular product (outbound logistics). Accordingly, incremental costs are induced as the cycle lengthens. A more conventional definition of lead time in the supply chain is the time from the moment the customer places an order to the moment it is received by the customer.

Bullwhip Effect is an observed phenomenon in forecast-driven distributed supply chain, that results from the variability of customer demand and information distortion along supply chain. By which demand order variabilities are amplified as they move upstream the supply chain. This effect originally results from one or more of the following reasons: the use of demand forecasting, supply shortages, order batching, price fluctuation, and shortage gaming. Bullwhip effect have a negative impact on supply chain performance, like: overloaded and/or under-loaded capacities, variation in inventory level, and high level of safety stock. One of the lead causes of the bullwhip effect is the break in the sharing of information between the different partners in the supply chain. Some of the solutions for reducing the bullwhip effect are to have real-time data up and down the supply chain, and reduce lead times (Bi, 2017).

Reducing the lead time have direct impact on the cost, since more lead time require using more resources, then enhancing the supply chain cost structure shall improve the supply chain performance.

A lost opportunity of taking efficient decisions or a delay in making a decision could be as a result of late arriving of relevant information to the decision maker, this also impact the level of flexibility and the level of responsiveness. The availability of the related information in the real time over the supply chain have significant impact on improving the supply chain performance.

In this research a suggestion has been made to use intelligent information system for better information sharing along the supply chain parties as a solution to reduce the lead time and reduce the bullwhip effect.

Agent-based Systems

An agent is a computer system component that is situated in a computing platform environment, and that is capable of autonomous action in this environment in order to meet its design objectives". It is a dynamical interaction, coordination, negotiating and mutual communications among a group of individual agents that take actions independently and make decisions on behalf of their client, and based on a set of computing functions and criteria. Moreover, a multi-agent system (MAS) is seen as a system that consists of a group of agents that can potentially interact with each other, or the successful combination of several autonomous intelligent agents working together. The agents-based MAS are distributed in an environment to perform distributed problem solving, which coordinate with each other to solve a given task. Recently, multi-agent systems receive a lot of attentions and many successful applications have been achieved in supply chain performance through collaborative agents (Alzoubi, Alnazer, & Alzoubi, 2016). The general architecture of each individual intelligent software agent contains all the centralized processes; that tasks given to each agent to accomplish which can be different, depending on their role. Some agents include the information provided either from the user or from other software agents. Others include all the functions required for the agents to be able to communicate, and to cooperate with other members of the agent society.

Research Dilemma

Companies over the supply chains suffering the challenge of competitive lead time and bullwhip effect, both lead time and bullwhip effect have an impact on the supply chain performance, longer lead time and high bullwhip effect will impact the performance of supply chain badly.

The bullwhip effect is a vibrant phenomenon in supply chains. It refers to the tendency of the variability of orders rates to increase as they pass through the stratums of a supply chain towards producers and raw material suppliers. The bullwhip effect reveals that there is a mild tremor in the SCM. It may be a mismatch between order and demand and thereby inventory becomes uncontrollable. If actions are not taken, it leads to a bigger problem over the supply chain.

So the major concern is the delay in receiving the right information in the right time, and or transmitting the wrong information from one stage to another toward upstream without discovering it,

which may lead to inefficient decisions, either because of wrong information or lost the opportunity to take the right decision because the delay in receiving the right information.

This research suggests using the Intelligent information systems and agent-based applications with certain technologies for better information sharing, and effective coordination and dynamical interaction over the supply chain.

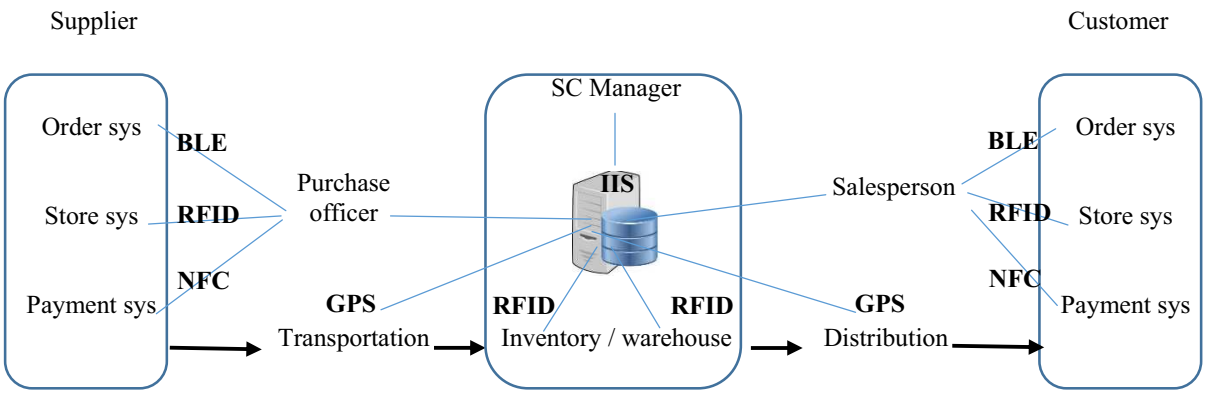
Research Question

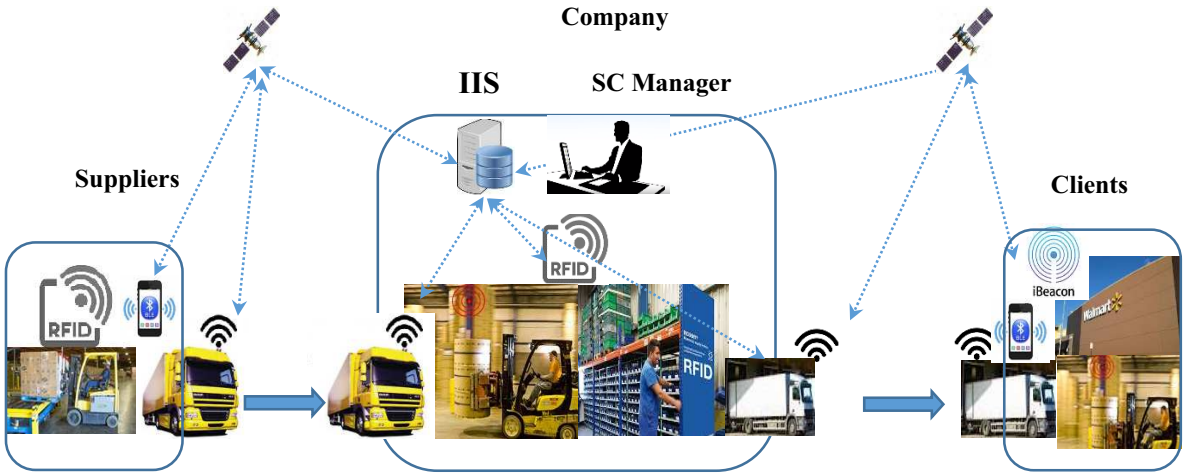
The problem of this research can be summarized in the following question:

1. How Intelligent Information Systems can enhance the supply chain performance?
   a. How Intelligent Information Systems reduce the lead time in supply chain?
   b. What components that the proposed Intelligent Information Systems should contain?
   c. How Intelligent Information Systems reduce the bullwhip effect in supply chain?

Research Model

The Role of Intelligent Information Systems on e-Supply Chain System Performance





Intelligent Information System for Supply Chain

Intelligent information system is an information system with an intelligent embedded capability, that has the capacity to auto communicate with other intelligent systems, gather information from different sources, analyses it, for better decision making process (Lee & Kim, 2008).

The proposed intelligent information system in this research based upon the integration between a number of agent-based technologies to be connected to backend database and using one interface, and these technologies are: Agent-based communication, BLE (Bluetooth Low Energy/iBeacon), RFID (Radio-frequency identification), NFC (Near Field Communications), and GPS (Global Positioning System) (Valverde & Talla, 2016).

Technology-based Infrastructure for Intelligent Information System

Agent-based communication: for communication, the software agents, use WARP (Workflow-Automation through Agent-Based Reflective Processes) architecture, moreover, the interaction protocol and supporting implementation based on the which is compatible with Extensible Markup Language (XML), which is acceptable to all software environments. Furthermore, is a multi-agent architecture developed to support distributed workflow management environments where distributed components are used to implement each of the workflow steps, and expected to adapt to, dynamically create, and understand evolving conversation policies, of distributed workflow management with implications into e-supply chain. In this domain, agents are "middle-agents" that represent the distributed components that implement each individual workflow step. By representing the component-based services of each step, multiple distributed agents can essentially manage a workflow or supply chain that spans several online businesses (B2B).

Bluetooth Low Energy (BLE): is a Bluetooth communication system with significantly lower power consumption, which enables data transmission and communication between all computers and mobiles, which known now with iBeacon devices. It's a secure proximity-based communication by giving two devices the ability to securely communicate with each other when they are in close proximity, iBeacon

have an approximate range of 70 to 450 meters, but with the added benefit that the device does not need to be physically held against a sensor as it can stay in your pocket or purse the whole time.

Moreover, iBeacons offer a cost-effective solution to in-building location services, with the added benefit of being cheap to deploy and being significantly less of a drain on a smartphone's battery.

By installing iBeacons across the operations areas (store) and combining them with "orders apps" that built for suppliers, customers, retailers (all parties across the supply chain), so it can identify the suppliers, customers, retailers, when they just arrived the store area, and communicate with them with relevant contextual information.

BLE communication consists of two main parts; advertising and connecting. Advertising is a one-way discovery mechanism (used by iBeacon). Devices which want to be discovered can transmit packets of data in intervals up to 10 seconds. After a device is discovered, a connection can be established. It is then possible to read the services that the BLE device offers, and for each service there are characteristics, each characteristic provides some value, which can be either read, written, or both read/written.

Radio-Frequency Identification (RFID): the radio frequency identification is a form of wireless communication that uses radio frequency to uniquely identify an object, the optical scanner uses radio waves to read data from small chips, known as tags which contain a stored information. RFID device communicate tags within a range could reach up to 15 meters. As each tag has its own unique code, readers can track and communicate with multiple tags at the same time. RFID device also connected with backend system for updating its database in the real-time.

Near Field Communications (NFC): is a wireless data transfer and a specialized subset within the family of RFID technology as a branch of High-Frequency (HF) RFID. NFC allows a secure data exchange between devices via short-range. NFC device is capable of being both an NFC reader and an NFC tag. This unique feature allows NFC devices to communicate peer-to-peer. NFC devices have taken advantage of the short read range limitations of its radio frequency. Because NFC devices must be in close proximity to each other, usually no more than a few centimeters, it has become a popular choice for secure payment.

Global Positioning System (GPS): It is a global navigation satellite system that a group of satellites in Earth's orbit able to communicate with a GPS device anywhere on the Earth, then provide the GPS device with location, speed, and time information. GPS technology is great for outdoor use, satellite signals are significantly more at out-building. GPS technology helped supply chain industry in real-time monitoring and controlling the fleet for improving its productivity.

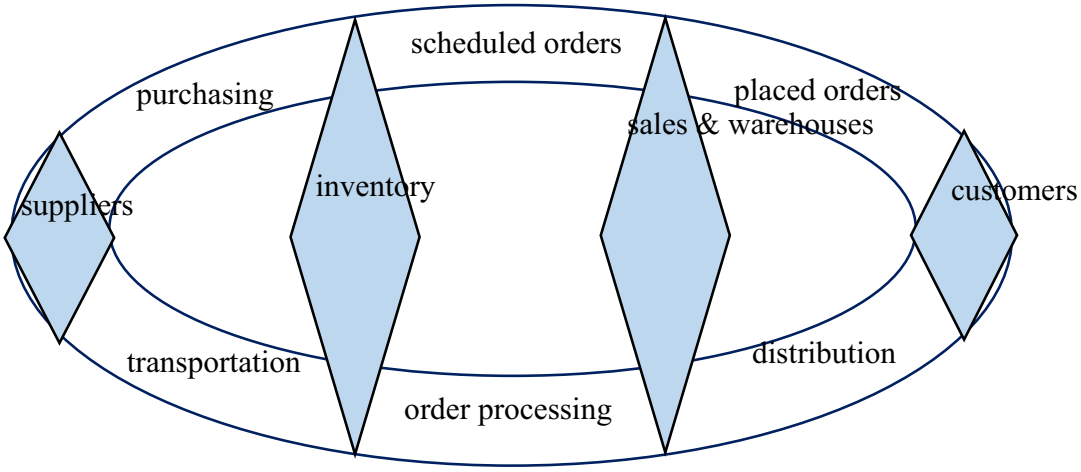
Molding and scenarios mechanism

Discussion of the suggested model

The assumption in this research covers supply chain network of (SME-FMCG), in which connect the retail and distribution companies with its upstream suppliers (producers) and downstream customers (malls / supermarkets). Although IIS implemented in different forms in the organizations, the implementation of the proposed IIS over the supply chain parties, and activities, would probably reduce the total lead time and enhance the supply chain performance.

Order fulfillment scenarios

Retail and distribution companies integrate and coordinate between the following activities (cycles) in order to fulfill the customer orders into three possible scenarios:



First cycle (ready-to-deliver orders)

The sales and marketing activity, where the salespersons visit in regular and continues base a list of target customers (malls / supermarkets), each salesperson have a distribution van or truck filled with their goods (ready-to-deliver) which they try to sell to the target customers. both the salesperson and the customer supposed to use the suggested intelligent information system (prescribed before they have their own devices that connected to their backend database and all devices working on the same platform).

When the salesperson enters the area of the customer, the customer's iBeacon device could identify the salesperson's device (mobile/laptop/tab), then an agent-based application will trigger a pre-organized conversation between the devices, the customer's iBeacon device will provide with the required goods (as it connected to the customer's database and have the updated status of the goods level in inventory). The salesperson's device will provide with the available goods in the van out of the required list (as it connected to salesperson's backend database and have the updated status of the goods level in inventory and warehouse). The interactive conversation will lead to issue an initial order based on three scenarios:

Immediate order for the goods available in the salesperson's van, then the salesperson would process this suggested order immediately (or make some changes). Once the salesperson delivers the order (shift the goods out of the van) to the customer, the salesperson's RFID device will scan it altogether and update the backend system accordingly, then customer could pay using NFC/RFID payment sys.

Second cycle (inventory-based order)

The second scenario when the customer order is not available in the ready-to-deliver warehouse, then a communication between the company's devices will take place to check if the order is available at the company's inventory or not, and in case the order is available, then the company's system will calculate the order lead time (order processing time + order delivery time), then to finalize the order with the customer.

The RFID devices in the company's warehouse will scan and update the system when they shift the customer's order from the warehouse to the distribution Van.

Third cycle (Scheduled order purchase-based)

The third scenario when the customer's order is not available at the company's inventory, so, the lead time calculation requires extra processes, to check if the required goods are part of our scheduled

procurement from the suppliers, if so, the company's system will calculate the order lead time (transportation + order processing time + order delivery time) then to finalize the order with the customer.

The supplier's iBeacon device will identify the company's device, then a communication will take place to suggest the initial order based on required and available goods.

The RFID devices on the company's transportation truck will scan and update the company's backend system when they shift the procurement into transportation truck, then customer could pay using NFC/RFID payment sys. The GPS devices on the company's transportation truck will update the company's backend system with its location in the real-time, and with the expected time to arrive.

Conclusion

Effective process integration and intelligent agents can optimize the lead time, by offering online information about inventories and products about the market demands at any given time. The integration along supply chain parties helps to reduce lead times, and making supply chain companies more competitive in the marketplace. Successful collaboration partnership in a supply chain and effective information sharing through implementation of agent-based IIS can also contribute to reduce the bullwhip effect.

Agent-based intelligent information systems can cut down on procurement lead times, and order fulfillment cycle, and enhanced the way companies procure raw materials from its suppliers to fulfill the customers' orders in shorter time. By having a direct line of communication from customers along with its suppliers, a company is able to share demand information with these suppliers. This would reduce the lead time over the supply chain and increase its efficiency and enhance its performance.

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