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Investigating the Effect of Extended Vendor Managed Inventory in the Supply Chain of Health Care Sector to Enhance Information Exchange

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Abstract

Inventory management in the healthcare sector is one of the most overlooked aspects in case of supply chain management. The main purpose of this research is to optimize the inventory, reduce the overall inventory across the whole supply chain and the information distortion as it moves up the supply chain. In this research, the whole supply chain is integrated by using the vendor managed inventory (VMI) approach. This extended VMI approach is made possible via the application of electronic data interchange (EDI). A website is created as a form of EDI to facilitate the communication of information. The issues in the traditional approach and the benefits of the proposed system are shown and then compared. In this study, real-time information sharing is possible among the retailer, distributor, and manufacturer which made this research very significant. Moreover, this study is applicable for inventory management among pharmacies, manufacturing companies, and distributors.

Keywords: Vendor managed inventory, electronic data interchange, supply chain, healthcare system.

1. Introduction

Raw material suppliers, manufacturers, distributors, transporters, retailers and even the customer themselves, each of these individual parties make up the whole supply chain. Each party or entity makes a maximum effort to satisfy the customer with necessary products. The healthcare sector is trying to cope with the increasing demand for new medicines. However, the lack of expertise and inventory knowledge, sometimes it becomes really hard to maintain all the orders. This situation often results in overstocking or under-stocking or no supply of essential medicine through the whole supply chain.

A challenging supply chain is putting on medicinal services segment to discover chances for building efficiencies and diminishing costs while improving the nature of consideration (See Hanna and Sethuraman [6]). Various distinctive supply chain management methods have been embraced lately but each of them have their own shortcomings. Supply chain management becomes more complex and complicated in healthcare systems

because a more accurate and precise supply of medicines has to be maintained for the patients (See Beier [1]).

In the healthcare sector, Supply Chain Management (SCM) not only deals with medicines, pharmaceutical components, gadgets but also takes the patients' health into consideration. A big part of this study is focused on reducing the information distortion which will reduce the bullwhip effect. The little variations of customer demand at the retailer point, which is the lowest portion of the supply chain, may create a large fluctuation in demand at the upper side of the chain. The bullwhip effect occurs when there are significant changes in the demand between two parties of a supply chain and any parties of the supply chain is trying to meet that demand by increasing the capacity. The bullwhip effect acts in an increasing manner, as the demand information gets distorted as it is passed from one echelon to other.

This study is conducted for the purpose of making the supply chain more flexible, transparent and efficient in the healthcare sector. In this study, the main problems of the existing supply chain in the healthcare sector are identified. Moreover, some approaches will be provided to overcome identified difficulties.

Vendor managed inventory (VMI) is thought to be an appropriate strategy to mitigate the problem related to product demand in supply chain. In other studies, VMI was included only on retailer-distributor dyad. In this present study, the main concern is to create a network with integrating VMI strategy across the whole supply chain. However, VMI approach cannot remove all problems in total supply chain. Therefore, in this study, to improve the transparency of sales data, accurate forecasting and reduce bullwhip effect, electronic data interchange is integrated with vendor managed inventory process.

Different studies were mainly focused on the two echelons of the supply chain (See Guimarães et al. [5] and Mustaffa and Potter [10]). Here the supplier takes the replenishment decision for the retailer. Therefore, demand related problems in the lower portion of the supply chain are removed. However, some demand related problems are arisen in the higher stages of the supply chain. So, another purpose of this study is to eliminate these demand related problems in the upper portion of the supply chain. That's why, in this study, extended VMI approach is used to create a relationship between upper and lower portion of the supply chain.

The main focus of this paper is to create a website to facilitate the communication of a real-time point of sales data, a delivery amount, forecasted amount, delivery suggestions made by each entity of the supply chain. Thus, the manufacturer can monitor the sales data of the retailer and the distortion of information can be also minimized across the supply chain.

2. Literature Review

A few comparisons were found between the traditional supply chain and VMI integrated supply chain by Disney and Towil [3]. The researchers found that VMI integrated supply chain performs significantly better than the traditional supply chain. The VMI

approach performs more effectively in the case of demand changes due to price variations and other causes.

Guimarães et al. [5] investigated multisite hospitals with a small warehouse service center and integrated VMI system with lean management. They found that VMI can not only save costs but also reduce many wastes across the supply chain.

Southard and Swenseth [12] showed that supply chain can be economically benefitted from a VMI approach with a technology, for example EDI system. The researchers measured the inventory management costs incurred in traditional supply chain of two agricultural co-operative industries in Nebraska by using proposed method. They found VMI approach is a better performer than traditional delivery methods and the technology was justified through logistics in various stages of supply chain.

Danese [2] applied "Extended VMI" approach as a first person across the whole supply chain in the health care sector and tried to explain how the extended VMI actually works in a big company. This study integrated the VMI, coordination of flow of materials and necessary information in different stages of supply chain. Moreover, investigation of the inventory management system in Malaysian healthcare sector has been previously explored by Mustaffa and Potter [10]. They focused on the interactions and communications between suppliers and clinics. The researchers used process mapping and data flow diagram to collect and show data. They found two issues, stock availability and emergency orders, that were present in the supply chain and proposed alternative supply chain approach by including vendor managed inventory approach. Furthermore, an analytical model was proposed by Yao at al. [13], which helped to realize how VMI can affect cost in a supply chain. The model showed the benefits obtained from VMI approach were not proportional to suppliers and retailers. The benefits of the suppliers and retailers were inversely related in most cases.

Dong and Xu [4] suggested that VMI philosophy can drastically reduce the costs experienced in the supply chain. The researchers confirmed that the retailers were benefitted from VMI but the suppliers' benefit depended on certain conditions. So, the research suggested VMI should be applied for a long period for suppliers benefit.

3. Methodology

In order to understand the structure of the existing supply chain in healthcare sector, interviews are absolutely important. Different issues of the existing supply chain were identified by analyzing the information obtained from interviews. Information flow processes were easily mapped out by using data flow diagram. So, the information and material flow with integrated VMI are represented by process mapping.

3.1. Interviews

Different pharmacy and clinic staffs, drag suppliers, agents and salesmen were interviewed. The current process of inventory management and order delivery systems were found out by interviewing. At clinics, inventory management, ordering and delivery procedures were also discussed. Therefore, major problems of existing supply chain

were established based on the answers of pharmaceutical representatives. The interviews were conducted in Dhaka, capital city of Bangladesh. More than 20 pharmacy retailers and staffs were interviewed. Interviews were conducted in formal manners. Some fixed questions were selected as a screening question to justify potential candidate. The main questions and their summarized answers are given below (one sample):

• What type of inventory management system do you use?

Ans: Periodic counting system is used to manage inventory.

• Is the current inventory management system created based on personal experience or set up by the supplier company?

Ans: The inventory system is mainly developed the experience of the sales manager. Some pharmacies use perpetual inventory management by using computer.

• Could you tell me how do you order medicine and how do the supplier send ordered medicine?

Ans: Most of the pharmacies can place an order for the necessary medicine to the distributor agents. If the agent doesn't visit the retailer in any particular day, the retailer has to wait until the agent comes. Distributor delivers the ordered medicines through the agent.

• Are there any misplaced order or any missing medicines?

Ans: Yes, when the quantities ordered by the pharmacies are written wrong in order logbook by the agent. Sometimes medicines are missing because of miscommunication.

• If there are misplaced orders, how often do they occur?

Ans: In small pharmacies, it was observed that misplaced orders occur roughly 1-2 times in a month.

• In case of misplaced orders, what do you do?

Ans: The pharmacies again contact with the distributor and inform about the situation. Then the distributor sends the agent with required medicine to the pharmacy.

• How often do stock out occurs?

Ans: Stock-out at the pharmacies occurs almost every week.

• What is done in case of stock out of medicines?

Ans: The pharmacies contact with the distributor to refill medicine and then the distributor send an agent to deliver the medicine.

• How often emergency orders are placed during a month?

Ans: For most pharmacies, at least 4-5 times in a month.

• When the distributors deliver emergency order?

Ans: The distributors generally deliver the product within 1-2 days from ordering.

• What happens when the distributor fails to fill the emergency order?

Ans: In this scenario, the pharmacies sometimes take back orders from customer or pharmacies sell the medicine by borrowing from another near-by pharmacy.

• Does over stock of medicine ever occur?

Ans: Yes, but it is a less occurring phenomenon than stocking out.

• If so, what are the main causes of over stock?

Ans: Lack of technical knowledge and wrong forecasts of medicine of the sales manager are prime causes of over stocking.

• Could you give me any suggestion as to how to improve your present inventory management system?

Ans: Most of the pharmacies suggested that, coordinating information about forecasting, demand and sales with distributors will improve present situation.

3.2. Present supply chain in the healthcare industry

In medicinal services industry, the supply chain is related to pharmaceutical items. Normally, healthcare industries are assuring high expectation of patients to provide necessary medicine and give satisfactory supplies of medicine to the drug stores.

3.2.1. Present replenishment system via Data Flow Diagram

A Data Flow Diagram (DFD) is used to represent the flow of data or information throughout the entire procedure, organization, system or processes. As a visual representation aids, a DFD can present all necessary actions with meaningful words and components. Generally four symbols are used to show the components, External Entities, Data Stores, Data Flows and Processes. The symbols are shown in Figure 1. An External Entity conveys information to the system or gets information from the system

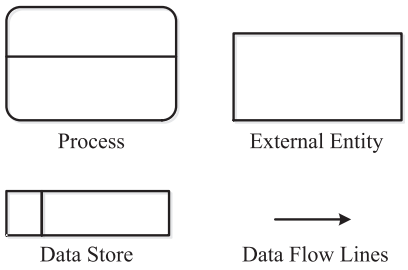

Figure 1: Four main DFD components.

or both. The Process collects data that needs processing and generates outputs. Data stores act as a file or database to stockpile the output from a process.

After completing several interviews, the main echelons and the DFD diagram of the organization's supply chain and information transfer among the manufacturer, distributor, and pharmacies are presented. The sequences of the processes are shown by adding numbers to each process and data store. The pharmacies control their own inventories and place order to the agent when necessary. The delivery of ordered medicine is made periodically by the suppliers, where the agent transports the medicines to the pharmacies via milk run approach. The data flow diagrams of the present replenishment system for retailer-distributor dyad and distributor-manufacturer dyad are shown in Figure 2 and Figure 3 respectively.

An agent is a person acts as a sales representative selected by the manufacturing companies. The agent generally collects orders from various pharmacies and clinics via milk run process. All orders are accumulated and referred to the staffs of supplier, who are responsible for making replenishment decisions.

Retailer-Distributor dyad: From Figure 2, it can be seen that, pharmacy sales the

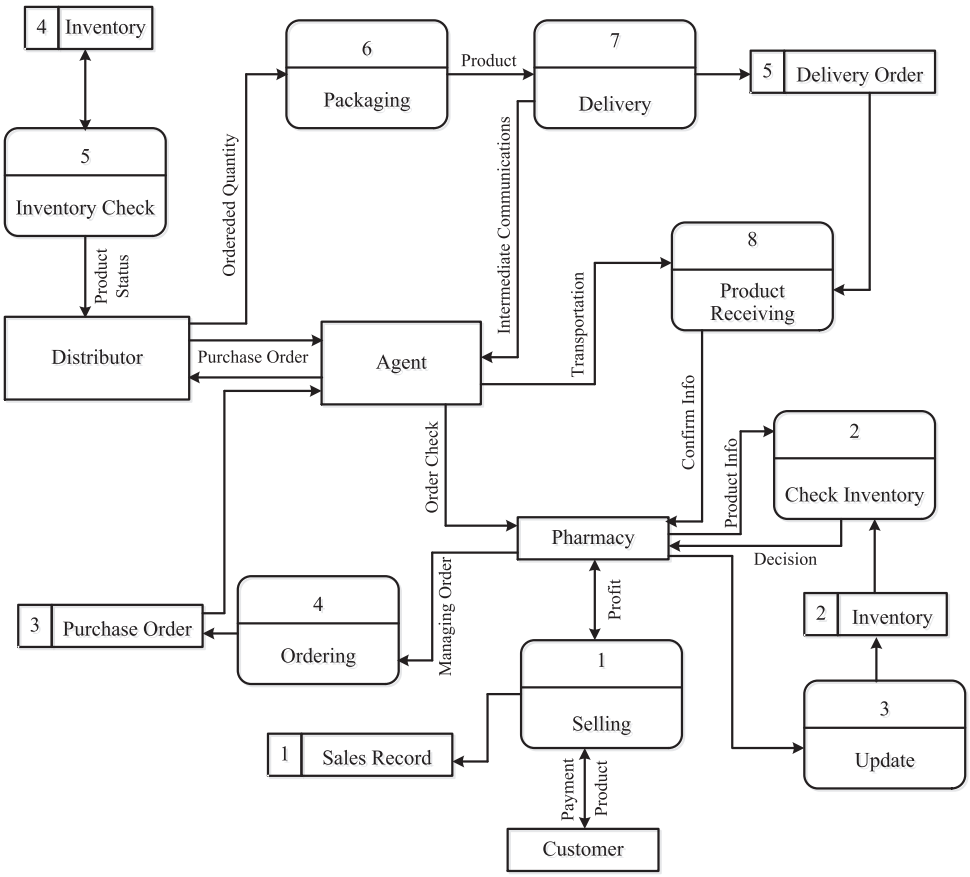

Figure 2: DFD for present inventory system (Retailer-Distributor dyad).

medicine to the customer and updates current inventory. An agent comes regularly to take orders from them. If the pharmacy considers any medicine is not available in store, they place an order for necessary medicine to the agent. The agent conveys the ordered quantity to the distributor. Distributor will check their own inventory, package the medicine and send the packaged medicine to agent. The agent will deliver the package to the pharmacy. Then the pharmacy will update the inventory.

Manufacturer-Distributor dyad: From Figure 3, it can be seen that, distributor sales the medicine to the pharmacy. Then distributor update current inventory. If the distributor considers that any medicine is not available, they place an order to the manufacturer directly.

However, different issues of the present healthcare systems are:

Forecasting: It is hard to anticipate the correct predictions for medications. One of

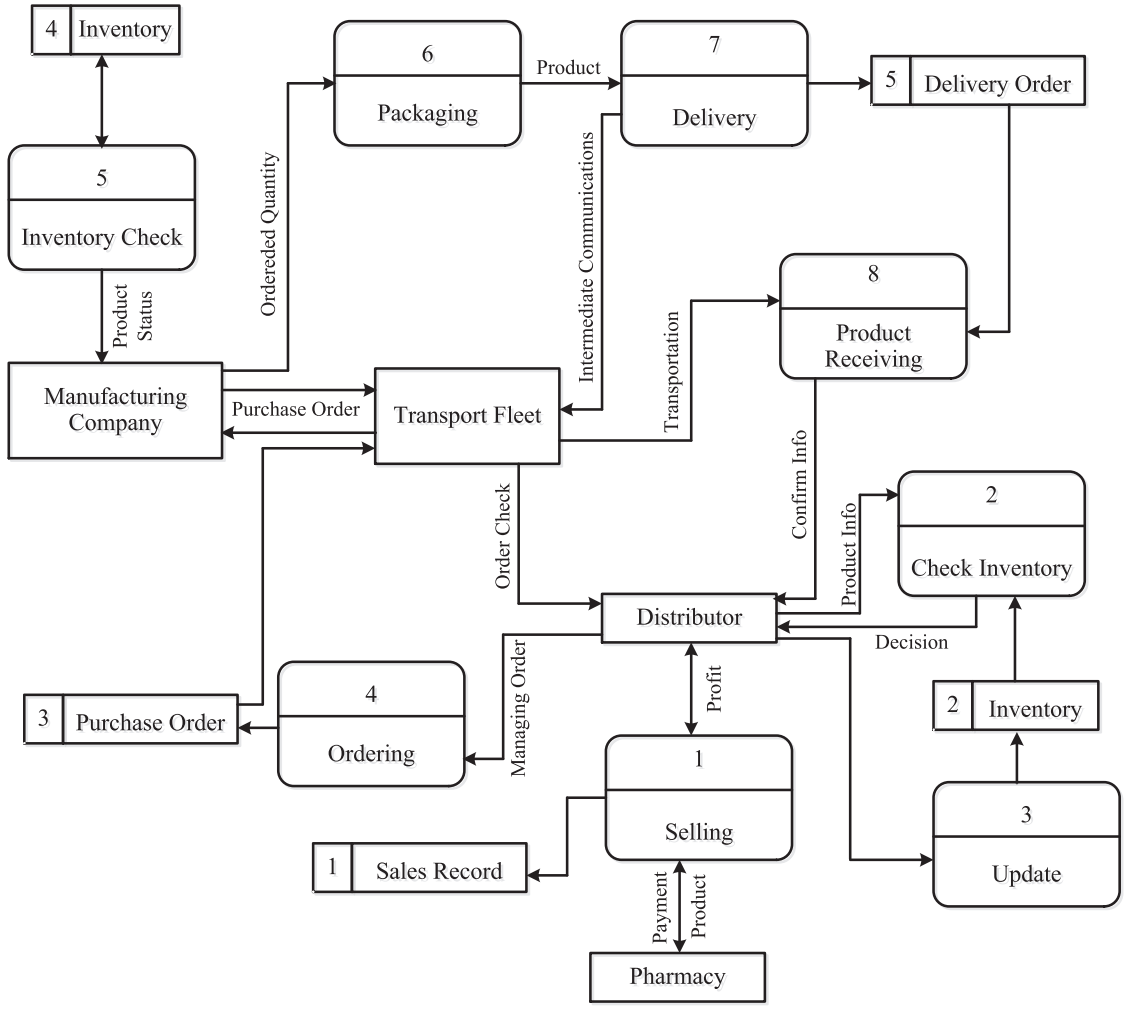

Figure 3: DFD for present inventory system (Manufacturer-Distributor dyad).

the issues is the utilization of exact information. Normally, for healthcare items, the determination of standard condition of forecasting is very unpredictable. Therefore, the absence of standard terminology is observed for health care items. In addition, the inclinations of clinicians makes further difficult to measure forecast (See Lauer [7] and McKoneSweet et al. [9]).

Lack of supply chain education: Familiarity with the idea of SCM, especially inside the emergency clinics is very low. In this way, salespersons and managers have little idea about supply chain of the medicine.

Emergency orders placing: It was observed that emergency orders occur really randomly. A sudden increase of demand for any particular medicine can rise for many occasional reasons.

When these emergency orders are placed, this ordered quantity can't be fulfilled until the next day. So, in case of emergency, the pharmacies and clinics have to rely on the wholesaler and other hospitals for buying medicines at a slightly higher price rate which lower their profit.

Other issues: The other fundamental issues are claimed by clinical administrations : distribution issues, delivery blunders, stock-outs, abundance of organization, challenges in dispersion, selection of proper routes, paper-based data trade (inward orders and between units), absence of stock deceivability, high inventory levels and "secret" safety inventory in each clinical service.

3.3. Proposed replenishment system via DFD

In this study, VMI is proposed as a suitable way to reduce the problems that existed in this current replenishment and inventory management system. The proposed strategy reduces the information distortion throughout the supply chain and diminishes bullwhip effect. Integrating extended VMI across the total supply chain will facilitate monitoring inventory, ordering medicine, more accurate forecasting, and efficient delivery.

The VMI approach is a very unique way to make the decision about replenishment of the product for supplier or manufacturer instead of the retailer. This implies that, supplier monitors the retailer's inventory (physically or by means of electronic informing) and determines delivery amounts, dispatching, and timing. Buying process is initiated by the supplier. The retailer has to give the final confirmation before the supplier sends the delivery package.

VMI makes the DFD very flexible and provides facility to monitor the inventory. Since, the supplier's information was not given due to confidential reasons. Therefore, chemical suppliers couldn't be included in this study.

Pharmacy-Distributor dyad: The pharmacy sells product and maintains inventory up-to-date. Inventory can be monitored by the distributor using an electronic means. The distributor will continuously monitor the inventory of the retailer.

If any medicine falls below the reorder point, the distributor will be notified and check own inventory. Then they will package the medicine and deliver via an agent to the pharmacies. Total processes are shown in Figure 4.

Manufacturer-Distributor dyad: Figure 5 shows the data flow in the manufacturer-distributor dyad. The distributor sells their product and maintains inventory up-to-date. This inventory can be monitored by the distributor using an electronic means. The manufacturer will continuously monitor the inventory of the distributor.

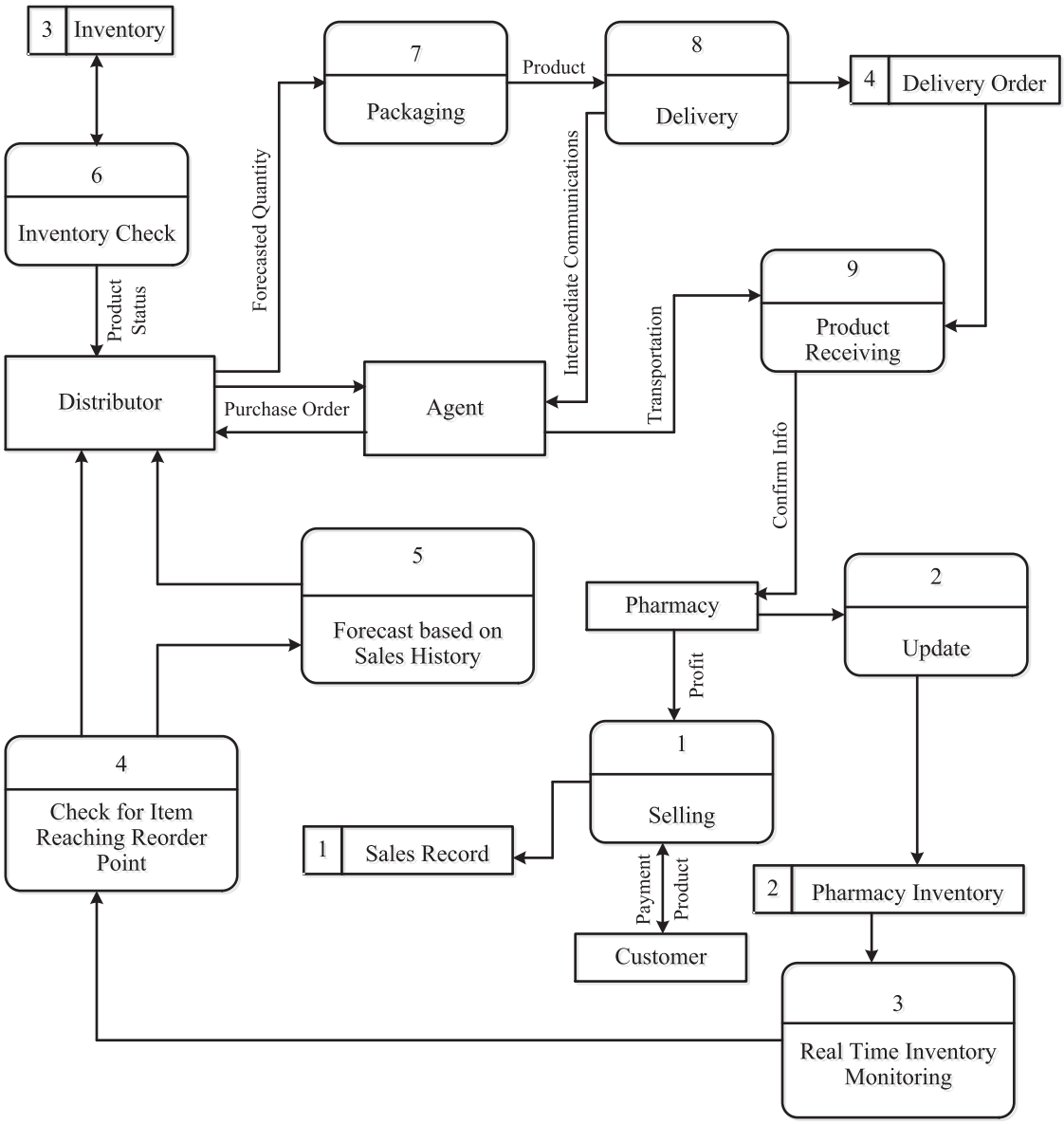

Figure 4: DFD diagram with VMI (Pharmacy-Distributor dyad).

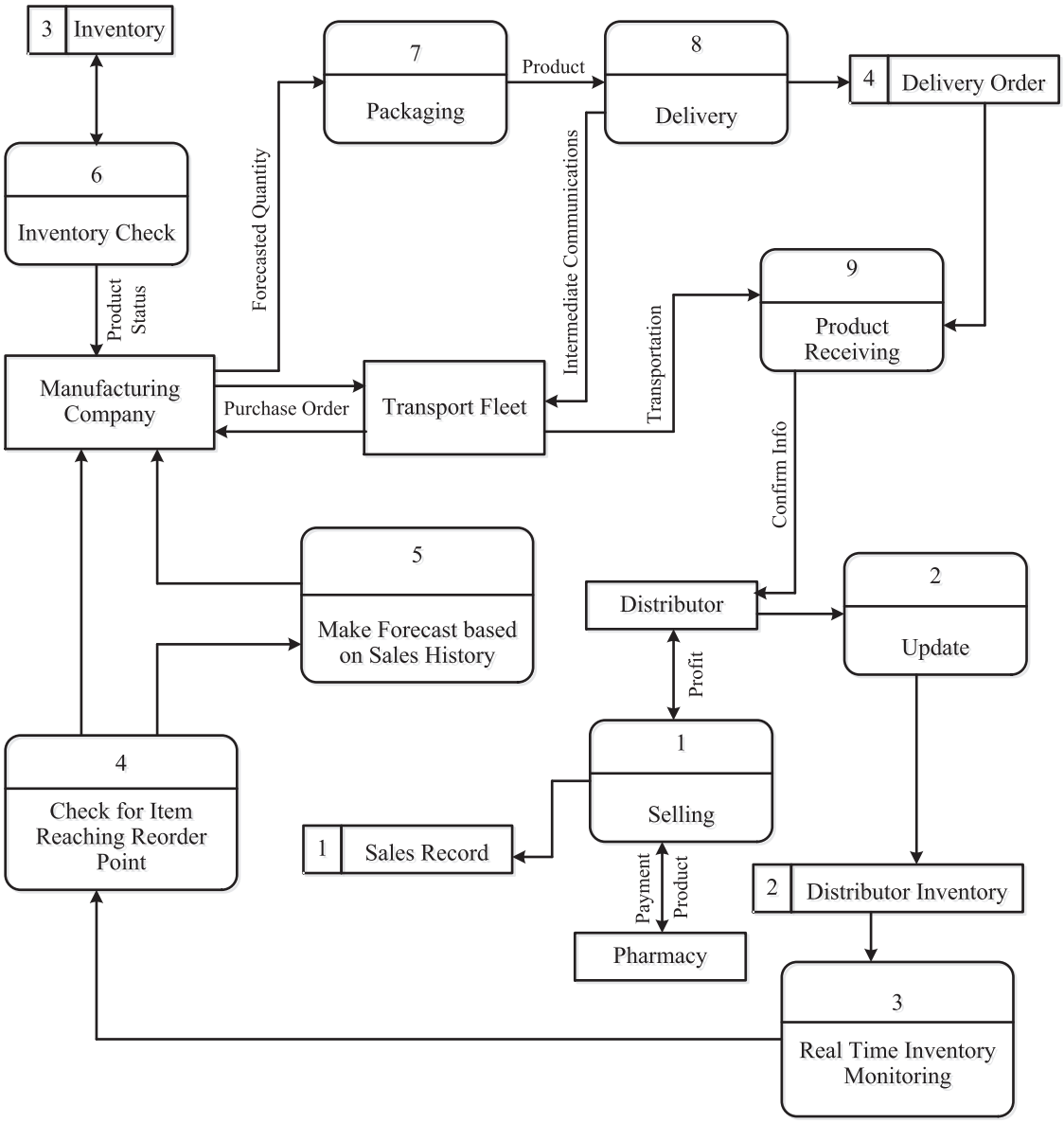

Figure 5: DFD diagram with VMI (Manufacturer-Distributor dyad).

If any medicine falls below the reorder point, the manufacturer will be notified and check own inventory. Then they will package the medicine and deliver via transport fleet to the distributor.

The benefits of integrating VMI across the total supply chain are shown below:

Better forecast: Manufacturer and distributor can monitor the actual pharmacies sales to the customer for VMI approach. In traditional system, the suppliers forecast products based on distributors order. But, by monitoring the sale records of the retailer,

the calculated forecast will be more accurate and better.

Expert handling: Generally, in pharmacy, the key replenishment decisions are: how much to order, how much to stock, when to order, how to stock etc.

Decisions are decided by the retailer himself without any knowledge about those things. In VMI approach, pharmacy decisions are decided and monitored by the production manager or supply chain engineers. Therefore, the chances of overstocking and under-stocking are greatly reduced.

Reduction of bullwhip effect: In case of VMI, the information generated in the retailer's end is the key information. Information is communicated throughout the total supply chain, from the retailer to manufacturer. Thus, bullwhip effect is reduced by VMI approach. However, bullwhip effect has many potential sources, for example, rationing game, order batching, price variation, demand signal processing (See Lee et al. [8]).

Reduced cost: For better forecasting, fewer inventories are required to satisfy the demand. As a result, inventory cost and handling cost is reduced.

Reduce ordering and planning efforts: As experts from manufacturing and distributor's side always monitor the inventory and the sales pattern of the pharmacy. Thus, sales data is used to forecast for the next period. In VMI approach, the replenishment decisions are transferred to the distributors and manufacturers. The retailer does not have any headache to reorder or plan for the next order. Therefore, ordering and planning efforts are reduced.

3.4. Implementation of Electronic Data Interchange (EDI)

Now VMI approach is highly efficient when incorporated with the EDI. The incorporated system facilitates to monitor the inventory of the retailer and the status of each product electronically. VMI works as a stock administrator and develops the electrical channel rapidly, especially between wholesalers and producers with a high volume of products and stores. The VMI procedure is controlled by a VMI engine. VMI engine utilizes verifiable everyday sales information to deliver a schedule plan.

EDI is utilizing business information and VMI engine assists the supply chain to provide full advantage. EDI makes everything easier for VMI. Real-time inventory monitoring is done by EDI. Otherwise, it would have been very difficult to track. In this study, a website is created to allow the supplier for monitoring real-time inventory data of the retailer. This website will facilitate the EDI information between the retailer and supplier.

The website will continuously maintain up-to-date the retailer inventory to the supplier by monitoring the inventory. If any item reaches the re-order point at any retailer or pharmacy, a notification is sent to the corresponding supplier. The supplier will immediately contact with the retailer via integrated messaging system through the website. The lead time is generally constant for small deliveries to the retailers. But the amount to be delivered is forecasted before. The lot size is determined by exponential smoothing

forecasting based on previous 10 weeks sales data. Forecasting procedure is described in the following section.

After receiving the message from the supplier, the retailer will decide whether they will accept the amount of forecasted medicine or not. After the retailer accepts the quantity, the supplier gets the message and physically delivers the medicine via an agent within short period of times.

The website was built by using HTML, CSS, JavaScript, Python, MySQL programs. In this website, all supply chain entities have their own dashboard, where they can see easily their current situation in the terms of sales, earnings, costs etc.

HTML and CSS are the key elements to create the website. HTML is used to create the skeleton of the website, for example, what writings will show on the website, how the webpages will appear etc. CSS is used to produce colors and visual aesthetics. CSS is designed to enable the separation of presentation and content, including layout, colors, and fonts. This separation can improve content accessibility and provide more flexibility. In this study, Python is used to do the back end functioning relating to database update, modify, delete and access through multiple user. JavaScript is usually embedded directly into HTML pages. JavaScript can be also used to accumulate multiple pages. MySQL is a database framework utilized on the web. Both small and large applications can be handled by it. MySQL is used in this study to create and manage databases for inventory management. Some screenshots of the website are shown in Figure 6.

3.4.1. Forecasting of medicine

Forecasting of medicine is a very important aspect in this study. In traditional approach, forecasting is done based on the amount of ordered medicine by pharmacies to the distributor. The same thing goes for the manufacturer. As a result, overstocking and under-stocking are common occurrences. So opportunity costs occur a lot. Customers do not get their required medicines in time. That is why, in this study, the forecasting technique is done based on the original sales to the customer by the pharmacies. Real sales data are considered as the controller of the total supply chain. So, forecasting for the distributor end is done based on the pharmacy's sale. Similarly, forecasting for the manufacturing end is done based on the sales of distributors. As a result, information distortion is reduced and the overall inventory is greatly reduced in total supply chain. Now, the main issue is the selection of forecasting technique. Among various methods, the most suitable technique for forecasting medicine is the 'Exponential Smoothing Equation' (See Papana et al. [11]). This equation takes forecasted amount and actual sales data of the previous time period into account. It also utilizes a smoothing constant to reduce the error from period to period variation. The equation is shown in equation (3.1).

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1}). \tag{3.1}$$

The terminology is given below:

F_t = Forecast amount for next period,

F_{t-1} = Forecast amount of previous period,

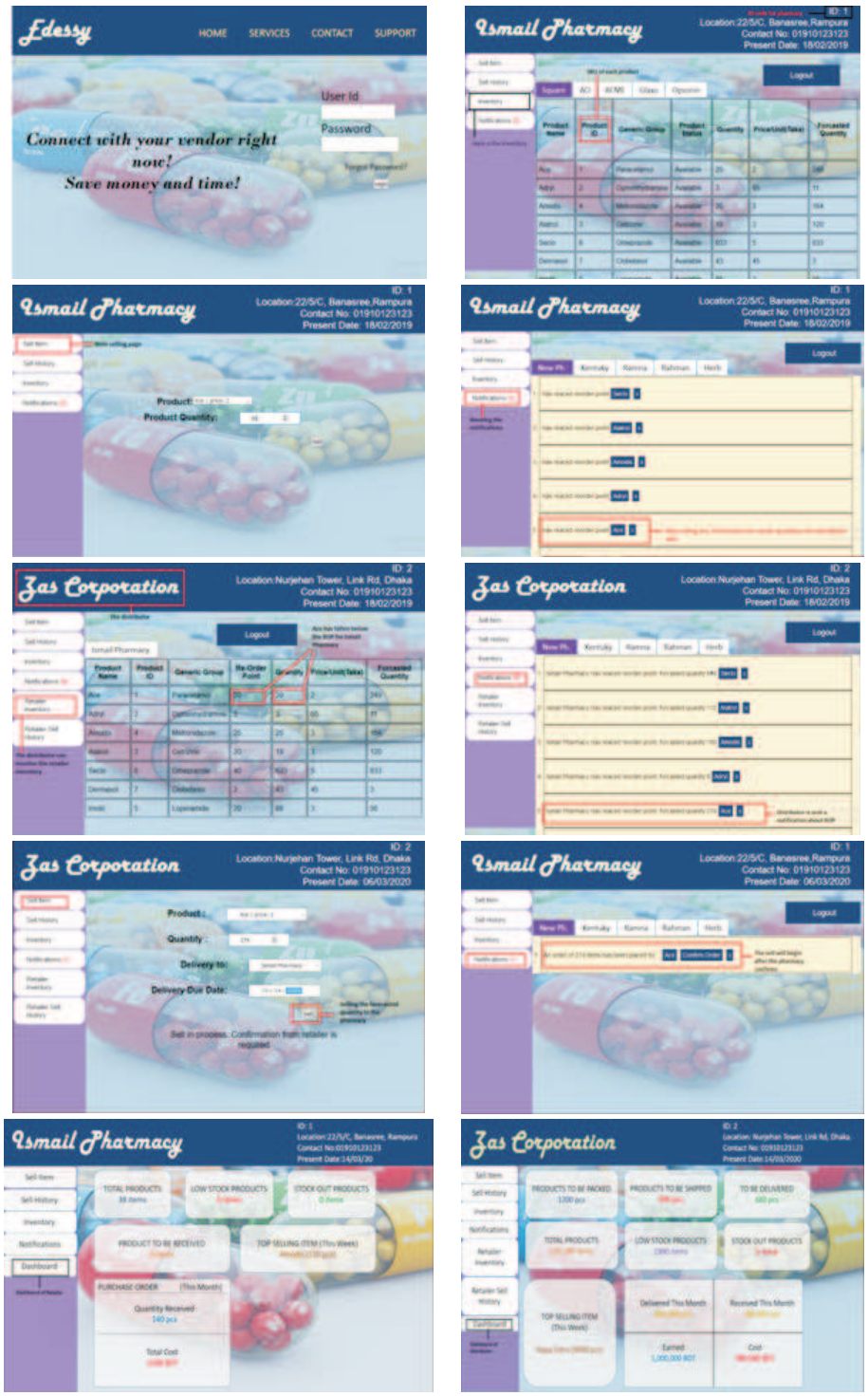

Figure 6: Overview of the website.

α = Smoothing constant,
A_{t-1} = Actual sale of the previous period.

The value of 'α' is taken as 0.2. The functioning flowcharts of the website for retailer-distributor dyad and supplier-distributor dyad are shown in Figure 7 and Figure 8 respectively.

4. Result and Discussion

This study is conducted to mainly focus on the shortcomings of existing SCM and propose a better approach to overcome shortcoming. As a result, a website is created to virtually visualize the total process of supply chain. By implementing the website, diverse benefits could be achieved.

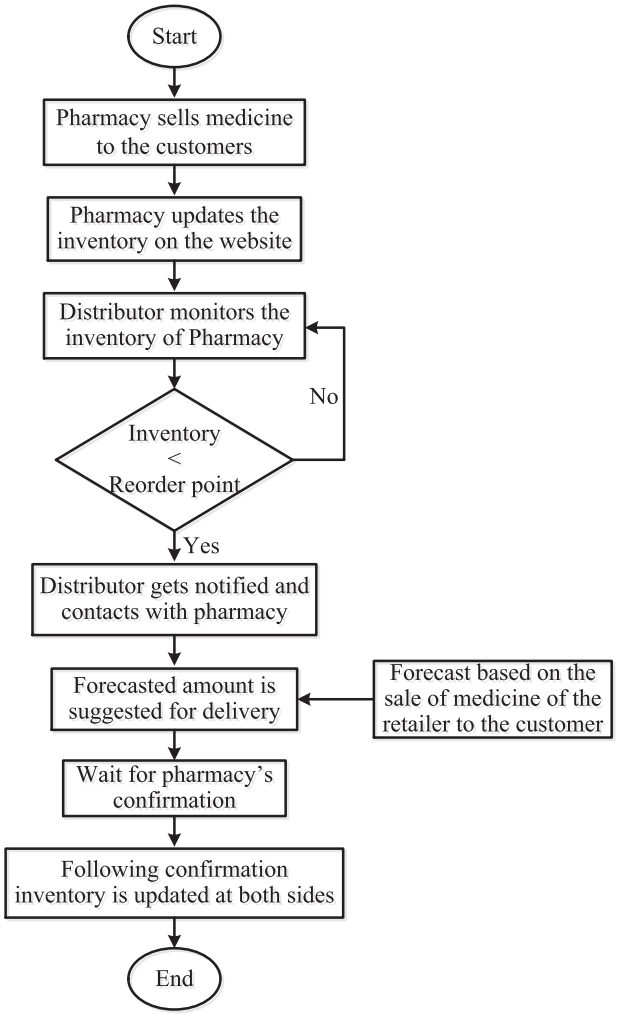

Figure 7: Flow chart of the working process of the website (Retailer-distributor dyad).

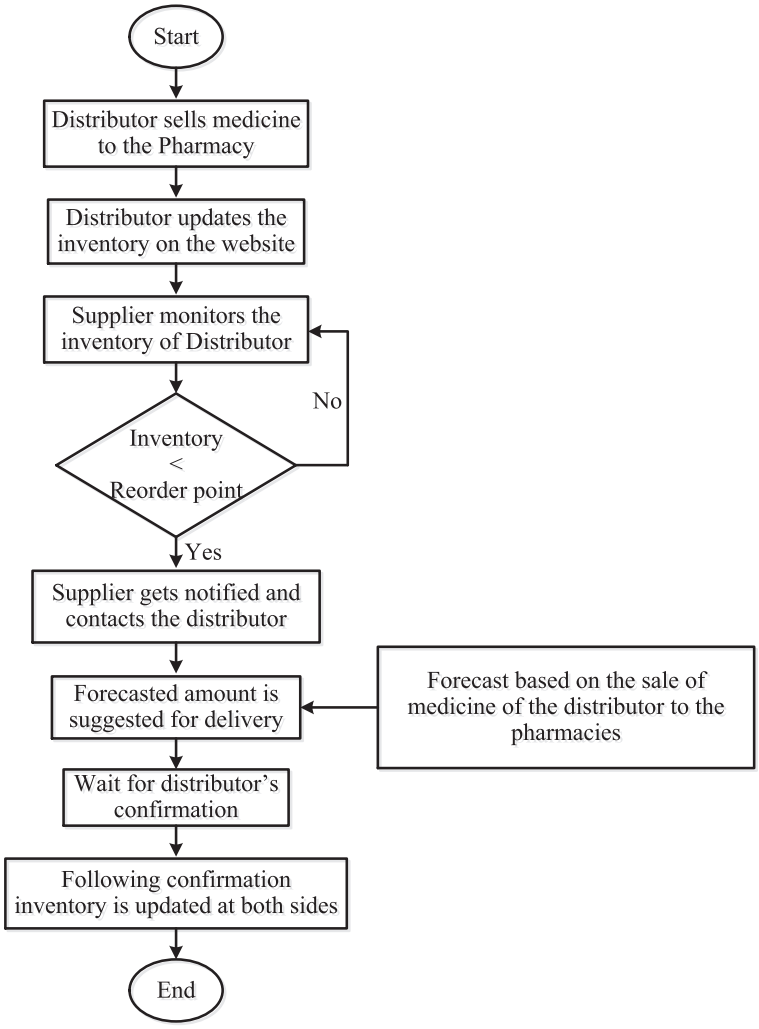

Figure 8: Flow chart of the working process of the website (Supplier-distributor dyad).

There are some key performance indicator (KPI) that can be used to show the benefits of using a coordinated website to facilitate the information sharing. The main KPIs are lead time, average inventory, carrying cost, backorder rate etc. All KPIs are compared before and after using of the website.

Delivery Time: In traditional SCM, two extreme cases can occur. One is worst case and another is best case. Normally, the retailer of the pharmacy sells the medicine to customers. If any medicines is finished or close to finish, he writes it down in a notebook. When an agent visits the pharmacy, the retailer orders the nearly stock out medicines. After collecting the order, delivery time is two days on average.

Now, for best case scenario, the retailer finds a nearly finished medicine or a stock out medicine. On the same day an agent arrives at the retailer. In this situation, the agent takes order and returns with product after two days. So, the lead time is maximum

two days. But in worst case, which is fairly regular event, the retailer finds out nearly finished product after leaving the agent. The agent returns after two days and takes the order. Agent delivers the ordered product after further two days. So, it is going to take four days to receive a product after it was found to be finished. A summary of this discussion are shown in Figures 9 and 10.

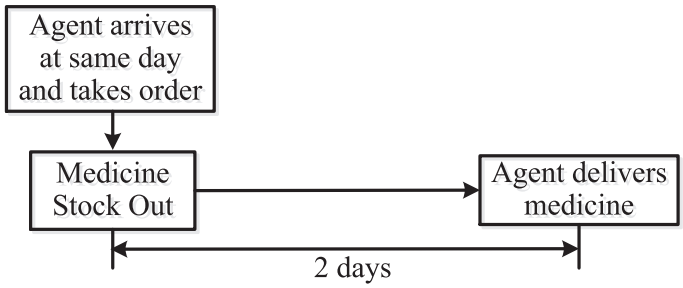

Figure 9: Time Required to Delivery in Traditional SCM (Best Case).

Figure 10: Time Required to Delivery in Traditional SCM (Worst Case).

In proposed VMI approach, any medicine reaches reorder point at the retailer's end, the distributor notifies the retailer and takes an order immediately. The agent delivers the product within two days. Here, in the worst case, it will take two days. But in the best case, stock out may occur before noon and the agent may deliver the product in evening. That's how the performance is improved by using VMI approach. Figure 11 and Figure 12 show the time may require in the proposed approach.

Inventory: Carrying inventory is largely dependent on the delivery time and lead time. For this KPI, a medicine is selected to show the improvement.

Amodis is a medicine, which is used in Bangladesh as a medicine of diarrhea and dysentery phenomenon. In rainy season, it was observed that, on average in every 30 minutes a customer buys Amodis and each person buys on average 4 pcs of Amodis. On average, a pharmacy is open for 14 hours in a day. This leads to 28 customers in a day. So, on average, in one day total quantity of Amodis sold to customer $= 28 \times 4 = 112$ pcs. In traditional SCM, for worst case, the retailer has to store at least for four days. So, the total quantity of Amodis required in worst case is $= 112 \times 4 = 448$ pcs. And normally in one box of Amodis, there are 50 pcs. So, the retailer has to order nine boxes of Amodis by considering the worst case scenario each time when ordering.

Figure 11: Time Required to Delivery in VMI approach (Worst Case).

Figure 12: Time Required to Delivery in VMI approach (Best Case).

But, in VMI approach via website, in worst case scenario, the retailer has to store for two days, which will lead to the total quantity required $= 112 \times 2 = 224$ pcs. So, the retailer has to order 5 boxes maximum. So, the average inventory required is almost half of the inventory required for traditional SCM.

By judging two KPIs, it is observed that, the proposed approach shows a lot of potential and provides benefit the entire supply chain. Here, only the relationship between the retailer and the distributor is shown but almost same thing goes for the distributor and the manufacturer. Website implementation will reduce delivery time and average inventory. Thus, it will reduce the carrying cost.

5. Conclusion

The supply chains of the healthcare sectors are still underdeveloped because of lack of experts in pharmaceutical fields. Commonly, the inventory management is generally done by the medical staff, who are good at medicines but not for managing inventory. Different aspects are related to manage inventory, for example, how much to be ordered, when to be ordered, which product to be stored, demand pattern of the required medicine etc. To overcome these difficulties, VMI approach has been recommended in this study. Many renowned companies like Wal-Mart and Proctor-gamble used VMI system effectively and wisely. However, VMI has a very promising future ahead in the healthcare sectors in terms of technology. VMI can manage every aspect of inventory smoothly, quickly and accurately if correctly interpreted. This study is mainly focused on creating a website which will provide the data transparency and reduce information distortion from echelon to echelon and stage to stage. It was observed that, the sales and delivery information are not incorporated among different stages of supply chain. That's why, the bullwhip effect occurred in the supply chain. Therefore, difficulties are arisen in our present health care industry, for instance, emergency order placing, stock out, overstocking etc.

A pharmaceutical inventory management framework has been developed to upgrade the supply chain. The entire inventory network is made by using interview technique from different entity, for example, producers (pharmaceutical organizations), merchants (medicate wholesalers), retailers (facilities and drug stores) and customers (patients). This study was focused on each phase of supply chain network to develop software system by integrating VMI.

Therefore, this study is conducted to save money, time and probably lives. The website can really help to communicate all the stages in supply chain and help to understand the demand of all products of the customers. The more precise forecasting techniques and information sharing among all supply chain stages can overcome many difficulties, such as bullwhip effect, unnecessary costs, etc. The website can also save a lot of time. The retailers are not experts in the supply chain or inventory management. So, they make many wrong decisions while ordering for products and do not take account of the costs or efforts for giving wrong orders. The website can help to facilitate the communication of all necessary information for business. Any person related to supply chain of medicine can monitor the inventory and take ordering decisions easily. Thus, this study will improve the present supply chain in the healthcare sectors. Moreover, this study will also improve inventory management throughout the total supply chain.

6. Limitations and Recommendations

This study is conducted to cover some necessary aspects of the supply chain in the healthcare sectors. However, some limitations cannot be overlooked. The limitations of the study are:

- The raw material provider could not be included in this study, as they are foreign companies and did not disclose the information regarding them.
- No cost-benefit analyses are not included in this study.
- No cash flow is added in the website. For online transaction, credit card systems or online bank systems should be implemented in the system. So, cash on delivery system is suggested.

There's still a lot of room for improvement. For the future study, few things can be recommended:

- The proposed approach requires a lot of trusts and mutual understandings. A more sophisticated approach can be developed to improve the performance of the system that may require less understanding.
- This study focused mainly on city areas. But the rural areas can be taken into account in the future which may require a totally different approach.

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