Supply Chain Insider
Volume 07, Issue 01, 2022. 163-181
Article Received: 17-04-2022
Accepted: 28-08-2022
Available Online: 30-08--2022
ISSN: 2617-7420 (Print), 2617-7420 (Online)
www.supplychaininsider.org

Managing Supply Chain Disruption Risks in Pharmaceutical Supply Chain through Reverse Logistics

Taki Tajwar, Tasnia Islam, Debnath Saummya Protyay, Mahdia Akter, Namira Afrose

Abstract - In recent years, reverse logistics has received increasing attention in supply chain management (SCM) due to the economic, political, and environmental reasons. The aim of this study is to show that supply chain areas like lead time can be improved through well management of supply chain (SC) disruptions using Reverse Logistics Network (RLN). Uncertain parameters are one of the challenging characteristics of RLN to improve complex SCM network like that in pharmaceutical industries. We state here that by optimizing RLN design with the use of a centralized hub system product delivery time; recycling technique; disposing ways of outdated products will be managed at a greater efficiency hence minimizing operational cost while meeting the demand of that period.

Keywords - Supply Chain Disruption, Risk Assessment, Reverse Logistics, Redefine, Forecasting, Demand Supply Optimality, Pharmaceutical Supply Chain

1. Introduction

Human body and every aspect of human life is connected to pharmaceutical industry. We are completely reliant on pharmaceuticals and nutritional supplements to keep ourselves healthy. However, unprecedented or precedent failures may encounter on the way in a complex and large supply chain like that in pharmaceutical. Hence return of pharmaceutical products for reconditioning or for disposing is a problem. Additionally, the quality and authenticity of the product must be maintained throughout the entire process.

In this study, we examine the intricacies of reverse logistics and the issues pharmaceutical businesses face. Returns are no longer seen as a cost burden or a roadblock

to profitability. Reverse logistics address the sustainability issue for pharmaceutical firms with end-of-life products. The market perception was bolstered and the misperception that returns are a cost concern while quality maintains market share was reaffirmed by a discussion.

Probabilistic risk assessment employing fault and event trees; vulnerability assessment using new team-based methodologies for purposeful agents; and decision analysis are the three main disciplines used in industry, from financial services to the process industries. Simulation software puts these into action, and experts then evaluate the results. To meet the new threats posed by terrorism, where probabilistic assessment offers significant hurdles, worst-case and contingent reaction scenarios have been devised. (Grossi, 2005)

This is the reason why Crisis Management and Emergency Response are now considered an essential component of Business Continuity Planning when constructing an organization's communication framework for managing interruption risk in the event of an emergency or crisis. (R, 2002)

A supply chain's repurposing of materials and products is called "reverse logistics." As the name implies, reverse logistics goes the other way around the supply chain than regular logistics. Reverse logistics includes, for example, the return of unsold goods from a retailer to a distribution hub or the manufacturer. Retailers and logistics companies deal with many customer returns that fall under this category.

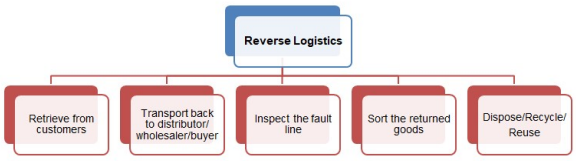


Figure 1: Reverse Logistics Network

Customers often believe that the product's supply chain is complete when they buy it or receive it. There are, of course, exceptions to this rule. A product returned or exchanged by a customer is once again part of the supply chain. The supply chain may have to be retraced to repair or recycle broken, dented, or otherwise unusable products. (Semrow, 2021)

Tracking the products after they have been sold to customers is known as "reverse logistics." Included here could be ideas for repurposing or recycling the outdated goods and any other ways it can provide value after its expiration date. The return of goods from the customer to the manufacturer is one of the most significant impacts of reverse logistics on supply chains. (System, 2021)

In supply chain management, the effectiveness of supply chain members is severely impacted by disruption threats. A growing amount of focus has been placed on supply chain disruption (SCD) to help mitigate risks and improve supply chain performance. (Song Xu, 2019).

2. Literature Review

2.1 Pharmaceutical Supply Chain

A supply chain (SC) is a network of facilities that includes all activities related to the movement of objects and the flow of information required for manufacturers to transform raw materials into completed products and for wholesalers to distribute these products to retailers for sale to end-users. (Belal Chowdhury) A supply chain, in its broadest meaning, encompasses all activities linked to production, raw material extraction, processing, storage, and transportation. (D Butler, 2009) It is a multi-step process in which a group of companies (suppliers, producers, distributors, and retailers) collaborates to transform raw resources into finished goods and deliver them to end-users.

Relationships, organizational networks, and multifunctional processes are all part of supply chain management (SCM). The adoption of SCM methods must ensure that the flow of data and information between suppliers, distributors, manufacturers, and customers are completely transparent. As a result, SCM focuses on procurement and contract management from the standpoint of material management. As a result, a sufficient information flow is required, with information systems playing a key role.

According to Agência Brasileira de Desenvolvimento Industrial (ABDI), the value flow in the Brazilian PSC begins in the chemical industry, continues through the pharmachemical sector, passes via distribution hubs, and culminates in the delivery of the completed product to hospitals and stores. Zahiri et al., on the other hand, divide the structure into five layers (primary manufacturer, secondary manufacturer, main distribution center, local distribution center, and demand point). Medical experience and safety are the primary goals of the medical sector. The Food and Drug Administration (FDA) and member nations regulate the pharmaceutical business through legislation and administrative actions aimed to protect the integrity of medications throughout the pharmaceutical supply chain. (Mitchell, 1998)

The execution of SCM methods must ensure that the flow of data and information between suppliers, distributors, manufacturers, and customers are completely transparent. (Kokilam, 2016).
Based on a material strategic approach, SCM focuses on procurement and contract management, (Kokilam, 2016) Remote Method Invocation (RMI) (also defined as speculative capacity) and reserve capacity (also referred as reactive capacity) research focuses on dealing with demand uncertainty in a variety of situations, including multi-product environments, unanticipated rises in demand, demand with wide base (Reimann, 2011) (Huang, 2016) (Biçer, 2017).

The majority of supply chain disruption risk literature concentrates on supply hazards, ignoring the impact of demand uncertainty on

risk mitigation techniques. The execution of SCM methods must ensure that the flow of data and information between suppliers, distributors, manufacturers, and customers is completely transparent. (Kokilam, 2016) The majority of supply chain disruption risk literature concentrates on supply hazards, ignoring the impact of demand uncertainty on risk mitigation techniques. Drugs travel through a chain of distribution that includes numerous parties.

A producer, a distributor, and a retailer are examples of these types of businesses. The quality of a unit of the drug product may be tested by a regulatory authority, like the FDA, before or during distribution through the supply chain. Blockchain Technology for Detecting Falsified and Substandard Drugs in Distribution: Pharmaceutical Supply Chain Intervention (Jamil, 2019)

2.2 Reverse Logistics

Reverse Logistics

Numerous firms and industries can benefit from reverse logistics. The following are some typical scenarios that necessitate reverse logistics solutions:

Refunds: For items returned in accordance with a warranty.
Returns avoidance: Reverse logistic methods focused towards decreasing returns by leveraging local repair partners or support websites
Remanufacturing: Constructing goods with a mix of new, refurbished, and recycled components
Refurbishing: Fixing returned items so they can be sold again
Packaging: Use sturdy packaging that can be returned up the supply chain to be used again.
Unsold products: If specified in the contract, return of unsold items to the producer
End-of-life: Reuse, recycling, or collection of products after the end of its useful life
Delivery Error: Product returns are possible in situations where deliveries go wrong, as when a customer refuses a delivery. Leasing and renting Returns of items that have been leased as well as rented for a set period of time.
Repairs and upkeep: Return of goods for repair and maintenance.

RLN has benefits in SC like streamlining the flow of goods so that risks causing delay are minimized. This happens because of better demand forecasting as RLN is optimized.
Best Practices for Reverse Logistics

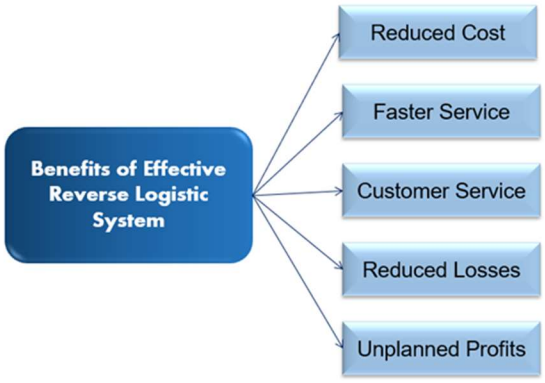
Any business focused on the sale of commodities must include logistics and reverse logistics. Some best practices of RLN include

Figure 2: Benefits of RLN

- Making a thorough plan for disposing of customer-returned goods.
- Creating specific codes to identify the causes of returned items, and create plans that are appropriate to address the underlying issue
- Establishing a clear reverse logistics flow for both information and items by working with specialists.
- Calculating the true cost of returns and the reverse logistics options.
- Collaborating with supply chain partners to improve overall efficiency by teaching them the best practices for reverse logistics.
- Making sure the supply chain channel can track information about returns.
- Consulting partners to create cooperative reverse logistics efforts and methods.
- Determining the causes of reverse logistics chain disruption and take targeted, practical steps to eliminate them.

2.3 Pharmaceutical Reverse Logistics

Reverse logistics enables industries to behave in an environmentally friendly manner. Manufacturers are responsible for collecting the items that have ended their life cycle or found faulty/broken and delivering them to the appropriate location in reverse logistics. Packaging materials such as plastic, metal, and glass can be collected, repaired, and changed into new items that can be sold in the



same or a different market. The reverse supply chain refers to the flow of returned materials.

Some goods' life cycles can be extended through reuse or recycling. Other products must be disposed of, and only a portion of their packaging can be reused; therefore, reusing or reselling the product is not an option. Knowing the residual value of a returned item might help increase participation in the recycling process.

Given the vast amount of goods and the money involved, reverse logistics solutions are crucial for the pharmaceutical business. When adopting reverse logistics in the pharmaceutical business, it is important to take into account the transparency of the returned products, automation as a cost-saving measure, the security of items clients return, and the final phase of disposition.

In addition, reverse logistics has been identified as an active component of green supply chain management (GSCM) techniques in the literature. In addition to applying new techniques, GSCM entails reactive monitoring of general environmental management programs and a shift toward more proactive actions such as recycling, recovery, reverse logistics, and remanufacturing. GSCM methods are integrative, rather than being focused on a single function or department, which promotes motivation and cooperation among the chain's participants.

To provide an environmentally safe recovery procedure, Manufacturing readiness Level (MRL) includes the collection and recycling of medicines returned back to producers. Expired pharmaceuticals, unlike products in other chains, such as electronic product chains, where the market value can be regained, have no market value. This distinguishes MRL. However, before their expiration date, some drugs collected from the internal SC might be returned to stock and replanted for usage. In contrast to a "second life" through remanufacturing, these products can have a "second chance of usage."

Visibility of inaccessible, trustworthy, and secure supply networks is becoming increasingly vital as the supply chain is becoming more complex than it was a decade ago. (Jamil, 2019)

3. Supply Chain Disruption

"Disturbance or difficulties that impede an occasion, activity, or process" is how disruption is defined. A supply chain disturbance is defined as an interruption in the flow of goods from the factory to the customer. While the analogy of a "broken link in a chain" used to work, today's complicated supply linkages are rarely so simple. Supply chain coordination may be compared to cogs in a machine that must mesh at the same time. As a result, disruption causes everything to come to a halt at the same time — the proverbial spanner in the works. To quickly define a few phrases in this regard, a hazard is an incident that has the potential to affect your supply chain. The prospect of loss or problems as a result of the threat is referred to as a risk. The threat, in our idiom, is the wrench. The risk is that the wrench will be dropped into the machine. The machine's cogs will then stop turning, and the mechanism will break down. This results in a variety of expenditures, such as machine repair, lost labor hours, and so on. Understanding supply chain disruption risk entails determining what could go wrong in the supply chain and the degree of the harm that would result if it did.

The worldwide cost of supply chain disruption caused by the coronavirus epidemic has been tremendous – several amounts of times so far – and the repercussions have included a growing interest in onshoring or nearshoring for essential businesses.

When products do not reach customers on time, the cost of supply chain disruption

includes revenue loss for individual businesses. However, disruptions in supply chains and shipments result in a variety of additional expenditures.

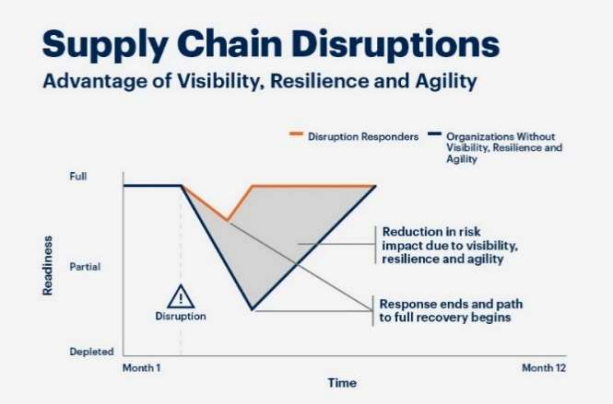


Figure 3: SCD Responders vs Non SCD Responders

Whenever parts are unavailable, for example, productivity is lost when workers sit idle. Around the same time, finding and onboarding other suppliers is time-consuming. Further consequences of supply chain interruption include a tarnished reputation, which encourages clients to shop around. Despite its achievements, the pharmaceutical supply chain still has a lot of obstacles to overcome.

According to a report from researchers at Imperial College of Science, Technology, and Medicine, all companies with an effective supply chain adhere to a four-step process that includes demand management, inventory management and distribution, supplementary production planning and scheduling, and primary manufacturing.

The global information analytics business touched on a variety of process difficulties, including a lack of coordination, inventory management, a lack of demand information, reliance on human resources, order management, temperature regulation, and shipping visibility.

One important business step is to investigate any supply chain disruptions using the "Forrester impact," for instance. The principal manufacturing site, however, exhibits the Forrester effect, which poses a problem since it is the least sensitive link in the supply chain, according to the study.

Due to this, it is challenging for firms to effectively address issues like supply shortages, national supply tenders, and epidemics.

Researchers claim that the drastic makeover involves new methods for evaluating, approving, and monitoring medications, new models of healthcare delivery, more diverse product kinds, therapies with shorter lifecycles, and several other modifications.

In general, the pharmaceutical supply chain is essential for ensuring that patients may obtain the pharmaceuticals they require without experiencing stress or obstacles along the route. Although the supply chain encounters a number of obstacles, businesses can take the required measures to ensure a smooth procedure from product creation to patient delivery.

4. Types of risks in supply chain (SC)

Numerous precedent or unprecedented risks may occur on the way of SC. However, this research paper focuses on the most common risks that have impacted SC in the pharmaceutical industry (PI) of Bangladesh at a large scale.

To broadly classify there are two types of risks - internal and external

1. **Internal risks:** An occurrence caused due to poor system communication, employee performance that may lead to disruptions in manufacturing facilities, operational inefficiencies, and low-quality products.

a) ***Operational risk*** is described as the risk of financial damage as a result of insufficient or failed internal procedures, people, or systems. Operational risks include issues with quality, delivery, and service.

b) ***Lead Times*** is the time it takes to obtain products and services from the supplier and then putting into the hands of the user is known as lead time.

c) ***Order Cycling Time*** is the average time it takes to ship an order from the time it is placed, except actual shipping time, and is an important metric to track in the order fulfillment process because it aids in measuring operational efficiency.

2. **External risks:** An occurrence caused by external sources such as weather, earthquakes, political, regulatory, and market forces is referred to as external risk.

a) ***Accidental risk*** is an unforeseen risk that results in losses and is normally covered by an insurance policy, such as a fire that causes personal harm, damage to equipment, materials, or the environment.

b) ***Catastrophic risk*** is where a significant number of people are exposed to the occurrence which can be man-made or natural, examples include a climatic catastrophe induced by global warming, pandemic like the COVID-19 outbreak, or an epidemic such as Ebola or a underwater volcanic eruption like that in Hunga Tonga.

c) ***Supplier risk*** is described as the risk posed by the supplier network's structure, such as ownership, individual supplier strategy, and supply network agreements.

d) *Demand shift for prescribed medicine* is the risk when the medical drugs are discouraged by specialists for the side-effects and vulnerability that might arise in the consumers' body. This case diminishes the demand and results in the fluctuations of drug intake.

3. **Other**: Unprecedented or invisible activities that may impact supply, demand but are now rare in Bangladesh are regulatory risk, organizational change, geopolitical risk, political and civil stability.

4.1 Consequences of Supply Chain Disruption (SCD) Risk

The problem in the current PC industry is caused as products are not tracked at the end of the SC. Products are not produced as per demand as demand is not properly forecasted. The way our model works is through the following:

- We assess risk and measure which is causing the most disruption
- We implement the solution of creating a central hub to manage delays while products return and better manage them with proper disposing technique
- As this happens, products will be better tracked and demand will be better forecasting optimizing the SC.

In Figure 4 and Table 1, we have accumulated the risks from primary and secondary data and found these risks to be the highest causing and the hub system that we proposed has the solution to the highest causing risks.

Risk Probability	
Risk Type	**Probability**
Operational	21
Order Cycling Time	17
Lead Times	16
Supplier	14
Accidental	12
Catastrophic	10
Demand shift for prescribed medicine	10

Table 1: Survey Data

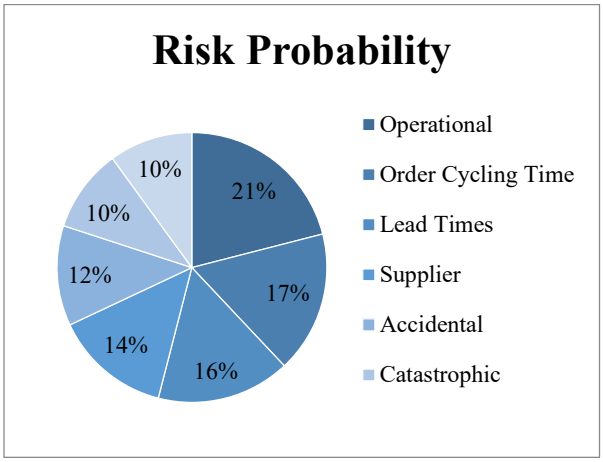


Figure 4: Risk Probability

The consequences of this SCDR as shown in Figure 3 has an impact on how end customers receive the product, its price, quality, availability, service and so on. We worked to frame the model first by finding out how the risks can cause an impact, which risks are more probable, what impact it can possibly have, and how it can be managed in an optimized way using a reverse logistics network (RLN). The causes are stated in Figure 4.b)

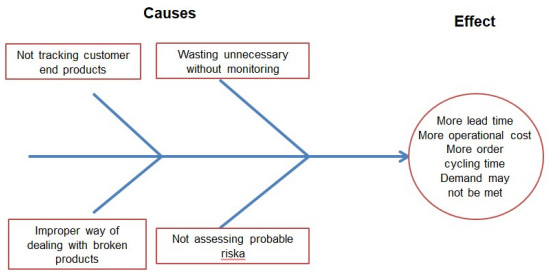


Figure 4.b) Cause and Effect Diagram

4.2 Model Development

This is our conceptual framework as shown in Figure 5 of assessing and managing SCD risk so that product returns can be handled in an efficient manner and if product returns are handled efficiently then by reusing, proper waste management and demand forecasting, then the above-mentioned risks will not cause delay in supply chain resulting in faster movement of products and fast replenishment in times of crisis.

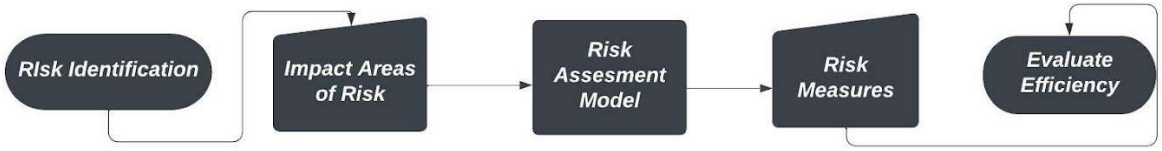


Figure 5: Conceptual Framework

Risk Identification

The risks discussed here needs to be identified every month by doing dynamic time series risk forecasting model and placed in a table by addressing which risks is the most concerning then example in 2021, catastrophic (COVID-19 pandemic) is to be the most prioritizing issue.

Impact Areas

In the next step we need to find out the impacted areas due to the disruption, if it affects the supply, demand, stakeholder, or let products go outdated etc, once sorted what the impact is, accordingly action can be taken. With the example of COVID-19, we can say that one of the impacted areas were the supply of drugs as the virus was swiftly mutating.

Risk Assessment Model (RAM)

A RAM tells us what to focus on and a visual matrix needs to be created so that non-technical teams can also understand the report and act. Hence a following template will be followed to assess the risks in a visual manner.

Figure 6: Risk Assessment Model

Risk Measures

The risk measures are actions that need to be taken based on the risk analysis data during time. As per our proposed framework, products that are not used, expired, returned, obsolete, no longer needed by the end customer, will be returned and which will be monitored in a proper technique so that even if products cannot be recycled and had to be disposed of, will be more efficient than the traditional process.

Evaluate Efficiency

A mechanism to evaluate efficiency depends to what factor will be used to calculate efficiency.

For lead time efficiency: $\frac{value\ added\ time}{cycle\ time}$

For order cycle time efficiency: $\frac{delivery\ date - order\ date}{total\ order\ shipped}$

For cost efficiency: $\frac{net\ of\ interest\ revenue}{expense}$

Through the probability analysis we can predict the risk and the consequences coming with it. This will allow us to predict the situation and take countermeasures likewise. There are a number of approaches to enhance the efficiency through it, but practically Relative Frequency Approach will be more effective in this case.

5. Proposed Framework

Redefined Reverse Logistics Network

Products from pharmaceutical company or warehouse will be sent to a central zone as referred as the hub, in that products will not have to be sent all the way back to the SC. in that cost will be reduced. The hub has referred will have segregated departments, first customer end products will be sorted

Then products will go to the hub where it will be segregated using automation later disposing or reutilizing it as per the need. We have discussed how the medicines can be processed after it is returned down the RLN.

Customer End Returnable Goods

Customers rather than throwing away the medicine in the sink they will send the unused medicine in a separate bag. Dropping off unused or expired drugs back to a drug store/pharmacy, location, or program as soon as possible is the best way to dispose of them. People who collect will be instructed to collect medicines separately from the user. at the same time awareness programs have to be implemented for people to give their medicines either to local drug store, or have a dedicated person for collecting the medicines from waste paper buyers, or they can hand over the unused medicines in a separate bad to the waste collectors as summarized in Figure 7.a.

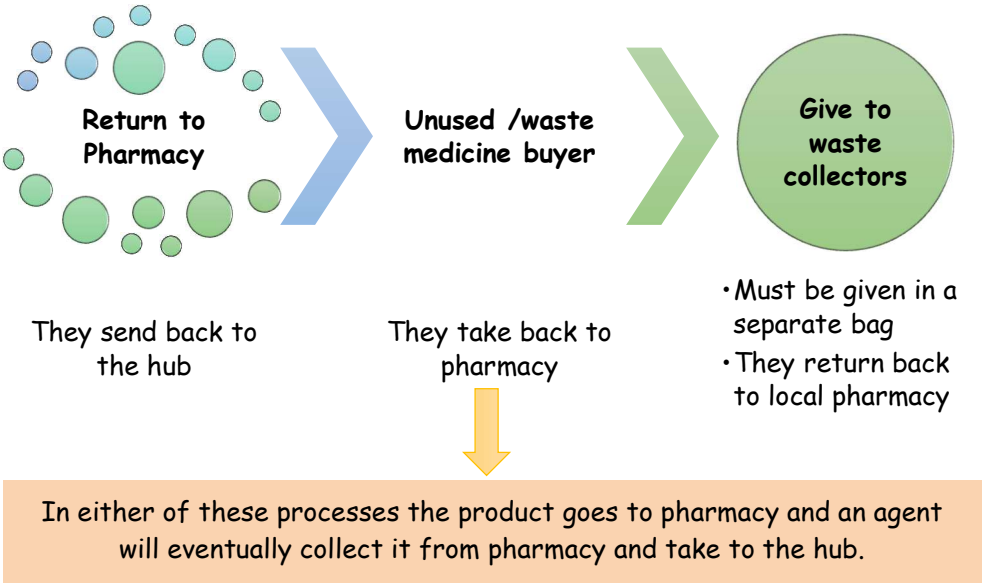


Figure 7.a: Return of Goods from Customer to Pharmacy

RLN Hub for meeting efficient demand

When the Pharmaceutical medicines are expired or returned when there is no demand or excess supply, they are returned to the factory for further processing. After returning

to the factory, drugs and other pharma-chemicals are divided into three categories:

- Destroyed
- Redefined
- Breakdown and reuse

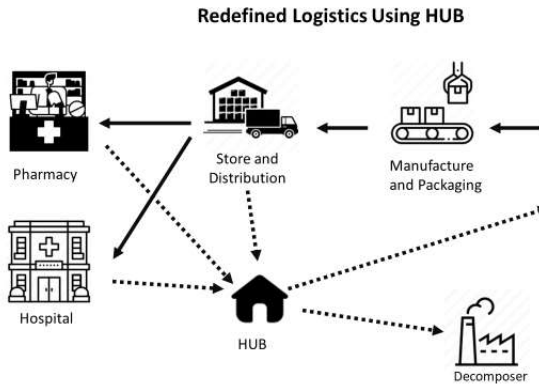


Figure 7.b: Redefined Reverse Logistics Network

Destroyed: Some medicals drugs when expired, not usable, or excess are simply

destroyed. And cannot be reused or even the materials produced are toxic and cannot be redefined in any way. Here the penalty cost is high since the produced good is totally not usable and has to be destroyed resulting in no return and ending in extra costs.

Redefined: There are some drugs when out of date can be redefined by adjusting the power and its components viz- A certain medicine of 50 mg is expired, then adding another 25/50 mg to it, can again make the medicine usable, and the lifetime is again restored for a certain long period of time.

Breakdown and reused: There are some chemical components that hold a long lifetime and usability through a long time and are even reused by extracting a compound chemical material. Some drugs have such high usability components in they, can be reused after the breakdown of the previous drugs. This saves the cost of raw materials to some extent and the process is efficient for a quite good number of drugs components.

These are the activities that are done for the medicine that is expired or returned to the factory for other reasons.

The RLN discussed in this paper and shown in Figure 7.b) is a closed loop, centralised, model. We have developed an optimal collection framework to determine the initiation of collection centers, recycling centers in order to minimize the total cost. The proposed model is to reduce transportation, storage cost as it goes beyond the SC while in Reverse Logistics. The hub makes the process efficient due to better collection system and reducing internal operational cost.

6. Risk Mitigations and Impacts

6.1 Lead Time Reduction

Lead time is the difference between the time taken and the required time between the processes.

Our proposed model puts an impact on the reduction of the lead time since the reverse logistics gets strengthened and puts an effect in analyzing the workflow and also allows the process to smoothen by bringing the returned products in an organized manner. That enables the maintenance of the already produced medicines and determines the demand and requirement to build for the next slot after the redefined and reused products.

We can determine the lead time by using the formula

Lead Time = pre-processing + processing + post-processing

where:

- Pre-processing is a time needed for handling the order, making sales order, and preparing supplies;
- Processing is a period when you make or collect the order.
- Post-processing is the time of delivery.

6.2 Ordering Cycle Time Reduction

Order cycle time is the amount of time, not including actual shipping time, typically takes to ship out an order once it has been placed. Because it enables gauging the effectiveness of the operations, it ranks as one of the most crucial KPIs to monitor in the order fulfilment process.

To determine how much time spend generating one unit, the Total Cycle Period calculation considers both Net Production Time and the number of units generated during this time.

Cycle Time = Net Production Time/Number of Units made

Faster time to market and, if other cost considerations are kept in check, a chance for greater profitability are two benefits of cycle time reduction. Cycle time reduction also makes a company more competitive with rival companies that provide comparable goods to the same clientele.

6.3 Operational Risk Mitigations

An advanced reverse logistics can be the factor behind the successful maintenance of the overall system allowing to deal with the operational flaws that lead to disruptions and result in loss. It is necessary to depict the spots in the operations in the existing chain to upsurge the profit and utilize the chance to develop the entire chain resulting in a more significant benefit for the company and business.

6.4 Demand Forecasting

Sometimes product is either at high supply with low demand or at high demand but with low supply. Since medicines are sensitive products, they need to be stored, handled delivered carefully.

High supply with low demand this indicates there is a surplus of products in the warehouse or at the pharmaceutical industries. They will return the surplus to the hub whereas mentioned earlier, depending on the scenario they will be either be destroyed, redefined, breakdown or destroyed.

Low supply with high demand in this case more supply is needed which means more operational cost, more wastage and if this RLN is optimized waste can be minimized while lowering operational costs and more

medicines need to be supplied so process will be optimized.

Based on a recent survey, we noted down some commonly used medications that are available in pharmacies almost all the time. So, in this survey, we tried to portray the demand and supply relationship. According to the information we have gathered by doing surveys from the different pharmacies we came to know that there are some medicines that have the same demand and supply so, they are maintaining the equilibrium. Some other medicines are like they are more demanded but supply is less and some are less demanded but supply is more. So, we portrayed a graph to represent the value that we have collected.

Medicine	Demand	Supply
Cap. Vita D3 (40000)IU	5	3
Cap. Retinal forte (50000)IU	4	2
Cap. E-cap 200mg	3	3
Tab. Cevit/Vasco 250mg	5	5
Tab Folic Z	3	4
Tab. Zinc 10mg	4	4
Tab Famotack 20mg	4	3
Tab Zimax 500mg	4	4
Tab. Palioxiio 0.5	3	2
Tab Algin 50 mg	4	5
Xpa XR	5	4
Ace Plus	5	5
Napa Extra	5	5
Tenil	5	3
Fexo	5	5
Dextromathorphen	4	4
Tufnil	4	3
Clob	4	5
Metronidazole 400 mg cap/tab	4	2
Albendazole 400 mg cap/tab	3	4
Setra 50	4	4
Ripose 5 mg	4	3

Table 2: Survey of medicine demand vs supply

For the survey, we approached the pharmacies and made a list of around 20 medicines of various groups as per the commonality and availability among them. We considered a scale of 1 to 5 to demonstrate the demand and supply levels accordingly.

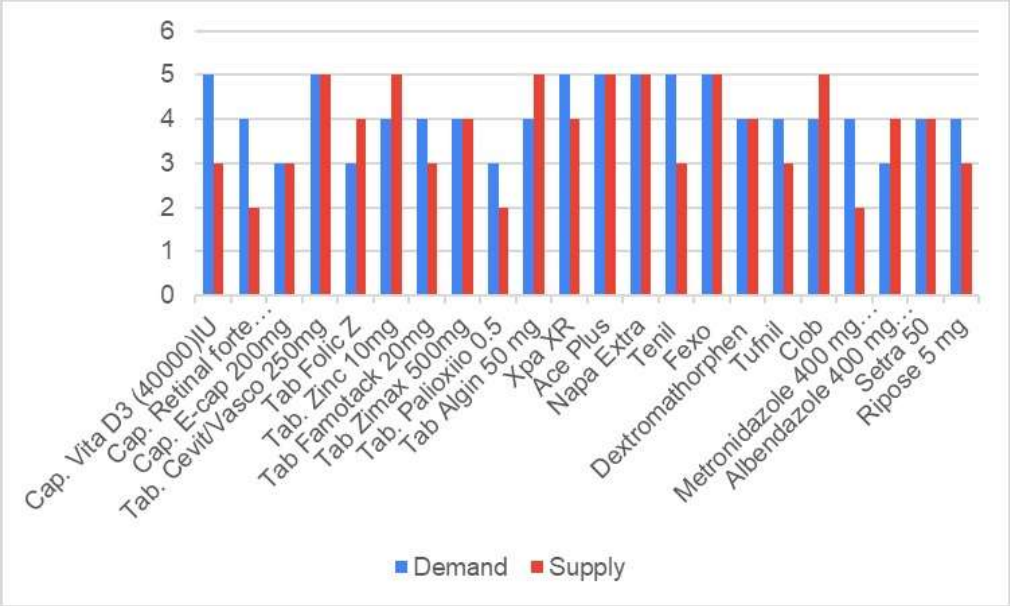


Figure 8: Demand Supply Survey Outcome

So, from the graph we can realize that demand does not always meet the supply, and sometimes supply is in surplus but the demand is less. So, it always varies all the time. This put an effect on the supply chain differential management most of the time.

For our collected set of data, we can notice the equilibrium and fluctuations. Of the present data set, we can identify the probability of equilibrium and its shift at the time of collection of data.

Probability	Total	22
Equilibrium	10	0.455
Higher demand	8	0.364
Greater supply	4	0.182

Table 3: Medicine Demand-Supply Equilibrium Probability

The developed RNA allows for accurately depicting the demand flow and detecting the proper requirements to meet the existing demand precisely. Forecasting the market more accurately can give a massive

advantage in the entire supply chain and help increase the graphs of business returns alongside meeting the order as required. As the updated RNA will allow to use and reuse the medicine or its elements meeting the production requirement and also giving us the picture of the exact requirements.

6.5 Profit maximization

Businesses go through the process of profit maximization to ensure that they have the highest output and price levels to maximize their profits. The company modifies impacting parameters to hit its profit goals, including sale price, production costs, and output levels.

Profit maximization is a goal in business, but it can be detrimental to the consumer if, for

instance, lower-quality labor and materials are used or if the company decides to raise project execution costs only for profit. Any business must be profitable to survive. Profits are the appropriate metric for determining the feasibility of a business plan. Without earnings, the company loses sight of its main mission and faces a direct threat to its survival.

Profits in a firm reflect efficient utilization and allocation of resources. Land, labor, capital, and organization allocation of resources and payments contribute to cultural - financial well-being.

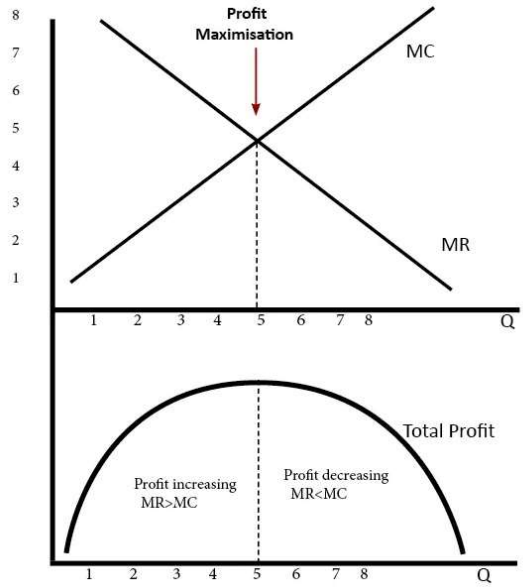


Figure 9: Profit Maximisation

The increase in income that occurs from the sale of one additional unit of output is known as marginal revenue (MR). While marginal revenue can remain constant over a specific amount of output, it will eventually slow down as the output level increases due to the law of diminishing returns. The difference between the total cost of production and the cost of creating or producing an additional unit is known as the marginal cost of production. Finding out when an organization might experience economies of scale to boost productivity and overall operations is the goal of marginal cost analysis. If the marginal cost of producing one additional unit is less than the per-unit pricing, the producer can turn a profit. If the overall supply chain in the pharmaceuticals industry improves, then marginal revenue will increase. Enhancement of marginal revenue can reduce the marginal cost for the industry.

	Units	Cost (per unit)	Total Cost	
New Demands	200	80	16000	
Expired/ Disposed (Used after refined and break down)	50	45	2250	Savings through redefine and breakdown
Adjusted production	150 + 50	(150*80) + (50*45)	14250	1750

Table 4: Profit maximization calculation

We are assuming that there is a demand for any particular medicine. Making all the product fully with new elements cost higher rather than if we refined the expired or disposed products. This will eventually be a cost-efficient process. This approach will help to save more and also fulfill the demand for the product in the market. Refine products can be used for cost efficiency that will help the pharmaceuticals industry reduce its cost and result in increasing the profit.

7 Implementation

Our proposed solution represents the solution to deal with the disruption effects after analyzing the risks. This suggested model can be utilized to avoid the disastrous effects of supply chain disruptions. And also allow the user to focus on the risk and their identification. When the risk is identified and the probability of occurring, this will help to predict the downflows and grant the opportunity to implement respective measures to lessen the loss and gain a better return. Our solution can be considered to detect the risks that the industry faces and their prevention to increase the optimality of the entire system.

8 Conclusion

As we try to optimise use of RLN, storage and transportation cost will be minimised, also with the use of hub, extra transportation hassle for emergency demand will not have to be passed with extra storage or other systems, the hub itself will suffice the need. The procedures of reverse logistics and the circular supply chain are the same: items and resources are reused, recycled, or resold. RLN is important because it helps save costs incurred as return rates have increased, implying that an efficient returns process can save your business money, maximize value of goods because repurposing returned goods helps manufacturers increase the value of goods or the sustainability of the supply chain – or both, and finally make it sustainable because consumers are increasingly concerned with sustainability, and repurposing goods achieves greater sustainability. In order to achieve a lean model, we have presented a minimal way to optimize collection and minimize waste.

9 References

Belal Chowdhury, M. U. (n.d.). Challenges Relating to RFID Implementation within the Electronic Supply Chain Management - A Practical Approach. *Software Engineering, Artificial Intelligence, Networking and Parallel/Distributed Computing* .

Biçer, I. &. (2017). Optimal dynamic order scheduling under capacity constraints given demand-forecast evolution. *Production and Operations Management,*, 2266-2286.

D Butler, J. B.-S. (2009). National Academy of Engineering (US); Institute of Medicine (US). *In Systems Engineering to Improve Traumatic Brain Injury Care in the Military Health System: Workshop Summary. Washington (DC): National Academies Press (US).*

Grossi, P. H. (2005). *Catastrophe Modeling: A New Approach to Managing Risk.*

Huang, L. S. (2016). Supply chain planning for random demand surges: Reactive capacity and safety stock.

Manufacturing & Service Operations Management,, 509-524.

Jamil, F. H. (2019). A novel medical blockchain model for drug supply chain integrity management in a smart hospital. . *Electronics,*, 505.

Kokilam, M. B. (2016). Strengthening the pharmaceutical supply chain management with information communication technology intervention: a Windfall to the Indian rural public healthcare system. *Journal of Health Management,* , 274-289.

Mitchell, P. (1998). Documentation: an Essential Precursor to Drug Manufacturing. *APICS The Performance Advantage, 8,*.

R, H. J. (2002). Corporate Business Continuity and Crisis Management as a Strategic Function.

Reimann, M. (2011). Speculative production and anticipative reservation of reactive capacity by a multi-product. *newsvendor. European Journal of Operational Research,*.

Semrow, R. (2021). *What is Reverse Logistics and How Can It Help Your Supply Chain?* Retrieved from C.H.Robinson I Blog: https://www.chrobinson.com/blog/what-is-reverse-logistics-and-how-can-it-help-your-supply-chain/

Song Xu, X. Z. (2019). Disruption risks in supply chain management: a literature review based on bibliometric analysis. *International Journal of Production Research*.

System, N. (2021). *The Importance of Reverse Logistics in Your Supply Chain*. Retrieved from Most Recent Articles: https://www.newcastlesys.com/blog/the-importance-of-reverse-logistics-in-your-supply-chain

Zahiri, B. Z. (2017). Toward an integrated sustainable-resilient supply chain: A pharmaceutical case study. *Transportation Research Part E: Logistics and Transportation Review,*, 103, 109-142.