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# Efficiency Improvement in Reverse Logistics and Examining the Relationships between Refund, Return Policy, Quality Policy and Pricing Strategy in E-Commerce Business.

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# Efficiency Improvement in Reverse Logistics and Examining the Relationships between Refund, Return Policy, Quality Policy and Pricing Strategy in E-Commerce Business.

By

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# Efficiency Improvement in Reverse Logistics and Examining the Relationships between Refund, Return Policy, Quality Policy and Pricing Strategy in E-Commerce Business.

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September 21,2018

# DECLARATION OF CO-AUTHORSHIP/ PREVIOUS PUBLICATION

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I hereby declare that this thesis incorporates material that is result of joint research, as follows:

*Chapter 1, 3 and 6.1 of the thesis were co-authored with my advisor, Dr Walid Abdul-Kader. In all cases, the key ideas, primary contributions, experimental designs, data analysis, interpretation, and writing were performed by the author, and the contribution of co-author was primarily through the supervision of Chiranjib Biswas on conducting the research methodically, refinement of ideas and editing of the manuscript.*

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# ABSTRACT

Reverse Logistics (RL), the process of returning goods from a customer to a retail or manufacturing source, is an increasingly important yet undermanaged business function. The advent of internet and mobile technology and its rapid growth worldwide facilitates online shopping. Research shows that 54% of customers are already buying goods online. Online retail sales are expected to hit $ 4.5 trillion USD by 2020. This shift in buying pattern comes with a more worrying change in customer behaviour in the form of increasing returns, a number of that is surging at an alarming rate. In fact, statistics show that 30% of all the products ordered online are returned. Returns represent a growing cost of doing business today, and they represent unique challenges that are separate from traditional forward moving distribution channels. This thesis analyses the challenges in reverse logistics supply chain (RSLC) and provides a directional approach to overcome these challenges.

The applications of emerging technologies for reverse logistics are discussed in this thesis. Also, this thesis discusses at length, return policy and its relevance in e-commerce business. A profit-maximization model is developed to obtain optimal values for refund, return policy, quality policy and pricing in terms of certain market reaction parameters. A numerical example is presented to show the applicability of the model given the parameters considered. The model provides valuable managerial insights for online apparel retailer in particular, to determine its strategic position under varying customer's purchase and return decisions.

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# LIST OF ABBREVIATIONS

B2C -Business to Consumer

CRC- Central Return Centre

MHI-Materials Handling Institute

OEM- Original Equipment Manufacturer

PRMS- Product Return Management System

RL- Reverse Logistics

RFID- Radio Frequency Identification

SLA-Service Level Agreement

# Chapter-1: Introduction

The internet's proliferation across the world has brought myriad changes in the societies and the global economy. Doing business becomes more efficient, agile and fast with the launch of e-commerce. In this entire business to consumer (B2C) world, logistics play a vital role for the success of e-commerce enterprises. As the quantum of business has increased enormously, the volume has surged. There is a difference between the actual item and the image of the product shown on the website, which leads to returns. Also, buying patterns have significantly changed for goods like clothes, where it is difficult to figure out whether a particular size would fit or not, so a customer decides to order multiple items and then chooses one or more from them depending on how good the clothes look and return the rest. In addition, when a customer finds the good faulty or they do not suit his/her expectations, customer will return the goods.

Now this returned good passes through a logistics system, which is referred to as Reverse Logistics (RL) System.

Let us understand the basic reverse logistics process.

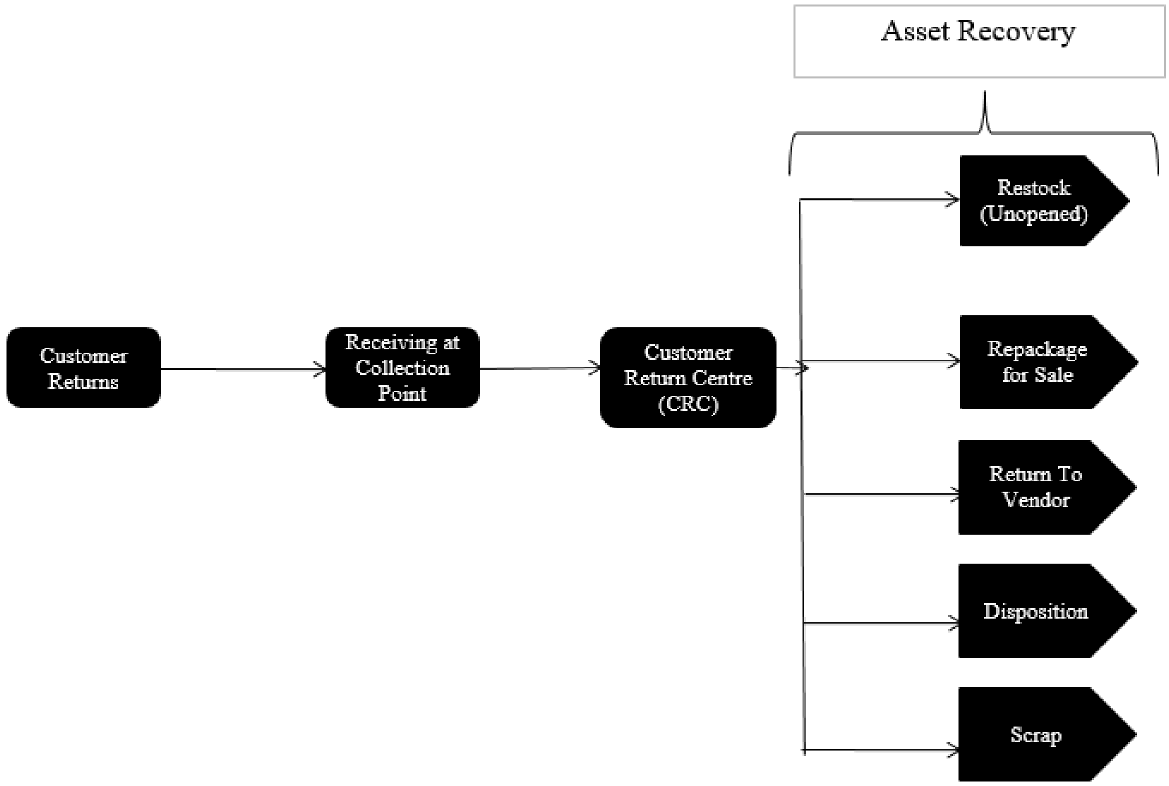


Figure 1: Reverse Logistics Process

Once customers decide to return the products bought online, they will inform the e-retailer online and will drop the same product either at the physical store nearby or at the nearest post office. These receiving points are called Collection Points. At the store, money is immediately credited to the customer's account after scanning the product bar code and the invoice copy. In order to return the product through the post office, the customer first orders the return label, which he or she receives from the online retailer either via mail or e-mail and then pastes it on the product and drops it at the nearby post office. Depending on the return policy of the online retailer, either this return label comes with prepaid postage in which case customer need not to pay anything to return the goods, or the customer pays at the post office depending on the parcel weight and destination.

From stores as well as from the post office, returned products reach the Customer Return Centre (CRC). If the product is returned through the post office, the customer has to wait until it reaches CRC, where the returned good is checked against the policy and credit is arranged afterwards.

At CRC, sorting is done depending on the condition of the returned good. From this point, the asset recovery process begins. An asset (returned good) has value and can be sold. The challenge is to find or recover the highest value for each item. The following are some of the activities that may follow:

- Restock –the product is found still current and immediately put on sale on the website.

- Repackaging for sale – The returned product is in “as new” condition and can be sold in the clearance area of the e-commerce site. These goods are often sold for slightly less than retail, but often higher than original cost.

- Return to Vendor – defective goods, warranty issues or service level agreements (SLA) often allow for return of goods. Again there are vendors who are extremely conscious about their brand and to avoid any dilution of the same, they want back all the returned goods. This channel often means the online retailer will recover the full cost of the items, but the cost of transportation to be considered.

- Disposition –Products are destroyed when they cannot be sold/used at the current location and return to the vendor is not feasible (perhaps because of high transportation costs, too low of volume, etc.).

- Scrap – Online retailers manage to land fill the returned goods by outsourcing.

# Chapter- 2: Research Aim & Objectives

## 2.1: Importance of Research

Companies today cannot disregard the reverse flow of the products and the ways to handle it as huge volumes of returns are increasing globally (Stock et al., 2002). Reverse logistics is a part of returns management which in turn is a part of supply chain management (Mollenkopf & Closs, 2005). Compared with forward logistics, reverse logistics is slow, uncertain, complex and often associated with high cost (Yanyan, 2010).

Scattered locations of facilities and of customers, and information barriers are the two important things every e-commerce company needs to deal with for returns.

Returns have been viewed by most enterprises as a loss or pain area; however, as e-commerce is essentially linked with high volume of returns as the introduction of this thesis revealed, the challenge to change returns from being a cost centre to a profit centre has been increased greatly.

I shall examine in this thesis what are the biggest challenges faced by today's online retailers and how we can design a return management framework to mitigate these challenges.

## 2.2: Objectives of the Research:

The objectives of this research are as follows:

1. Examine the complexity of the reverse logistics system.

2. Identify the forces involved and document recent trends and developments in business and infrastructure and research.

3. Discuss the mitigation opportunity for this complexity.

4. Address the relevance of generous return policy and determine the optimality in terms of refund, return policy, quality policy and pricing strategy.

5. Address the complex relationship of refund, return policy, quality policy and pricing strategy.

## Chapter-3: Literature Review

This chapter describes the basic concepts of reverse logistics in e-commerce. Highlights and discusses the research work of various authors and critically evaluates the gap between the studies. The theoretical perspective of authors is identified during the analysis of their research.

### 3.1: Logistics in e-commerce

Logistics in e-commerce has been playing a vital role in sending right products to the right customer in a most efficient way. This enhances the overall customer experience to a new level and elevates the brand image of the organisation. Huge competition among retailers compel to exceed customer satisfaction by providing the best services. For example, Amazon assures its customers one-day delivery. eBay offers free or very low freight charges for most of the products. In addition to the superior quality of products, customers pay lot of attention to smooth delivery. Not only excellent product delivery system helps in retaining the existing customers but also winning new customers. There are two main types of logistics; forward logistics in which the products/services flow from manufacturers to customers, and reverse logistics in which the products flow from customers back to manufacturers (Figure 2).

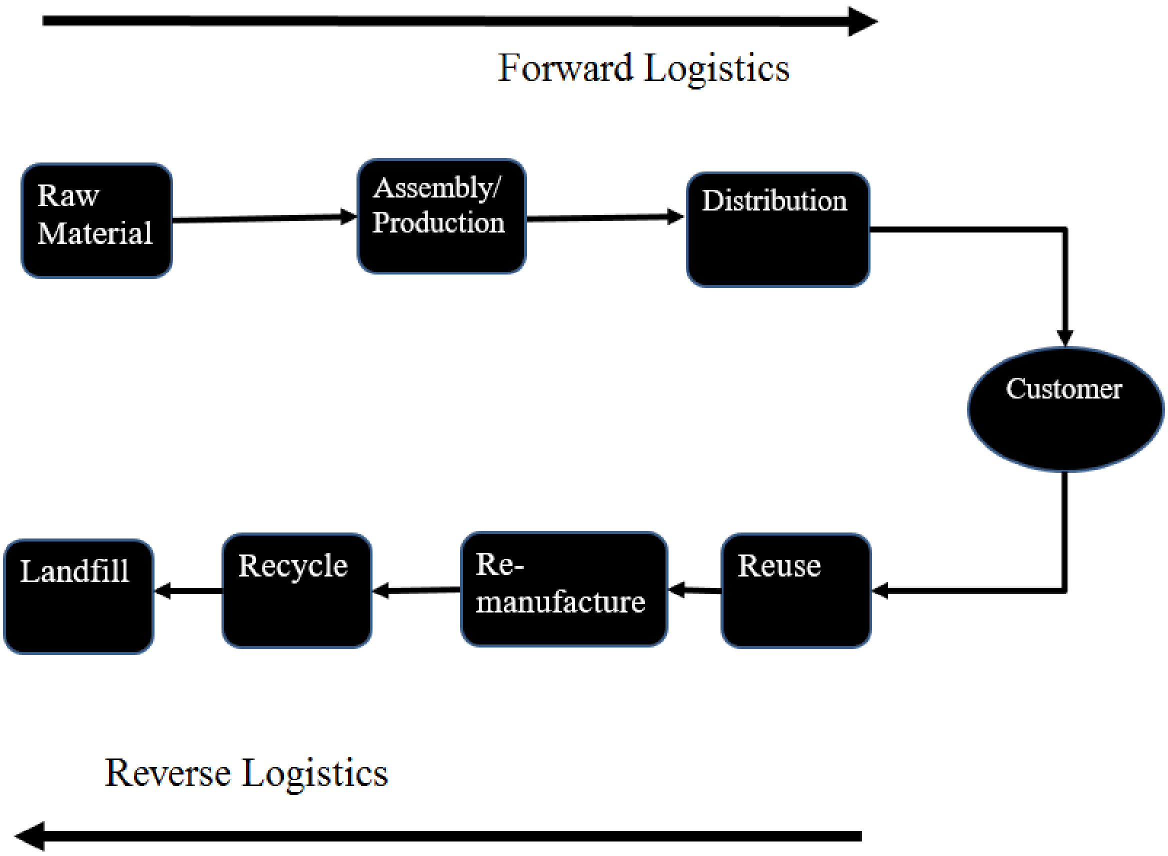


Figure 2: Forward and Reverse Logistics Process

RL has four main steps as defined by most of the authors including Lambert, Riopel and Abdul-Kader (2011): gate keeping (entry), collection, sorting, and disposal.

In the white paper published by Pricewaterhousecooper, named "Reverse Logistics: How to realise an agile and efficient reverse chain within the consumer electronics industry, May 2008", focussed on examining the value drivers that trigger companies in setting up a reverse chain strategy and how they embed this strategy into their process, technology and organisation. Renowned consulting firm Deloitte has identified in their research paper named 'Moving forward in reverse, why reverse logistics need a dedicated channel: 2014', stated that managing reverse logistics through forward logistics channel is costly and increasingly complex.

Xu and Jiang (2009) studied RL in e-commerce environment and analysed some features of RL. Their paper discusses the reason for RL development in e-commerce and its problem in development. The paper has outlined a few major noteworthy features of RL in e-commerce, which are: i) slow process to recover value, ii) in comparison to forward logistics, RL has multiple beginning points, iii) poor predictability. The paper also discusses the reasons for RL development in e-commerce, which are: i) consumer protection, ii) due to the large scale surge in e-commerce industries in recent times, the return reaches almost 36% of the purchased items online; therefore, to remain sustainable in the business and to compete, RL has become imperative; iii) due to the difference in real & images of the product sold online, causing the return of the products. The paper recommends for having right attention on RL by the senior management, zero return policy for some commodities and nurturing the right talent in the organization. However, the list is not sufficient to develop the right RL system in e-commerce business.

A RL process has been designed by Yanyan (2010) where the IT challenges as well as logistics challenges are discussed. The paper discusses briefly about three types of RL processes: i) self-type, ii) 3PRL model, iii) strategic alliance RL model, iv) integrated solution provider model. This paper has argued that the effectiveness of RL model depends on enterprise's IT infrastructure and logistics capabilities. The recommendations provided are: i) building comprehensive logistics information tracking, ii) establish return & repairable system, iii) establishing a sound internal RL processing system. The author has argued that with appropriate RL system & processes, companies can reclaim products at the lowest cost with maximum benefit and for that companies must learn better use of electronic information system.

Harrysson and Landin (2015) have analysed the total cost in their thesis, a case study of a European online retailer. The online retailer's customer has freedom to return through mail to distribution centre (DC) or to drop at the store. The authors had studied two geographic markets, the UK and Germany. Their study found that the cost of return to DC is much higher as compared to dropping at the store. However, return at store is not popular in German market because of credit issues. Store had certain limitations while the study was conducted, e.g., if the returned good is of specialty type, then selling the returned good which are in OK condition, at the store becomes difficult. There were some system issues existed. For instance, the receipt copy did not have the price of returned goods, which were bought online and therefore, the collector had difficulty to determine price, by making calls to the call centre. The researchers have suggested some improvement which can substantially bring down the total cost as follows: i) incentivise dropping at the store, ii) improving the information technology system at the store, iii) promote pre-registration of the returned good by the customer online and thereby gate keeping time reduces substantially.

There has been lots of research on RL process and risks/uncertainties associated with it. Rezwan (2011) has talked about the uncertainties associated with RL, which are of five types: quantity, variety, cycle time, quality and market trend. As the return process falls under PUSH system, the author argues that if retailer/manufacturer doesn't have proper planning of the operation, it would have no choice but to dispose of the returned product in order to avoid inventory. With the help of RFID technology, the quantity of products getting returned is determined and therefore, the decision /planning can be done much in advance. Earlier, return used to follow: collection, then to Centralized Return Centre (CRC) and then to OEM. But with the use of RFID, sorting can be done in the first step and then directly to OEM, thereby avoiding unnecessary transportation. By using RFID, it is possible to determine the time spent within the return logistics and knowing the variations, this data could be used effectively for planning. And when the purpose for return is to repair, by using this, data customer service centre can provide a more accurate promise date to the customer. Active RFID tags and EDL (Electronic Data Log) can be used to save information about products while in use, which can be very well considered to determine market trend. And this market trend information can be used to reduce the other uncertainties. This paper has also alerted on the limitations of RFID usage by saying that: i) some tags cannot be detected by remote readers, ii) many manufacturers do not use same tags as they don't want their product information to be used by competitors, iii) lack of international standard, iv) metal & liquid environment disturb significantly in reading RFID tags, and v) RFID tags are more expensive than printed labels. A further research can be done on real time data collection of the returned products, with the intervention of IT, by the retailers and a design of effective framework to utilise these data for advanced planning of the entire RL supply chain.

Walsh et al. (2014) have analysed the decision of implementation of product return management system (PRMS) by online retailers. They have built theory through the construction of a framework. The proposed framework helps researchers and online retail managers to understand better the drivers for decision to invest in and implement PRMS and the preventive instruments of returning goods. Based on literature review insights and interviews with many online retailers, researchers assimilated the findings and categorised three main instruments as preventive measures which are i) monetary, ii) procedural and iii) customer-based. Each instrument is being weighed carefully as per the informants' comments as well as the observations in the literatures reviewed. Informants allude that once the decision is made to implement PRMS, then the type of instrument chosen depends on the target group. Not all instruments are suitable for the firm. It depends on the assortment and the strategic focus. Researchers have proposed for further research for i) measurement of the effectiveness of these instruments as return prevention instruments, ii) examining PRMS for retailers, selling low risk vs. high-risk products, iii) identifying the relationship of these instruments with each other and to explore any causal relationship, iv) virtual try-on which is part of customer based instrument.

The actual return rate, which is being observed by the online retailer is vital information for the entire supply chain and the manufacturer/supplier can benefit from it, provided the retailer agrees to share the same information with the manufacturer/supplier. Yan and Cao (2017) described about the return information which is crucial for the overall profit of the supply chain channel, if the same is being shared by the online retailer with its supplier/manufacturer under the conditions: 1. when the product is compatible online, authors argued that there is a motivation by the manufacturer to seek the product return information from the online retailer. 2. researchers had analysed two mechanisms under which this information can be shared, and these are a) manufacturer uses two-part price contract with online retailer for information sharing, b) manufacturer uses revenue sharing contract plus profit split with online retailer. The authors' findings are i) if the estimate about product by the manufacturer return is less than the actual return observed by the online retailer, then two-part price contract can be utilised, otherwise the whole supply chain profit gets decreased, ii) using revenue sharing to motivate online retailer always benefits manufacturer as its profit gets influenced by the revenue sharing, but online retailer does not benefit from revenue sharing. However, the whole supply chain always benefits from revenue sharing, while the online retailer shares its product return information with the supplier/manufacturer. The researchers also examined three factors; viz. payment method, assortment size and order size, which affect the returns. Product return is likely to increase if consumers pay through credit cards, because of its painless payment method, consumers often ended up shopping more than they need, which they return upon receipt. Choosing from a large assortment associated with large amount of time that consumer has to spend, but returning the product won't come with refund of the time spent, therefore, large assortment discourages product return in other way. Thirdly, consumers buying less amount of product online due to their low confidence about the product reliability, would end up returning the product because of the associated doubt. However, consumers who buy more online products are certain about the product performance and return less. Two distinct areas prescribed by the authors, wherein further research can be conducted based on the literature are: i) suitable product return related operation strategies which can be adapted by the online retailer and the manufacturer based on the consumer's payment method, ii) appropriate product return related operation strategy which online managers can proactively adapt to fit customer groups that have different order sizes.

Mukhopadhyay & Setoputro (2004) studied the optimal pricing and the return policy, under e-commerce environment and developed a profit maximization model to obtain these optimal policies under certain market reaction parameters.

Li, Xu and Li (2013) have developed and analysed a joint decision of pricing strategy, return policy and quality policy for the online retailer. They found that customer demand depends on selling price and amount of refund, and customer return depends on amount of refund and product quality. Based on these, they examined the online retailer's optimal decisions.

Krapp et al (2013) in their paper provided a generic forecasting approach for predicting product returns in closed-loop supply chains. The approach is based on Bayesian estimation techniques. Furthermore, they adapted this forecasting model to a specific lag distribution, namely the Poisson distribution, and demonstrated its routine with a numerical example. This model allows user to forecast product returns on the basis of fewer limiting assumptions. The main contribution of this approach is its generic formulation which leaves degrees of freedom to the user when adapting it to a specific problem. Areas that depend on the results from a forecasting system, such as inventory management, can embed this estimation procedure.

Table 1: Literature Review & Gap Study

| S. No. | Author | Literature Review | Key Out / Recommendations | Process | Technology | Customer satisfaction | Risk | Gap |
|---|---|---|---|---|---|---|---|---|
| 01 | Mukhopadhyay and Setoputro (2004) | Designing the optimality of product price & return policy. | Expression for Optimal price ( p), return policy (r), resultant Demand ( D) and return quantity ( R) have been obtained ,considering certain reaction parameters of the market sensitivities. | | | | Y | The expression did not consider the uncertain nature of demand and return function. |
| 02 | Xu & Jiang (2009) | This paper analyses some features of RL. It discusses about the reason for RL development in e-commerce and it's problem in development. | # Management Focus on RL. # Zero return policy for certain commodities. | Y | | Y | | The recommended list is insufficient to adapt by any online retailer to successfully efficient RL process. |
| 03 | Yanyan (2010) | A new PL process considering the challenges of IT & Logistics ,faced by enterprise. | RL model depends on enterprise's IT infrastructure and logistics capabilities. The recommendations are of 3 types: a) building comprehensive logistics info tracking ,b)Establish return & repairable system ,c) establishing an internal RL processing system. | Y | Y | | | 1. What kind of IT infrastructure needed not elaborated in the paper. 2.Classification and concentration of reverse logistics not explained. |
| 04 | Rezwan (2011) | The uncertainties related to return of the products and to mitigate that uncertainties through the use of RFID technology. | Most of the uncertainties i.e., quantity, quality, cycle time, market trend can be dealt with the introduction of RFID . | Y | Y | Y | Y | Considering the vast assortment size of the product available online, introducing RFID for all categories ,while returning is not a cost effective solution. |
| 05 | Krapp, Nebel and Sahamie (2013) | Provided a generic forecasting approach for predicting product | Modelled the returned flows using Bayesian Approach. It was adapted to a specific lag | | | | Y | The approach is generic, and subjected to certain limitations. The choice of the appropriate return |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | returns in closed-loop supply chains. | distribution ,namely Poisson distribution and demonstrated with a numerical example. | | | | | time distribution has to be made carefully in each individual case. It has to approximate the true underlying distribution at least to some degree. At the moment, the suggested approach leaves this choice to the user and makes no recommendations. Further research should investigate the robustness of this forecasting approach more intensively, for example in case of increasing variance etc. |
| 06 | Li, Xu, and Li (2013) | Examining the complex relationships between the return policy, product quality and pricing strategy of online direct distributor. | Optimal value of retail price, refund value, quality policy , ensuring direct distributor's profit function have been determined. | | | | Y | In this paper refund represents the return policy however, apart from refund value, there are many components which constitute the overall return policy and together influence the customer's return behaviour. |
| 07 | Walsh, Mohring, and Koot (2014) | Authors have analysed the decision of implementation of product return management system (PRMS) by the online retailers. | The proposed framework helps researcher and online managers to better understand the drivers ,for decision to invest in and implement PRMS and the preventive instruments of returning goods. | Y | | Y | Y | 1. These return instruments have been derived based on interviews with various online retailers. The effectiveness of these instruments are to be measured to validate these findings. 2. The causal relationship (if any) between these instruments also need to be ascertained. |
| 08 | Harrysson and Landin (2015) | They had studied the total cost of product return and focused two geography markets, the UK and Germany. | Their study found that cost of return to DC is much higher as compared to dropping at the store. | Y | Y | Y | | 1.There are a large section of customers who do not prefer to visit store for dropping return goods.<br>2. This study is not useful for the online retailer who doesn't possess any physical store. |
| 09 | Yan and Cao (2017) | The authors described about the return information which is crucial for the overall profit of the supply chain channel, if the same is being shared by the online retailer | 1. When the product is compatible online, authors argued that there is a motivation by the manufacturer to seek the product | Y | | | Y | Further study can be conducted on Operation strategies related to product return, considering two aspects : a) customer's |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | with its supplier/manufacturer. | return information from the online retailer. 2. Researchers had analysed two mechanisms under which this info can be shared ,and these are a) manufacturer uses two part price contract with online retailer for information sharing, b) manufacturer uses revenue sharing contract plus profit split with online retailer. | | | | | payment method, b) different order size, which can be adapted by the online retailer and manufacturer. |

## Chapter-4: Challenges in Return

### 4.1: Online Retailer's RL process

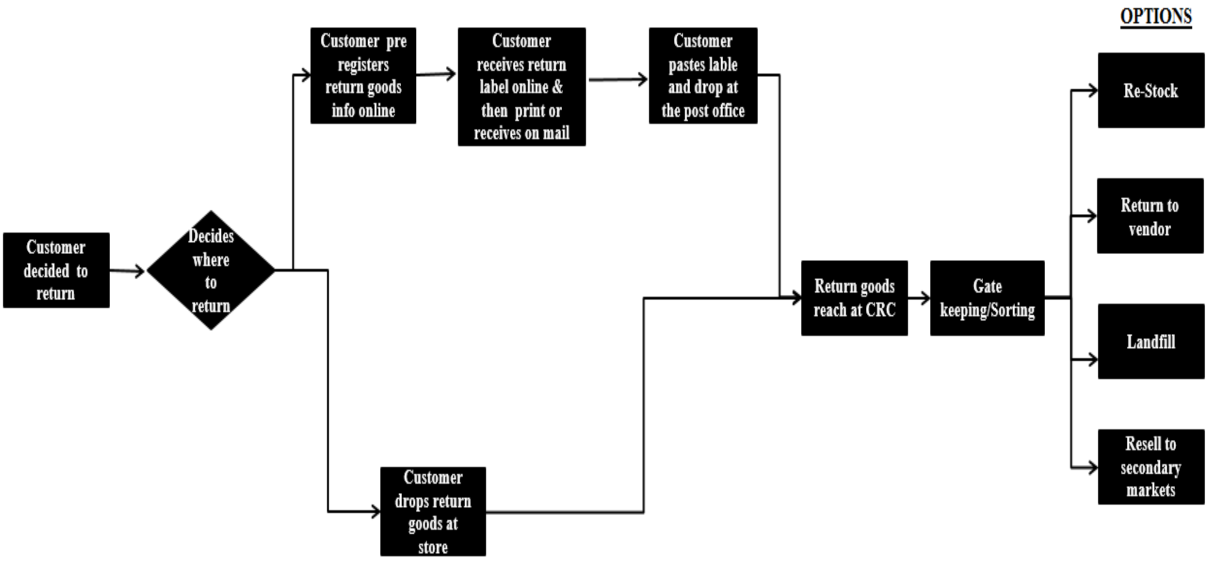


Figure 3: Online Retailer's RL Process

From the interviews with online retailers, the major process flow has been identified as described in Figure 3, which are currently in practice.

### 4.2: Scope of Online Retailer

From the literatures reviewed and the interviews with the online retailers, the below three major areas have been found, which fall under the scope of online retailers in order to enhance the customer's return experience and to make the RL process efficient.

- Reduction of return
- Return Policy

- RL process diagnosis.

Let’s explain the above now.

Reduction of Return:

One of the main reasons for return in e-commerce business is, mismatch of the actual product bought online and the digital picture of the product available online. By putting picture with better resolution, for example, HD picture of the product, the discrepancy can be narrowed down to large extent, which will lead to decrease in return rate.

Virtual try-on can help a lot, particularly in case of fashion accessories, clothes, wherein customer can upload their picture portal online and with the help of the software, the product’s picture will be superimposed on customer’s picture and then customer can feel how the product would look on him/her. Instead of buying out rightly and return afterwards, this method surely helps to reduce the unnecessary return.

Return Policy

Return policy must have clarity, simplicity and it must provide convenience. By offering noticeable return policy, online retailer can catch buyer’s attention and lift sales volume. I found that return policy influences buying decision of the buyer. Online retailer and seller need to see that returning good is an effort to continue a positive business relationship. A painless return is a harmless event in comparison to a negative review of the customer’s experience and loosing customer forever. There has been long debate on free return which is the expectation of the customers in today's world across geographies. And this in turn leads to buyer's trust. Zero return charge, in fact demonstrates confidence in online retailer's business. As per eBay data analytics, 30-day free return can lift your conversion close to 17% and with 60-day free return, this rate goes up to around 34%.

Diagnosis Reverse Logistics Process

- Transportation of return goods is a factor which increases the overall cost of reverse logistics and therefore, optimisation of the route of transportation is essential.
- During our interviews with e-retailer, we found tracking return goods is a challenge. What item to be tracked is an important decision, firm has to make, because tracking each & every item might add huge cost burden which may jeopardize the firm's profitability. How this is to be tracked is the second decision, that online retailer has to take.
- Tackling uncertainty is the biggest challenge in Reverse Logistics. Taking decision on the returned good before it reaches CRC is an absolute essential aspect, if the firm wants to be efficient in RL business process, considering the current return rate hovering around 30%.
- One of the most important factors associated with customer satisfaction is the speed at which, credit or exchange to customer takes place against the returned goods.
- Service Level Agreement (SLA) with manufacturer and other vendors, viz. land-filler, secondary marketer.

Generous return policy would increase sales revenue, at the same time would increase the cost of doing business as, return increases.

## **4.3: Clear, Simple and Convenient Return Policy**

Let's analyse why clear, simple and convenient return policy is needed for various customers.

The New Shopper: These shoppers are first time buyers, who do not have any prior buying experience with a particular online retailer. For them, only the digital pictures are available at the moment, instead of touching and feeling the product. For them, having a proper return policy is nothing but a safety net, in case it doesn't match their expectations.

Gift Buying Shopper: For a gift giver, return is a critical consideration, because if the gifts are not being liked by the recipient or the recipient got same gift more than one, or it doesn't fit well, obviously the return would be the solution left.

Occasional Shopper: This type of shoppers represents 45% of Canadian online shoppers (Canada Post (2016) 'E-commerce returns: From costly complication to competitive advantage'). They generally purchase 2 to 6 times a year. They would appreciate more reassurance around returns. They would become repeat customers if they experience better return process.

Hyper Shopper: This type of shoppers represents 10% of Canadian online shoppers (Canada Post (2016) 'E-commerce returns: From costly complication to competitive advantage'). They purchase 25 times or more per year. These customers matter most because they buy the most and help to make brand value of the retailer. And they expect best-in-class return experience from the retailer.

Footwear or Apparel Shopper: Colour, fabric, weave, texture, weight, fitment matters most for this type of product(s) and for that matter, shoppers often tend to buy more in quantity. Six out of 10 customers avoid purchasing any apparel or foot wear from merchant who doesn’t provide free returns (Canada Post (2016) ‘E-commerce returns: From costly complication to competitive advantage’).

In the same white paper published by Canada Post, it is stated that customer has pre purchase preferences and post purchase experiences which are being shared herewith for the purpose of study.

Pre-purchase preferences: The findings are as follows:

- 25% of customers prefer clear return policy mentioned in the website.
- 30% of customers expect free return by mail.
- 23% of customers emphasize ease of making return.

It is obvious that when return policy does not meet pre-purchase expectation, the retailer looses sales.

Post-purchase experience: In the same survey, it was revealed that 1 out of 4 shoppers had issue in returning process in the last 12 months. It leads to missing future sales when shoppers get disappointed with the return experience because they avoid repeat purchase.

## 4.4: Reasons of Returns

Based on our study we have categorised reasons of returns for major online retailers, are as follows:

- Defective merchandise
- Poor Quality Products
- Do not match buyer’s expectations
- Improper fitment
- Items purchased with intent to send some back, e.g., purchase more than one size to try on and choose for best fit one(s).

The issues identified by shoppers while returning goods are as follows:

- Online retailer does not cover the cost of the return.
- Having difficulty in communicating with customer support team of the online retailer.
- Not capable to return to the store.
- Items were not eligible for return.

While during our extensive discussion with online retailers, we found most of the gaps of expectations of the customer from online retailer, for return, can be fulfilled, however, free return is an issue which would lead the business unsustainable, if implemented. As per the study made by Canada Post, less than 25 % of the existing online retailers, offer free returns by mail, in Canada, because it’s not realistic for the business to bear the cost of the return alone by the online retailer. This aspect has led to a focus study in this thesis, on how to address this issue of bearing cost of return, as part of return policy.

In this thesis, I will research on two things, i.e., i) how to track the return goods, taking leverage of the emerging technologies and, ii) to design a model, which would help retailer to determine an optimal value of the key business parameters, considering the profit margin unaffected, under condition when customer returns good, which is not due to any fault from retailer's end.

# Chapter-5: Recent Trends & Adaptation of Emerging Technology in Supply Chain

## 5.1: Digital Supply Chain

The supply chain today is a series of largely discrete steps taken through marketing, product development, manufacturing, and distribution, and finally into the hands of the customer. Digitization brings down those walls, and the chain becomes a completely integrated ecosystem that is fully transparent to all the players involved — from the suppliers of raw materials, components, and parts, to the transporters of those supplies and finished goods, and finally to the customers demanding fulfilment. With the advent of the digital supply chain, silos will dissolve and every link will have full visibility into the needs and challenges of the others. Supply and demand signals will originate at any point and travel immediately throughout the network.

According to Materials Handling Institute (MHI)'s 2017 annual survey on next generation supply chains, only 16% of respondents say their organizations are working towards digital supply chains today, though 80% believe digital will be the predominant model within the next five years. Lack of expertise in digital technologies such as predictive analytics, robotic automation, advanced machine learning and Internet of Things (IoT) is the foremost adoption challenge for most players.

The situation is similar in reverse logistics as well. According to the Reverse Logistics Association, the volume of returns annually is estimated to cost between USD 150 and 200 billion. Up to 91% of returns are a direct result of retailers' efforts to attract new customers through free returns on unwanted purchases, prompting customers to deliberately over-order.

Adding to the complexity, returns are often managed by third-party logistics providers (3PLs) such as FedEx and DHL. 3PLs help shippers accelerate the returns process without having to deploy manpower at every location. However, this often leads to bloated inventories at the 3PL fulfilment side, mandating digital logistics processes to minimize losses and channel inventory, where needed, in real time.

## 5.2: How digital is transforming reverse logistics

- **Smart tagging for track-and-trace operations:** Connecting products throughout their lifecycle in real-time is at the core of digitizing logistics operations. Integrating next-generation super-high-frequency RFID, sensing, data logging, and on-chip analytics with beacon sensor technology, enables retailers and manufacturers to connect products and track them across their journey. They can also classify items into categories such as damaged, used, replacement, or recycle, enabling a faster and more robust supply chain network.

- **Flexible returns for superior customer experience:** Today's customers demand greater control over every step of the logistics process. A well designed, flexible returns process should allow customers to drop off return packages at a convenient location, which can then be tracked using sensors and beacons, and processed appropriately. Recognized as an innovative supply chain leader, UPS pioneered this practice with **UPS Returns Flexible Access**. The program accelerates return of shipped goods back to the company's warehouse, without the hassle of shipping labels for customers or the need for additional manpower required to do the job.

- **Autonomous vehicles and drones for faster shipping and returns:** Drones are the future of logistics delivery as they address two major challenges – shortage of drivers and long-haul driver fatigue. Powered by robotics technology, drones not only enable delivery the same-day, within a few hours, or even minutes, but also handle returns at the same pace. Amazon's

Prime Air drone delivery system, complete with airborne fulfilment and docking stations, is the most anticipated project in this space.

- **IoT enabled warehouses for storage optimization, maintenance, and security:** IoT enabled smart warehouses can be equipped with RFID tags, sensors, wearables, robots, and smart equipment, enabling better storage capacity utilization, as well as safer, cost-efficient, and faster operations.

# Chapter-6: Proposed Framework

## 6.1: Tracking Returns

Here we will discuss how internet of the things (IoT) can be leveraged for tracking return goods. IoT promises far-reaching payoffs for logistics operators and their business customers and end consumers. These benefits extend across the entire logistics value chain, including warehousing operations, freight transportation, and last-mile delivery. And they impact areas such as operational efficiency, safety and security, customer experience, and new business models. With IoT, it would be possible to begin tackling more difficult operational and business challenges in a more thorough manner.


Figure 4: IoT- enabled capabilities (Reference: Internet of Things in Logistics by DHL & Cisco, 2015)

As shown in Figure 4, applying IoT to logistics operations promises a substantial impact. It permits monitoring the status of assets, parcels, and people in real time throughout the value chain.

It allows obtaining real-time data and analyses the business performance. Business processes can be automated and thereby manual interventions can be eliminated, which will lead to improved quality, predictability and lowering cost. Entire value chain can be optimized with the intervention of IoT wherein people, systems and assets work together and with the application of analytics, wider improvement opportunities can be identified.

To optimize the return process, the tracking and monitoring of the return goods is essential. Many researchers have proposed RFID (Radio Frequency Identification) to track the goods. RFID is the use of an object called RFID tag which is applied to a product for the purpose of identification and tracking by using radio waves (Rezwan, 2011). Retailers have been using **RFID** for tracking purpose in forward logistics for a long time, but using it in RL is not as common.

**Real-time Location System (RTLS)** is a robust, multi-purpose, enterprise platform that supports an infinite number of asset-related applications "on top." It uniquely offers security, safety, compliance, and RTLS functionality, all in one integrated system and includes both long-range location and instant choke point detection thanks to its dual frequency implementation (i.e., 433 MHz and 125 KHz).

The network is fully IP-based and built upon standard hardware and software. It can be implemented using either wired Ethernet (with or without Power over Ethernet (PoE)), or using Wi-Fi connectivity. It can be configured to be a standalone system, or can be a sub-net within the facility's primary local network, making installation simple and cost effective. The IP-based nature of the system also allows for remote monitoring, diagnostics, and software updates, making maintenance and management of the system easy and efficient. Active RFID tags are battery-operated remote sensors that report data back to a remote server that can run either on premise or in the cloud – exactly.

There is another RTLS system which is known as Bluetooth Low Energy (BLE) based iBeacon. Bluetooth Beacon Tracker is a real-time locating system (RTLS) that locates and tracks the movement of active Bluetooth Low Energy (BLE) devices. The system works inside multi-story buildings or throughout an entire campus. BLE signals from battery driven beacons are at the core of the indoor location technology. It has one of the latest technologies that has emerged and become an industry standard available on most devices today. It uses so called BLE beacons (or iBeacons) that are inexpensive, small, have a long battery life and do not require an external energy source. The device detects the signal from the beacon and can calculate roughly the distance to the beacon and hence estimate the location. Its ability to track the whereabouts of Bluetooth devices publishing their presence (that is, beaconing) enables tracking applications to monitor movements within a physical space.

Even Wi-Fi can be used in a similar way as BLE beacons, but requires an external power source, more setup costs and expensive equipment. The signal is stronger and it can cover more distance than BLE.

We see optimal conditions for IoT to take off in the industry. There is a clear technology push through the rise of mobile computing, consumerisation of IT, 5G networks, and big data analytics, as well as a pull from customers who are increasingly demanding IoT-based solutions.

The above-indicated solutions i.e., RFID, BLE, Wi-Fi and mobile computing can very well be integrated with ERM (Enterprise Recourse Management) system to track the parcel with return goods.

## 6.2: Determining Optimal Strategy

Mukhopadhyay and Setoputra (2004) had developed profit maximization model to obtain policies for price and the return policy in terms of certain market reaction parameters called as sensitivity co-efficient. The paper provides number of managerial guidelines for marketing & operational strategies to influence the market reaction parameters and thereby maximizing the profit.

Li, Xu and Li (2013) later on further researched on this model and introduced quality as a factor in the return function and also considered the cost of maintaining that quality which is then added in the profit function. In this paper theoretical models were developed to examine the impact of online distributor's product quality, return policy and pricing strategy on the customer's purchase and return behaviours differentiating distributors based on their strategy as cost or price focused. In addition, the paper studied pricing strategy, return policy and quality policy in four situations and these are, where customer's demand is sensitive to price or return policy as well as return is sensitive to return policy or quality.

Based on the above mentioned literatures, I have developed a model. And the model is most suitable in apparel online retail business. The technological advancements in tracking return goods, mentioned in the previous sections, are not explicitly considered in the model.

We consider a simple supply chain system consisting of two parties: the online retailer who sells a product, and customers who buy the product. We formulate the flow of payment as follows. A customer buys a product from online retailer and pays p dollars. After receiving and trying the product, the customer may decide that it does not match his/her expectations, and then decides to return the product. The online retailer will issue r dollars back as refund to the customer

($0 \le r \le p$). We can interpret retailer offers no return when $r = 0$ and full return when $r = p$. In addition, higher r means that the online retailer is practicing more generous refund (Mukhopadhyay & Setoputro, 2004).

Let's introduce base demand and sensitivities of market below.

$\alpha$ = Base demand or primary demand, which does not depend on the price, refund, return policy or even quality policy. $\alpha > 0$, this base demand depends on the brand image and general economic factor which are outside the scope of this paper.

$\beta$ = Demand sensitivity with respect to price. Specifically, as p increases, demand is reduced from its base value at the rate of $\beta$ units. Note $\beta > 0$.

$\gamma$ = Demand sensitivity with respect to refund value r. It represents the rate of demand increases from its base value as refund becomes more generous (increasing r). Note $\gamma > 0$.

$\zeta$ = Demand sensitivity with respect to quality q, higher the quality q, the greater the demand quantity D. $\zeta > 0$.

Apart from refund value r, there are other elements in the return policy as described previously in this paper such as, clarity in the policy, free return, free return window length, time for credit/exchange of product to customer etc. which influence the customer's purchase & return behavior enormously and therefore we have considered return policy separately from refund in this paper and represented this return policy as s in the expressions below.

$\varsigma$ = Demand sensitivity with respect to return policy s. As s increases (more generous), demand also increases from its base value. $\varsigma > 0$.

**Formulating Demand Function**

The demand for the product *D* is a function of p, r, q and s.

$$D = f\,(p, r, q, s) \tag{1}$$

$$\text{With } \frac{\partial D}{\partial p} < 0\,,\ \ \frac{\partial D}{\partial r} > 0, \frac{\partial D}{\partial q} > 0, \frac{\partial D}{\partial s}\ > 0. \tag{2}$$

Now assuming a linear demand function as assumed by many researchers (Tsay and Agrawal, 2000; Padmanabhan and Png, 1997; Parlar and Wang, 1994; Zhao and Weng, 2002), demand of the product can be formulated as:

$$D= \alpha - \beta\, p + \gamma\, r + \zeta\, q + \varsigma\, s \tag{3}$$

**Modelling Return Function**

In this model, the online retailer is allowing the customer to return the item for a refund of r dollars. While this policy will motivate more demand, this will also generate more quantity returned by the customer. The return quantity R can be expressed by the following linear equation:

$$R = Ø + \psi\, r - \upsilon\, q + \omega\, s \tag{4}$$

Where Ø = Base return quantity, which does not depend on refund value (r), quality factor or return policy. Ø > 0

$\psi$ = the refund –return quantity sensitivity coefficient. Higher the return value r, the higher the return quantity R. And $\psi > 0$, as r increases, the return quantity also increases, because it motivates more and more customer to return product (Li et al,2013).

$\upsilon$ = the quality- return quantity sensitivity: the higher the quality q, the lower the return quantity R.

$\omega$ = the return policy- return quantity sensitivity: as the return policy s increases (more lenient/ generous), it leads to motivate customers to return goods and thereby R increases.

As seen in equation (4), $\frac{\partial R}{\partial r} > 0$, $\frac{\partial R}{\partial q} < 0, \frac{\partial R}{\partial s} > 0$.

**Cost Function**

Better the quality, higher the cost to improve the quality. The cost related to quality is associated with improving the failure rate of the product, market it with highest level of transparency and delivery speed. Cost function of quality C is used here as the second continuously differentiable convex as $C= \lambda q^2$ where $\lambda > 0$ is a scalar parameter (Chao et al., 2009).

In order to set up and maintain the reverse supply chain as per the online retailer's return policy, the cost associated is called as Cost of return policy (T).

Cost function of return policy $T = ƛs^2$ where $ƛ > 0$ is another scalar parameter.

**Profit Function**

Online retailer sells products and then provides return service for returned products.

Profit of the online retailer can be written as:

$$\Pi = D\,p - Rr - C - T \qquad (5)$$

where D p = the revenue generated by selling D quantity product with each price p

and Rr = the total refund value for return quantity R.

C & T are already defined.

Using equations (3) and (4) into equation (5),

$$\Pi = (\alpha - \beta\, p + \gamma\, r + \zeta\, q + \varsigma\, s)\, p - (\O + \psi\, r - \upsilon\, q + \omega\, s)\, r - \lambda q^2 - \bar{\lambda} s^2 \qquad (6)$$

By taking first derivative of the profit with respect to price (p) and refund value (r), quality policy (q), and return policy (S), we have:

$$\frac{\partial \Pi}{\partial p} = (\alpha - \beta p + \gamma\, r + \zeta\, q + \varsigma\, s) - \beta p$$

$$\frac{\partial \Pi}{\partial r} = \gamma\, p - (\O + \psi\, r - \upsilon\, q + \omega\, s) - \psi\, r$$

$$\frac{\partial \Pi}{\partial q} = p\, \zeta + \upsilon\, r - 2\, \lambda\, q$$

$$\frac{\partial \Pi}{\partial s} = p\, \varsigma - \omega\, r - 2\bar{\lambda} s$$

Let the first order derivatives, be equal to 0, we get

$$\left.\begin{array}{l} -2\, \beta p + \gamma\, r + \zeta\, q + \varsigma\, s = -\, \alpha \\ \gamma\, p - 2\psi\, r + \upsilon\, q - \omega\, s = \O \\ p\, \zeta + \upsilon\, r - 2\, \lambda\, q = 0 \\ p\, \varsigma - \omega\, r - 2\bar{\lambda} s = 0 \end{array}\right\} \qquad \ldots\ldots\ldots (7)$$

By manipulating and equating the above equations, we obtain the optimal solutions as follows.

1) The optimal retail price is

$p^* = -(-2\,\varsigma\,\omega\,\lambda\,Ø + 4\,ƛ\,\gamma\,\lambda\,Ø + 2\,ƛ\,\zeta\,\upsilon\,Ø + (2\,\omega^2\,\lambda - 8\,\psi\,ƛ\,\lambda + 2\,ƛ\,\upsilon^2)\,\alpha / (\beta\,(-4\,\omega^2\,\lambda + 16\,\psi\,ƛ\,\lambda - 4\,ƛ\,\upsilon^2) + \varsigma\,(4\,\gamma\,\omega\,\lambda + 2\,\zeta\,\upsilon\,\omega) + \varsigma^2\,(\upsilon^2 - 4\,\psi\,\lambda) - 4\,ƛ\,\gamma^2\,\lambda + \zeta^2\,(\omega^2 - 4\,\psi\,ƛ) - 4\,ƛ\,\gamma\,\zeta\,\upsilon)$

2) The optimal refund value is

$r^* = -(-2\,\varsigma^2\lambda Ø + 8\,ƛ\,\beta\,\lambda\,Ø - 2\,ƛ\zeta^2\,Ø + (2\,\varsigma\,\omega\,\lambda - 4\,ƛ\,\gamma\,\lambda - 2\,ƛ\,\zeta\,\upsilon)\,\alpha) / (\beta\,(-4\,\omega^2\,\lambda + 16\,\psi\,ƛ\,\lambda - 4\,ƛ\,\upsilon^2) + \varsigma\,(4\,\gamma\,\omega\,\lambda + 2\,\zeta\,\upsilon\,\omega) + \varsigma^2\,(\upsilon^2 - 4\,\psi\,\lambda) - 4\,ƛ\,\gamma^2\,\lambda + \zeta^2\,(\omega^2 - 4\,\psi\,ƛ) - 4\,ƛ\,\gamma\,\zeta\,\upsilon)$

3) The optimal quality policy is

$q^* = -(-\zeta\,\varsigma\,\omega\,Ø - \varsigma^2\,\upsilon\,Ø + 4\,ƛ\,\beta\,\upsilon\,Ø + 2\,ƛ\,\gamma\,\zeta\,Ø + (\zeta\,(\omega^2 - 4\,\psi\,ƛ) + \varsigma\,\upsilon\,\omega - 2\,ƛ\,\gamma\,\upsilon)\,\alpha / (\beta\,(-4\,\omega^2\,\lambda + 16\,\psi\,ƛ\,\lambda - 4\,ƛ\,\upsilon^2) + \varsigma\,(4\,\gamma\,\omega\,\lambda + 2\,\zeta\,\upsilon\,\omega) + \varsigma^2\,(\upsilon^2 - 4\,\psi\,\lambda) - 4\,ƛ\,\gamma^2\,\lambda + \zeta^2\,(\omega^2 - 4\,\psi\,ƛ) - 4\,ƛ\,\gamma\,\zeta\,\upsilon)$

4) The optimal return policy is

$s^* = -(\varsigma\,(2\gamma\lambda Ø + \zeta\,\upsilon\,Ø) - 4\,\beta\,\omega\,\lambda\,Ø + \zeta^2\,\omega\,Ø + (\varsigma\,(\upsilon^2 - 4\,\psi\,\lambda) + 2\,\gamma\,\omega\,\lambda + \zeta\,\upsilon\,\omega)\,\alpha)/ (\beta\,(-4\,\omega^2\,\lambda + 16\,\psi\,ƛ\,\lambda - 4\,ƛ\,\upsilon^2) + \varsigma\,(4\,\gamma\,\omega\,\lambda + 2\,\zeta\,\upsilon\,\omega) + \varsigma^2\,(\upsilon^2 - 4\,\psi\,\lambda) - 4\,ƛ\,\gamma^2\,\lambda + \zeta^2\,(\omega^2 - 4\,\psi\,ƛ) - 4\,ƛ\,\gamma\,\zeta\,\upsilon)$

The following website was used to solve the equation (7) :http://wims.unice.fr/wims/en~tool~linear~linsolver.en.html

## 6.3: A Numerical Study

In this section, we use several numerical examples to analyse the effect of variations of the market parameters ($\beta$, $\gamma$, $\psi$, $\upsilon$, $\zeta$, $\varsigma$, $\omega$) on the online retailer's optimal policies ($p^*$, $q^*$, $r^*$, $s^*$) and to determine the optimal profits ($\Pi$). The data used to conduct these computations are assumed to represent real world scenarios as close as possible. In this paper, we chose a set of representative results

α = 1000, β = 10, γ = 5, Ø = 10, ψ = 3, υ = 8, λ = 260 (Li et al ,2013), ζ = 5, ς = 4, ω = 3, ƛ =220.

Units of Refund (r*), Price (p*) and Profit (Π) are in dollars. Units of Demand (D) and Return (R) are in quantity (Numbers).

From section 6.2 , we obtained q= $\sqrt{C/\lambda}$; s = $\sqrt{T/ƛ}$ where C and T are cost of quality improvement and cost of setting up return policy, respectively, and their units are in dollar. Both λ and ƛ are scalar parameters with values 260 and 220, respectively.

We first analyse the influences that the changes in market parameters have on the decisions of the selling price, refund value, quality policy and the return policy. We then study the effects of the decision variations on sales quantity, return quantity and the online retailer's profit.

Table 2: Optimal results of the sensitivity of demand to the selling price (β)

| Demand Sensitivity (β) | Refund (r*) | Price (p*) | Quality (q*) | Return Policy (s*) | Demand (D) | Return (R) | Profit (Π) |
|---|---|---|---|---|---|---|---|
| 10 | 53.2227 | 63.7068 | 1.3052 | 0.2163 | 636.4368 | 159.8752 | 31583.1301 |
| 11 | 46.9669 | 56.4515 | 1.1536 | 0.1930 | 620.4077 | 142.2512 | 27987.6754 |
| 12 | 41.9904 | 50.6798 | 1.0329 | 0.1744 | 607.6563 | 128.2310 | 25127.3516 |
| 13 | 37.9371 | 45.9789 | 0.9347 | 0.1593 | 597.2705 | 116.8118 | 22797.6112 |
| 14 | 34.5719 | 42.0760 | 0.8531 | 0.1468 | 588.6478 | 107.3311 | 20863.3517 |
| 15 | 31.7333 | 38.7839 | 0.7843 | 0.1362 | 581.3745 | 99.3341 | 19231.7504 |
| 16 | 29.3067 | 35.9696 | 0.7255 | 0.1272 | 575.1567 | 92.4976 | 17836.9252 |
| 17 | 27.2084 | 33.5360 | 0.6746 | 0.1194 | 569.7803 | 86.5862 | 16630.8219 |
| 18 | 25.3761 | 31.4109 | 0.6302 | 0.1125 | 565.0852 | 81.4240 | 15577.5659 |
| 19 | 23.7621 | 29.5391 | 0.5911 | 0.1065 | 560.9498 | 76.8771 | 14649.8334 |
| 20 | 22.3297 | 27.8778 | 0.5564 | 0.1012 | 557.2795 | 72.8416 | 13826.4472 |

The price sensitivity parameter of the demand (β) has a direct influence on the selling price. We start analysing with β =10 until 20, while the values of other parameters remained same as mentioned above. Using these values (α, β, γ, Ø, ψ, υ, λ, ζ, ς, ω, ƛ), we obtained optimal values, demands, returns & optimal profits as described in section 6.2, which have been gathered in Table 2. From the table above, we see when the price sensitivity parameter (β) is low, online retailer should charge a high selling price. In this scenario, customer will pay more attention to refund and the return policy of the online retailer. The retailer should provide a high refund in order to generate high demand. With lenient return policy, online retailer should provide a better quality and as the price sensitivity is low, retailer can charge high selling price.

Table 3: Optimal results of the sensitivity of demand to the refund value (γ)

| Demand Sensitivity (γ) | Refund (r*) | Price (p*) | Quality (q*) | Return Policy (s*) | Demand (D) | Return (R) | Profit (Π) |
|---|---|---|---|---|---|---|---|
| 0.5 | 3.0129 | 50.2951 | 0.4311 | 0.4367 | 502.4573 | 16.8998 | 25129.9696 |
| 1.0 | 7.3615 | 50.6000 | 0.5003 | 0.4098 | 505.5022 | 29.3118 | 25260.6088 |
| 1.5 | 11.8222 | 51.1319 | 0.5729 | 0.3842 | 510.8157 | 42.0364 | 25504.2027 |
| 2.0 | 16.4585 | 51.9059 | 0.6500 | 0.3597 | 518.5472 | 55.2543 | 25867.9175 |
| 2.5 | 21.3421 | 52.9443 | 0.7330 | 0.3358 | 528.9207 | 69.1696 | 26362.5941 |
| 3.0 | 26.5571 | 54.2787 | 0.8233 | 0.3124 | 542.2510 | 84.0217 | 27003.5616 |
| 3.5 | 32.2055 | 55.9521 | 0.9229 | 0.2891 | 558.9688 | 100.1002 | 27811.8692 |
| 4.0 | 38.4146 | 58.0233 | 1.0342 | 0.2656 | 579.6590 | 117.7670 | 28816.1359 |
| 4.5 | 45.3481 | 60.5716 | 1.1602 | 0.2415 | 605.1171 | 137.4869 | 30055.3425 |
| 5.0 | 53.2227 | 63.7068 | 1.3052 | 0.2163 | 636.4368 | 159.8752 | 31583.1301 |
| 5.5 | 62.3338 | 67.5819 | 1.4748 | 0.1894 | 675.1488 | 185.7707 | 33474.5955 |

We analysed whole set of data with varying values of γ from 0.5 to 5.5 while the other parameters were having the set values as described in the beginning of this section. The result is shown in Table 3. The refund value influences customer demand and the return quantity directly, as it is displayed in Table 3. The more the refund, the higher the demand and so is the return quantity.

If the customer pays less attention to quality, online retailer should focus on low quality and low price products (Li et al., 2013).

Table 4: Optimal results of the sensitivity of demand to quality policy (ζ)

| Demand Sensitivity (ζ) | Refund (r*) | Price (p*) | Quality (q*) | Return Policy (s*) | Demand (D) | Return (R) | Profit (Π) |
|---|---|---|---|---|---|---|---|
| 0.5 | 51.9036 | 63.0412 | 1.2961 | 0.2192 | 630.6306 | 155.9997 | 31211.4504 |
| 1.0 | 52.0353 | 63.0987 | 1.2968 | 0.2188 | 631.3619 | 156.3885 | 31252.6346 |
| 1.5 | 52.1707 | 63.1602 | 1.2975 | 0.2185 | 632.0714 | 156.7874 | 31293.8406 |
| 2.0 | 52.3097 | 63.2259 | 1.2984 | 0.2181 | 632.7594 | 157.1966 | 31335.0725 |
| 2.5 | 52.4524 | 63.2956 | 1.2993 | 0.2178 | 633.4258 | 157.6163 | 31376.3334 |
| 3.0 | 52.5989 | 63.3694 | 1.3003 | 0.2175 | 634.0708 | 158.0465 | 31417.6257 |
| 3.5 | 52.7491 | 63.4474 | 1.3014 | 0.2171 | 634.6944 | 158.4874 | 31458.9510 |
| 4.0 | 52.9031 | 63.5297 | 1.3026 | 0.2168 | 635.2965 | 158.9391 | 31500.3103 |
| 4.5 | 53.0609 | 63.6161 | 1.3038 | 0.2165 | 635.8773 | 159.4016 | 31541.7035 |
| 5.0 | 53.2227 | 63.7068 | 1.3052 | 0.2163 | 636.4368 | 159.8752 | 31583.1301 |

We have examined again optimal values, demand, return and profit with different values of demand sensitivity (ζ) and obtained the results as shown in Table 4. It shows that when customer pays more attention to quality, online retailer can maximise profit by marginally improving quality.

Table 5: Optimal results of the sensitivity of demand to return policy (ς)

| Demand Sensitivity (ς) | Refund (r*) | Price (p*) | Quality (q*) | Return Policy (s*) | Demand (D) | Return (R) | Profit (Π) |
|---|---|---|---|---|---|---|---|
| 1.0 | 7.5254 | 50.5299 | 0.2041 | 0.0635 | 503.3106 | 31.1344 | 25186.2017 |
| 1.5 | 11.9551 | 51.0723 | 0.3231 | 0.0926 | 508.9637 | 43.5585 | 25444.1889 |
| 2.0 | 16.5621 | 51.8568 | 0.4469 | 0.1228 | 517.0358 | 56.4797 | 25821.1815 |
| 2.5 | 21.4179 | 52.9061 | 0.5774 | 0.1546 | 527.7569 | 70.0984 | 26328.2765 |
| 3.0 | 26.6064 | 54.2520 | 0.7168 | 0.1885 | 541.4490 | 84.6501 | 26981.0315 |
| 3.5 | 32.2295 | 55.9380 | 0.8679 | 0.2252 | 558.5512 | 100.4206 | 27800.7093 |
| 4.0 | 38.4146 | 58.0233 | 1.0342 | 0.2656 | 579.6590 | 117.7670 | 28816.1359 |
| 4.5 | 45.3257 | 60.5881 | 1.2199 | 0.3106 | 605.5816 | 137.1492 | 30066.5046 |
| 5.0 | 53.1798 | 63.7432 | 1.4311 | 0.3618 | 637.4317 | 159.1763 | 31605.6856 |

As explained before, we examined with the varying values of the sensitivity of demand to return policy (ς) and the results are displayed in Table 5 above. We can see when customer becomes highly sensitive to the return policy, online retailer can generate high demand, by enhancing quality, charging high selling price, offering better refund and lenient return policy. Along with high demand, return quantity surges however, retailer generates high profit.

Table 6: Optimal results of the sensitivity of return to refund (ψ) and return policy (ω).

| Return Sensitivity (ψ, ω) | Refund (r*) | Price (p*) | Quality (q*) | Return Policy (s*) | Demand (D) | Return (R) | Profit (Π) |
|---|---|---|---|---|---|---|---|
| 3.0,3.0 | 53.2227 | 63.7068 | 1.3052 | 0.2163 | 636.4368 | 159.8752 | 31583.1301 |
| 3.5,3.5 | 43.6768 | 61.2764 | 1.1403 | 0.2096 | 612.1599 | 154.4801 | 30416.0239 |
| 4.0,4.0 | 37.0302 | 59.5842 | 1.0255 | 0.2050 | 595.2565 | 150.7372 | 29603.3929 |
| 4.5,4.5 | 32.1363 | 58.3382 | 0.9409 | 0.2017 | 582.8104 | 147.9932 | 29005.0361 |
| 5.0,5.0 | 28.3824 | 57.3825 | 0.8761 | 0.1991 | 573.2638 | 145.8990 | 28546.0760 |
| 5.5,5.5 | 25.4119 | 56.6263 | 0.8248 | 0.1971 | 565.7093 | 144.2512 | 28182.8831 |
| 6.0,6.0 | 23.0026 | 56.0129 | 0.7832 | 0.1955 | 559.5822 | 142.9233 | 27888.3150 |
| 6.5,6.5 | 21.0092 | 55.5054 | 0.7487 | 0.1942 | 554.5128 | 141.8326 | 27644.6009 |
| 7.0,7.0 | 19.3326 | 55.0785 | 0.7198 | 0.1931 | 550.2492 | 140.9223 | 27439.6184 |
| 7.5,7.5 | 17.9029 | 54.7146 | 0.6951 | 0.1922 | 546.6132 | 140.1528 | 27264.8142 |
| 8.0,8.0 | 16.6692 | 54.4005 | 0.6738 | 0.1915 | 543.4759 | 139.4951 | 27113.9810 |

We have identified here that customer's reaction to return due to refund is similar to that of return policy. Therefore, both ψ and ω have been considered with equal values for each experiment, whereas the values of other parameters are set values as described in the beginning of this section, and the results are summarised in Table 6. Customer will pay attention to quality when customer is less return sensitive to refund and return policy. In that case, Online retailer should provide lenient return policy and attractive refund.

Table 7: Optimal results of the sensitivity of return to quality policy (ʋ)

| Return Sensitivity (ʋ) | Refund (r*) | Price (p*) | Quality (q*) | Return Policy (s*) | Demand (D) | Return (R) | Profit (Π) |
|---|---|---|---|---|---|---|---|
| 2.0 | 50.9801 | 62.9905 | 0.6794 | 0.2250 | 629.2932 | 162.2566 | 31236.4498 |
| 2.5 | 51.1042 | 63.0339 | 0.7293 | 0.2246 | 629.7268 | 162.1632 | 31257.5380 |
| 3.0 | 51.2391 | 63.0801 | 0.7795 | 0.2241 | 630.1880 | 162.0513 | 31279.9624 |
| 3.5 | 51.3851 | 63.1292 | 0.8300 | 0.2235 | 630.6774 | 161.9210 | 31303.7433 |
| 4.0 | 51.5421 | 63.1811 | 0.8808 | 0.2230 | 631.1953 | 161.7719 | 31328.9029 |
| 4.5 | 51.7105 | 63.2360 | 0.9321 | 0.2223 | 631.7424 | 161.6039 | 31355.4653 |
| 5.0 | 51.8903 | 63.2938 | 0.9838 | 0.2216 | 632.3190 | 161.4168 | 31383.4565 |
| 5.5 | 52.0818 | 63.3546 | 1.0360 | 0.2208 | 632.9259 | 161.2102 | 31412.9044 |
| 6.0 | 52.2852 | 63.4186 | 1.0886 | 0.2200 | 633.5636 | 160.9839 | 31443.8393 |
| 6.5 | 52.5007 | 63.4857 | 1.1419 | 0.2192 | 634.2328 | 160.7377 | 31476.2935 |
| 7.0 | 52.7287 | 63.5560 | 1.1957 | 0.2183 | 634.9342 | 160.4711 | 31510.3016 |
| 7.5 | 52.9692 | 63.6297 | 1.2501 | 0.2173 | 635.6686 | 160.1837 | 31545.9006 |
| 8.0 | 53.2227 | 63.7068 | 1.3052 | 0.2163 | 636.4368 | 159.8752 | 31583.1301 |

Finally, we ran our analysis with varying values of return sensitivity for quality (ʋ) from 2.0 to 8.0. The values of the remaining parameters were unchanged. The results have been displayed in Table 7. We find here, when the customer return is more sensitive to quality, the online retailer should provide product with higher quality.

## 6.4: Stochastic Return

While our model increases the threshold of existing literatures in this topic, it is recognized that in number of ways, this research could be embellished. We have assumed in our model development that the demand & the return functions are linear. However, in reality these can be nonlinear. Also, the return can be uncertain. Therefore, based on the model developed above, we have researched further to deal with uncertainty in return.

We are going to analyse the flow of returned products, i.e., the quantity of product returned at the end of period *t*, which is obviously depends on the sales prior to *t*. This means, the return is a function of the sales. Therefore, this relationship needs to be incorporated for estimating the product returns through designing a model. For the sake of simplicity, we hereby assume that the horizon would consists of finite number of periods with identical period/duration.

At any point in time the sales of the subsequent periods are considered random. Let:

$$\check{s}(t) = s(t) + \acute{\varepsilon}_t$$

describes the random amount sold in period $t \in N_0$, where s(t) are the expected sales in period t and $\acute{\varepsilon}_t$ are independent error terms with expectation $E(\acute{\varepsilon}_t) = 0$. We do not require the error terms to be normally distributed trying to keep the model as generic as possible. Note that we do not make any assumptions concerning $s(t)$.

We further assume that a product has been sold in period *t* can be returned within a timeframe from $t + q$ to $t + z$ where $q \leq z$.

If a product is not returned within this time, it would never be returned.

*q* and *z* can be interpreted as the minimum and maximum time lag.

The probability a product *i* that has been sold in period *t* gets returned in period $t + k$ (where $k \in \{q, \ldots, z\}$) is assumed as constant for all *t* with fixed *k* and *i*. Therefore, we can say that, the return probability solely depends on the time lag *k*, but not on the period of sale *t* or on the product number *i*.

Each product is associated with a sequence of random variable either zero or one, denoting whether the product has been respectively returned or not, we can write as:

$$X_i^{t,k} = \begin{cases} 1 \; if\ product\ i\ is\ sold\ in\ period\ t\ and\ returned\ k\ periods\ later \\ 0 \; otherwise \end{cases} \qquad (8)$$

According to the assumptions from above, it is possible that a product will never be returned. Thus:

$\sum_{k=q}^{z} X_i^{\,t,k} \in \{0;1\} \quad \forall\, i, t$ holds true.

A product sold in period $t$ can only be returned in periods $t + k$, $k \in \{q,\ldots,z\}$.

Otherwise the probability of return is zero. Therefore, the time of return of product $i$ sold in period $t$ can be represented by a random variable $Y_i^t$ with support {q, ,z}. The corresponding probability mass function P ($Y_i^t$ = k ) is equal to P ( $X_i^{\,t,k} = 1$ ) and by assumption independent of $t$ & $i$. Hence, we can define,

$$p(k) := P(Y_i^t = k)$$

And, the probability that product $i$ will never be returned is given by:

$$1 - \sum_{k=q}^{z} p(k)$$

**<u>Model Function of the return flow:</u>**

Using equation (8), we can express the random amount of returned products in period r by:

$$\dot{r}(r) = \sum_{k=q}^{z^-} \sum_{i=1}^{\check{s}(r-k)} X_i^{\,r-k,k}$$

where $z^-$ := min { r, z} and $\check{s}(r-k)$ is assumed to be an integer.

To forecast the returns during period r , we calculate the expected value of return ,

$\mu_{\Gamma}$: = E [ṙ (г)]. Since, ṙ (г) is composed of random number of random variables, we use Wald's Lemma (see the appendix below) and derive:

$$\mu_{\Gamma} = \sum_{k=q}^{z-} s\,(\Gamma - k).\,p(k)$$

The return quantity can now be revised in equation (4), considering the stochastic part and this can be written as:

$$R^{*} = \text{Ø} + \psi\, r - \upsilon\, q + \omega\, s + \mu_{\Gamma}$$

The random nature of return will affect profit. Therefore, the revised profit function of the online retailer can be written as:

$$\Pi^{*} = p\,(\alpha - \beta\, p + \gamma\, r + \zeta\, q + \varsigma\, s) - r\,(\text{Ø} + \psi\, r - \upsilon\, q + \omega\, s + \mu_{\Gamma}) - \lambda q^{2} - \lambda\!\!\!^{-} s^{2}$$

## 6.5: Model Contribution and Managerial Insights

The optimal model solutions have helped to address the following questions.

1) How do optimal refund and return policy affect by customer's purchase & return decisions? Given that customer's returns are sensitive to refund, return policy and the quality of the product & services, how should the online retailer maximize profits by way of different pricing, quality, refund & return policies?

2) How do optimal refund, return policy, customer 's purchase decisions and return decisions affect the online retailer's pricing strategy? Given that customer demand is sensitive to selling price, refund, quality & return policies, how should online retailer determine its pricing, refund & return policies to maximize profit margin?

3) How online retailer's services & quality policy gets influenced jointly by refund, return policy, pricing strategy, customer's purchase and return decisions?

4) How to cater the varying types of customer's demand and returns, ensuring at the same time minimum return quantity through appropriate combination of pricing decision, refund value, quality and return policies? How should the online retailer determine its strategic position under the condition of varying customer demand & return types?

# Chapter-7: Conclusions & Future Research Direction

## 7.1: Conclusions

Tracking returned goods is a challenge for every online retailer and how can this be addressed with the help of emerging technology, has been discussed in this thesis. However, this technology factor is not explicitly considered in the model developed in this thesis.

The model can help online retail managers to determine the optimal values of business parameters, under the varying purchase and return decisions of customers, keeping a sustainable profit margin. The validation of this model with numerical examples, has demonstrated that how the online retailer should determine its strategic position under the condition of varying customer demand and return types. In this model, quality has been considered separately from base demand, as we found that quality influences customer's purchase decision. We identified that previous research works have considered refund (r) as return policy. However, we have deep dived further on return policy to understand how it is impacting e–commerce business. There are several elements which constitute return policy, for example, return facility at store or through mail, speed at which credit / exchange is made to customer, window period of free return, etc. Therefore, return policy has been introduced separately in both demand and return expressions. In the cost function, cost of setting up the return policy (T) has been considered similar to cost of quality improvement (C). And this (T) has been introduced in the profit function. One of the challenging feature of return is unpredictability and therefore, in the return function, we have introduced stochastic part successfully and the overall profit function has been revised accordingly. These have made the model more holistic and apropos considering the current apparel online retail business.

## 7.2: Practical Implication

In the model functions expressed in this thesis, all the majoring factors, have been considered, which are refund value, return policy, quality policy and price and their associated coefficient of market reaction, with respect to demand and return quantity. Sustainability of any enterprise depends primarily on its profit margin. And in this thesis, optimality has been determined for all these factors, which would ultimately support the sustainable profit. Online retailer, by applying this model, would be benefitted to remain sustainable at the same time, creating surge in demand with right policies and pricing strategy. This model is most suitable for adaptation by online apparel business.

## 7.3: Future Research Direction

In this research, it is assumed that demand is a linear function, but in reality, it can be non- linear as well as uncertain. For perishable goods, the constraint is time. If time factor be introduced in the model, it could be used for perishable items as well. Competition impacts business to a great extent. For example, in smart phone industry, apart from American manufacturers, there are Asian players, who provide stiff competition. Therefore, competition can be incorporated explicitly in the model where demand not only depends on refund, price, return policy and quality policy but also on the decisions of the competitors. Based on the model developed here, future research which includes uncertain demand, multi-channel competition and multiple-period return problems is worth exploring.

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# Appendices

## **Appendix A:** Wald's Lemma

Expected value of a random number of random variables.
Consider the sequence of random variables $\{Y_N\}$, where:

$$Y_N = \sum_{i=1}^{N} X_i$$

and $X_i$ are assumed to be independent and identically distributed with finite expected value. If the upper bound of summation $N \in N_0$ is a random variable (independent of $X_i$) itself with probability mass function $f(k) = P(N = k)$, $E(N)$ is existing, then the expected value of $Y_N$ can be expressed as:

$$E(Y_N) = \sum_{k=0}^{\alpha} P(N = k).\ E\left(\sum_{i=1}^{k} X_i\right) = \sum_{k=0}^{\alpha} P(N = k).k.\ E(X_i)$$

$$= E(N).\ E(X_i) \qquad \text{……….} \ (A1)$$

This result is often called as Wald's Lemma.

By using equation A1 where $z^- := \min\{ \text{г}, z\}$ and $\check{s}(\text{г} - k)$ is assumed to be an integer, , the expected value is derived as:

$$\mu_{\text{г}} = E\left(\sum_{k=q}^{z-} \sum_{i=1}^{\check{s}(\text{г}-k)} X_i^{\text{г}-k,k}\right) = \sum_{k=q}^{z-} E\left(\sum_{i=1}^{\check{s}(\text{г}-k)} X_i^{\text{г}-k,k}\right) = \sum_{k=q}^{z-} s(\text{г} - k).p(k)$$

**Appendix B:** Approval e-mail from IEOM for using the published material in this document.

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Dear Sir/ Madam,

I have submitted paper title "Reverse Logistics Challenges in e-commerce" at IEOM Washington DC (ID# 264), which has been accepted by the organizing committee.

I am currently pursuing MASc Industrial engineering at University of Windsor and as a part of fulfillment of the degree (MASc), I am writing thesis , wherein I am going to use the following section from the paper submitted at IEOM:-

Section 2: Literature Review.

Section 3: Reverse Logistics at a glance.

Section 4.1: Tracking Goods.

I, therefore, request you hereby, for your approval to use the content of the above mentioned sections in my thesis.

I am CC ing my supervisor Dr Walid Abdul-Kader in this e-mail.

Thanking you,

Yours faithfully,

Chiranjib Biswas

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## Vita Auctoris

Chiranjib Biswas, was born in 1973 and is currently a candidate for the Master of Applied Science (MASc) degree in Industrial Engineering at the University of Windsor and hopes to graduate in Fall 2018. Mr Biswas holds Bachelor of Technology (B Tech.) in Industrial Engineering from Regional Engineering College (now known as National Institute of Technology), Jalandhar, India. Mr Biswas has got 20 years of experience in driving business process transformation in diverse domains like Automotive, Manufacturing, Consumer Products and Financial Service in world class organizations. Before commencing MASc, he was employed with Royal Bank of Scotland (RBS) in India, as Vice President-Process Optimisation. He is PRINCE2.0 certified and Master Black Belt (MBB) trained. Mr Biswas has tutored and coached Lean & Six Sigma to hundreds of employees in industries from 2007 until 2016, in the capacity of Continuous Improvement Champion.