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RUHR-UNIVERSITÄT BOCHUM



REVERSE LOGISTICS FOR CHURN REDUCTION:

A REVIEW OF OPPORTUNITIES AND CHALLENGES

IN THE CASE OF VIETNAM'S MANUFACTURING

INDUSTRY

BACHELOR THESIS 
Vietnamese-German University

BINH DUONG 2021

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Thesis title

Reverse logistics for churn reduction:
A review of opportunities and challenges in the
case of Vietnam's manufacturing industry

A thesis presented

By

Le Hoang Trong Minh



Vietnamese-German University

Submitted to the department of Mechanical Engineering of the
RUHR-UNIVERSITÄT BOCHUM and VIETNAMESE-GERMAN UNIVERSITY
in partial fulfillment
of the requirement for the degree of
BACHELOR IN MECHANICAL ENGINEERING

Nov 2021

Major: Mechanical Engineering

Abstract

Due to the growing in environmental concern and the competitiveness of sustainable development, reverse logistics, which relatively new idea in Vietnam for both scholars and business men, has become a field of relevance for many organizations in recent years. In the thesis, aspects of reverse logistics will be review which including definition, foundation and model of reverse logistics. The barriers for implementation of reverse logistics according the practice in Vietnam will also be defined. Finally, a review about a Markov chain model approach for forecasting the distribution of products will be defined with numerical example.

Affirmation

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Chapter 1: Introduction

1.1 Define problem

During the last decade, with the increase of urbanization and industrialization, the economic has developed rapidly and the population growth has been remarkable, which lead to the raise in the living standard in many countries. Moreover, the life cycle of products recently is shorter day by day and the modern living style of many consumers make them easy to give up on old product and buy a new version of that product. As the result of those practice, the amount of discarded and returned products increase rapidly which raise the concern about the environmental condition at this rate of economic growth. Reverse logistics appeared to be a suitable method to deal with returned and discarded products for sustainable development in order to archive both ecological and economic goals. On the other hand, the management of reverse logistics is real challenge for any organization applying it as the returned product is a big problem as it is random in many aspects. Finding an effective forecast method for the returned products will provide the organization with valuable data for an effective processes management in reverse logistics.

About the reverse logistics in Vietnam, both academic scholars and business participants are still learning about this new concept. The implementation of reverse logistics in Vietnam is just at the early state for most industry sectors, especially in manufacturing industry. Moreover, with the increase in the amount of product consumed and discarded, the increasing in policies and laws for end-of-life products and the need of changing business model have created the motivation for companies from many sectors to pay more attention on the management of reverse flow. However, implementing reverse logistics might face some barriers directly affecting the effective implementation.

1.2 Aim of the thesis

With the problems are defined, the aim of the thesis is to study within three problems:

Firstly, the thesis has to research theory around reverse logistics to answer the question:

- What is reverse logistics in supply chain?

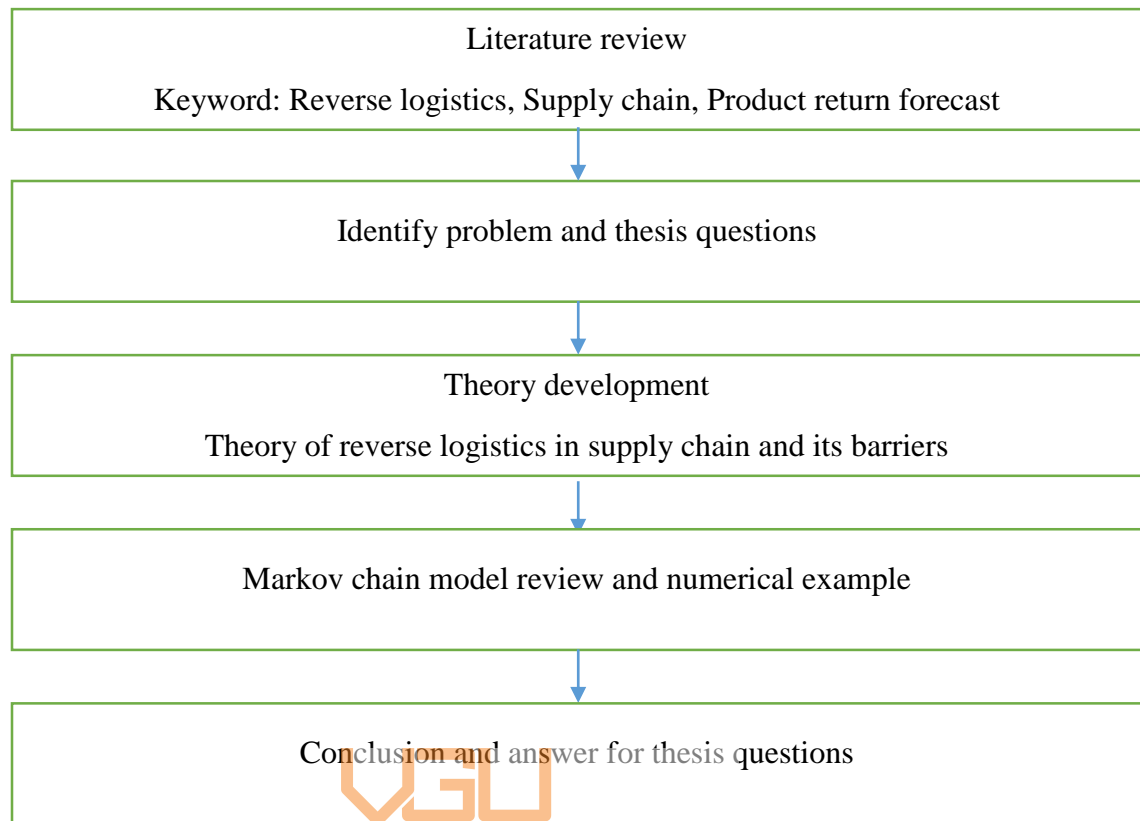
Secondly, the thesis has to define the barriers of reverse logistics to answer the question:

- How do the external and internal factors influence reverse logistics implementation in Vietnam?

Finally, the thesis will review a Markov chain model approach for predicting the distribution of products at different states in reverse logistics.

1.3 Thesis procedure

The thesis procedure is illustrated in Figure 1 as follow:



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Figure 1: The procedure of the thesis

Chapter 2: Literature review

2.1 Definition of reverse logistics

The theory of Reverse Logistics (RL) has been researched and evolved over the years, and authors have defined the definition of RL in different ways. Many statements have been made to describe the process of good recall or reverse flow of goods but none of them were mentioned as reverse logistics.

One of the earliest definition of reverse logistics was given by Lambert and Stock in 1981. The definition was made to describe the activities or objects that were not following the common rules of most other shipments: “Some movement is going in the wrong way according to the forward direction because most shipments are going in the same direction.”.

The next definition was found to be given by Murphy and Poist in 1989. They described reverse logistics as the flow of goods from a consumer to a producer in a channel of distribution.

In 1992, a similar but extended definition comparing to Murphy and Poist’s was stated by Pohlen and Farris as: “The movement of goods from customers toward manufactures in channels of distribution”.

Also in 1992, the Council of Logistics Management gave a definition which stressed the recovery aspects of reverse logistics. Reverse logistics is the term often used to refer to the role of logistics in recycling, waste disposal, and management of hazardous materials; a broader perspective includes all issues relating to logistics activities to be carried out in source reduction, recycling, substitution, reuse of materials and disposal.” (Stock, 1992). In 1993, Kopicky showed another definition for reverse logistic. According to Kopicky, reverse logistics is a phrase relating to the management of logistics and handling activities of packaging, harmful or non-toxic items; and it encompass the flow of goods and information in the reverse direction of forward logistical activities.

In 1997, a definition focusing on the ability of reverse logistics of transforming removed items with the purpose of partly recovering these items value was showed by Fleischmann. Fleischmann defined reverse logistics as a process that encompasses all logistical activities involving the transformation of products that no longer fit consumers’ criteria into marketable reusable products.

Later on 1998, the term “environment” was first mentioned in the definition of reverse logistics with the concept: “Reverse logistics is the process whereby companies can

become more environmentally by minimizing, recall and recycling used materials.” by Carter and Ellram.

In 1999, Rogers and Tibben-Lembke published the most generally used term of reverse logistics as “Reverse Logistics is the process of planning, implementing, and controlling the efficient, cost effective flow of raw material, in process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal.”.

Later on, there are many new definitions with little changes based on different perspectives.

To be summarized from above definitions, there are some aspects of reverse logistics:

- The main targets for reverse logistics are diverse. They can be raw-materials, semi or fully finished items, packaging, industrial waste or scrap.
- The reverse logistic flow is the total opposite of usually logistics flow (forward logistics flow), which generally is the return from customers to manufacturers.
- Using reverse logistics, the goal is to partially recover the value of goods while also removing waste and scrap as needed to address environmental and economic concerns.

Finally, the thesis propose reverse logistics based on above three aspects is :

“Reverse logistics is a method to optimize the flow of goods in the opposite direction of general logistics flow in order to recover the value of goods as well as reduce the amount of waste or scrap due to the environmental problems.”

2.2 Fundamental of reverse logistics

In the early of 1970s, wastes from private households, industry, business and agriculture, including toxic trash, were dumped in local landfills untreated, which relatively raised the concern about environmental degradation. Also during the 1970s, many countries have realized problems from the rapid pace of industrialization and societal issues, which included the overload in exploiting, producing, consuming and wasting. All of these have resulted in the resources crises and environmental issues which can be seemed as a big challenge for sustainable development of production and consumption. Sustainable development was primarily characterized as the harmonization of “triple-bottom line” factors of economic, environmental and social aspects, with the roles of meeting the current generations’ demands while not harming future generations ‘ability to fulfil their own demands.

In the late of 1980s, a new economic growth model known as “closed-loop economy” arose with the goal of achieving sustainable development. Its main principles are “Reduction, Reuse and Recycle”. The “reduction” concept aims to reduce the amount of resources and energy consumed in producing and consuming activities while also reducing pollution. The idea of “reuse” is to maximize the remaining values of returned items through effective processes of recovering. The principle of recycling is to convert waste or scrap to secondary resource and reduce waste for final disposal. The closed-loop economy is suitable for achieving ecological balance in economic operations, reducing pollution; and improving the quality of economic development.

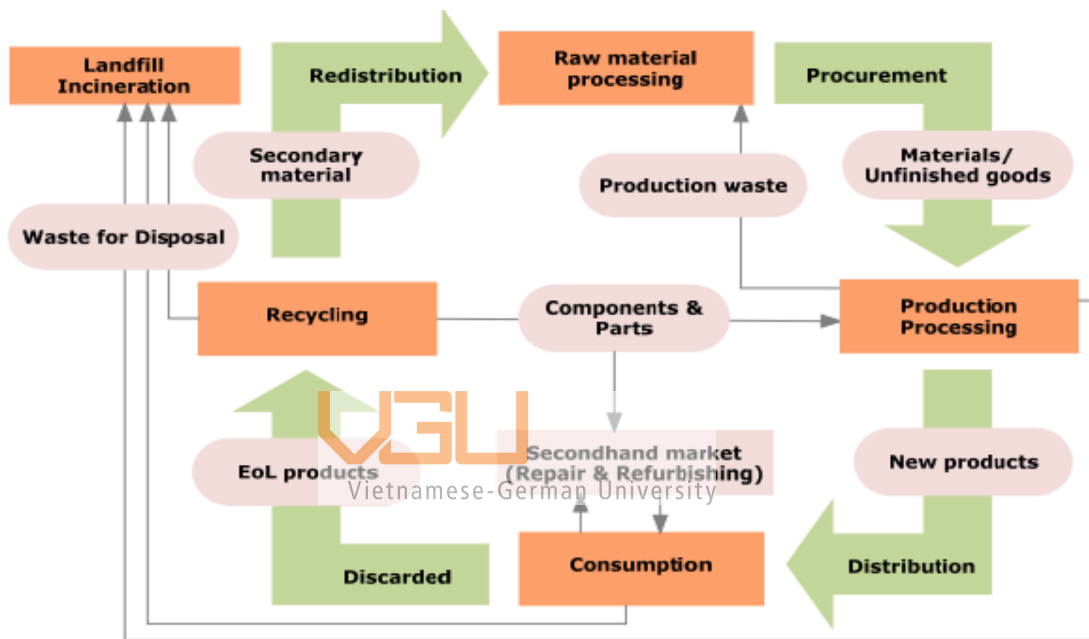


Figure 2: A close-loop economy model (Baumgarten/Walter,2003)

With the present of closed-loop economy, waste management have had a new way to approach by emphasizing closed-loop economy’s key principles of “reduction, reuse and recycle”. The new waste management method is used as one of the aspects utilized to ensure sustainable growth by managing the issue of wastes in the economic and ecological way, which necessarily involves the support processes of collection, transportation, storage, classifying, evaluation, disassembling and restoration. The new waste management approach is also considered as logistics management of waste stream (waste logistics), and it is firstly considered as the foundation of reverse logistics in 1990s.

Although reverse logistics is developed based on waste management, it is different at some points. Reverse logistics concentrates on items that have recover value, which will enter a (new) supply chain after treating processes. While, waste management focuses on

that goods that have no reusable potential after processes of treatment, which will be eventually ended up at landfill sites or incinerations plants.

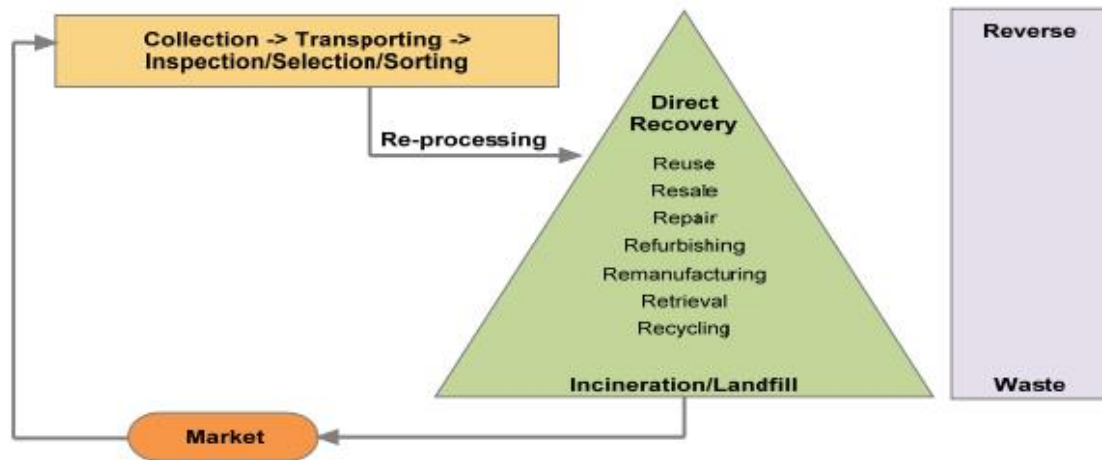


Figure 3: The difference of reverse logistics and waste management (Brito,2003,40)

2.3 Supply chain management and reverse logistics

2.3.1 Overview of supply chain

As the concept of sustainable development was created in the 1990s, it was presented and applied to a variety of fields including management, engineering and supply chain. As the result, supply chain has become a common topic for many authors, resulting in the definition of several supply chain concepts from various perspectives, and some typical concepts can be mentioned:

- According to Christopher (1992), a supply chain is a network of organizations that are involved in various processes and activities that produce value in the form of goods and services given to end consumers via upstream and downstream linkages.
- The supply chain was defined by Ganeshan and Terry (1995) as a network of production and distribution options for trading inputs, converting them into semi-finished or finished items and distributing them to clients.
- Chopra and Meindl (2001) demonstrated that the supply chain encompasses all necessary procedures that meet consumers' needs, whether directly or indirectly. Not only do manufacturers and suppliers play a role in supply chain, but so do transportation, warehouse, retailers and customers. Alternatively, supply chain can be defined as the interconnection of suppliers, customers, manufacturers and service providers in the context of a business process.

In general, supply chain is described as a group of three or more “members” (organizations or people) involved in the direct forward or reverse movement of “products” (goods, services, information, and money) from the original inputs to end consumers.

From the definition, three degree of supply chain complexity can be defined: a “direct supply chain”, an “extended supply chain”, and an “ultimate supply chain”.

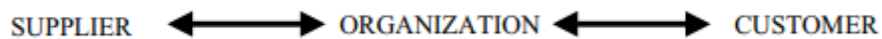


Figure 4: Direct supply chain

(Source: Journal of business logistics, Vol.22, No.2,2001)

A direct supply chain involves the forward and/or reverse flow of items, services, money, and information between a supplier, an organization, and a customer.

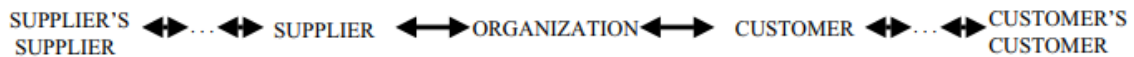


Figure 5: Extended supply chain

(Source: Journal of business logistics, Vol.22, No.2,2001)

An extended supply chain is made up of a number of suppliers and customers, all of whom are involved in the forward and/or reverse movement of goods, services, money, and information.

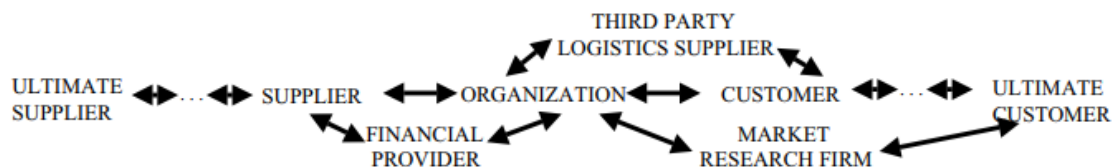


Figure 6: Ultimate supply chain

(Source: Journal of business logistics, Vol.22, No.2,2001)

The members of an ultimate supply chain are essentially the same as those of the other two degrees (suppliers, organizations, and customers). Aside from those, there are others external participants in the supply chain who play various responsibilities. In this example supply chain, a financial provider may provide funding, assume business risk, and provide advices; a third-party logistics provider handles logistics between two members; and a market research firm provides data on the eventual client to the organization.

Due to the complexity of supply chains, the management of those supply chains relatively play an important role to archive the sustainable development. Supply chain management deal with all the issues relating to the full complexities of the designing, planning,

operating and controlling of value chains and networks that extend beyond individual enterprises and their immediate suppliers and customer relationships (Klaue,2009) in order to achieve the goal of delivering goods and/or services to ultimate consumers; linking movements from raw material suppliers to final disposition; and archiving the overall effectiveness in the supply chain (e.g. cost, time and quality) and bringing values to ultimate consumers. In order to archive the goals, supply chain management must establish a collaboration approach that emphasizes the integration of functions, instruments, and organizations; which is required to ensure economic, environmental, and social performance throughout a product's lifecycle.

2.3.2 Model of reverse logistics process

Traditionally, reverse logistics has been a function within organizations delegated to logistics, customer service, or marketing departments, where customers with warranted or defective products can returned them to their suppliers (Ha Nguyen, 2012). After acquisition process, returned products are collected and brought to the locations where they are checked and classified into different categories. Then, depending on the decisions made, they will be repaired, remanufactured, recycled, reused, or final disposed to recapture the most value. Finally, recaptured value products are distributed into original or new supply chain. To summarize, reverse logistics process includes of five key processes: product acquisition, logistics, disposition, recovery, and redistribution.

- Product acquisition is the process of acquiring of returned or discarded items from the last users. There are two types of product return which are planned return and unplanned return:
 - o Planned return can normally be seen as a form of programs which encourage customers to return their used products for something in exchange; and this makes organizations feel ease because they know what will be returned and when:
 - Trade-in program: where companies allow clients to trade in old products for a portion on new products.
 - Company take-back: where companies collect end-of-life products from consumers for both commercial and environmental reasons.
 - Leased or rented products: where clients return items at the end of renting periods.

- Service work: where good is delivered to a repair center to be fixed and subsequently returned to consumer.
 - Unplanned return cause more difficulty for organization. Normally, products of unplanned return are uncertain in term of reasons, time, products' quality and quantity:
 - The customers changed their minds.
 - The consumer claimed the item was defective.
 - The item was harmed during transport.
 - Warranty return.
 - A problem with the seller (such as wrong type of product or number of products delivered).
 - Warranty return.
 - The manufacturers perceived the products to be defective and make products recall.
- Logistics is the set of processes of collecting, transporting, consolidating, handling, and storing returned products from the acquisition points to the disposition points.
- Disposition may appear to be the most significant phase in reverse logistics processes as it is a critical process for establishing the profitable reverse logistics. As the condition of the returned products are possibly unknown, they have to be inspected and sorted before being disposed in the way that maximize their value. There are several ways that returned products can be disposed based on the condition of returned products:
 - Reuse: when a product package is reused or an item is return to store for reselling to different consumers.
 - Repair/Repackage: where a returned product that has undergone with suitable repairing or repackaging can be allowed to be reused.
 - Resale: where products is resold to the secondary market.
 - Return to supplier: when a product acquired from a supplier is returnable under the terms of the supplier's return policy.
 - Recycle: when returned product is broken down and disassembly for components which are later utilized for other purposes.

- Renew: when the functionality of an old product is restored by replacing broken pieces or remanufacturing in some way so that it can be placed back into service.
- Junk: where broken products or components, which are unable to repair, renew or reused, are sent into landfill.
- Recovery is the process where products are being processed based on the disposition choices (repair, resale repackaging, remanufacturing and recycle)
- Redistribution is the process of delivering recovered products back to market (remarketing and developing market for recovered products) and delivering junk to landfills.

2.3.3 Reverse logistics in supply chain

Reverse logistics is currently playing an essential role as a sustainability measurement for development of a sustainable supply chain, with the main purpose being to collect and recycle used items and resources. This is shown through the coordination of reverse logistics with other processes to contribute economic and ecological goals for firms. Furthermore, recycling and reuse can produce extra values and economic advantages for each and every member of the supply chain. Therefore, it is strategically important for reverse supply chain (reverse logistics) to integrate in the entire supply chain in order to achieve the optimization for supply chain activities. Moreover, from a tactical perspective, reverse supply chain has also played the role of closing “the-loop” for supply chain management; and transforming traditional supply chain into the form of closed-loop supply chain.

A closed-loop supply chain is a network consisting of the original supply chain (forward supply chain) connected to reverse supply chain. Comparing to the original supply chain, closed-loop supply chain can be seen as a broader view of supply chain as it is capable to deal with the return flow of after used goods with the help of reverse supply chain which is impossible for traditional supply chain. For this reason, a closed-loop supply chain is more suitable to archive both goal of economic and ecological goals of the sustainable development.

However, as integrating with the reverse supply chain, closed-loop supply chain has to consider a lot of different costs of reverse logistics including costs for acquisition, sorting, transporting, recovering and redistribution. Moreover, the integration with reverse logistics has added more complexity into the whole supply chain management with all the issues of planning and organization structuring for product design recovery, re-

engineering, product data management, installed base support, or evaluating end-of-life scenarios (Nguyen Ha, 2012). For these problems, it seems impossible to create a close-loop supply chain to obtain both economic and ecological goals at firm level approach. On the other hand, closed-loop supply chain with network-level approach can be a possible broader view to reach the sustainable goals. With this network-level approach, the operation of reverse logistics requires the active participation of other members in the supply chain. This will make reverse supply chain an open system where other firms can join and share the resource and capability in managing processes of acquisition, inspecting and sorting, reuse, recycling, remanufacturing, redistributing and discarding of returned products following the principle of closed-loop economy and total life cycle basic of a product from the original firm.

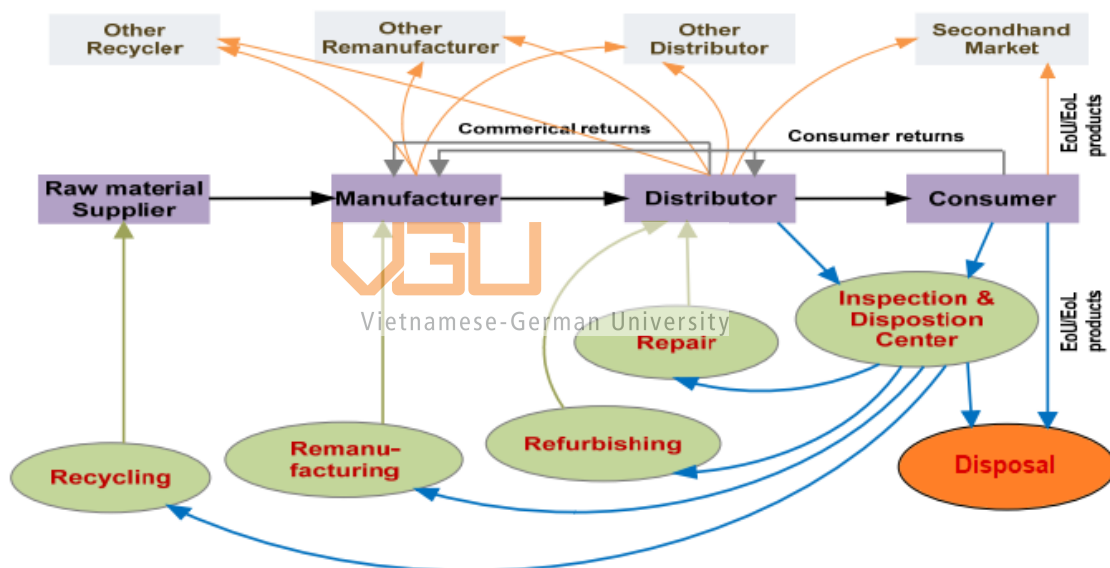


Figure 7: Model of closed-loop supply chain with reverse logistics (Nguyen Ha,2012)

2.3.4 The difference between forward logistics and reverse logistics

Although forward logistics and reverse logistics are both main components of closed-loop supply chain, they are different in many aspects. According to Tibben-Lembke (2002), forward and reverse logistics are compared based on different criteria:

Forward	Reverse
Forecasting relatively straightforward	Forecasting more difficult
One to many transportation	Many to one transportation
Product quality uniform	Product quality not uniform
Product packaging uniform	Product packaging often damaged
Destination/routing clear	Destination/routing unclear
Standardized channel	Exception driven
Disposition options clear	Disposition not clear
Pricing relatively uniform	Pricing dependent on many factors
Importance of speed recognized	Speed often not considered a priority
Forward distribution costs closely monitored by accounting systems	Reverse costs less directly visible
Inventory management consistent	Inventory management not consistent
Product lifecycle manageable	Product lifecycle issues more complex
Negotiation between parties straightforward	Negotiation complicated by additional considerations
Marketing methods well-known	Marketing complicated by several factors
Real-time information readily available to track product	Visibility of process less transparent

Figure 8: The difference between forward logistics and reverse logistics (Tibben-Lemke, 2002)

- Challenging to forecast: Reverse logistics seems to be more difficult to plan than the forward logistics as the returned products are unpredictable in term of quality, quantity, and time. According to Tibben, reverse logistics generally follow movement of forward logistics, which means that a large quantity of sold items are expected to have a large return volume of items later.
- Many to one transportation: The number of origin and destination sites is one of the most significant differences between forward and reverse logistics. Forward logistics transports goods from a single point of origin to multiple destinations (e.g. from raw material to many distributors). Reverse logistics movement, on the other hand, occurs from several origins to a single destination (e.g. from many customers to recall center or waste treatment point).
- Product and packaging quality: Products in forward flow are normally one type of product and are in a complete packaging with all the information, which make it easy to stack and control the quality and quantity of products during transit. Whereas the products from reverse flow is various in term of type, packaging, quantity and quality which make it difficult to stack for transit.
- Destination/routing not clear: The destination and routing of forward flow is planned as it starts from original supplier and move to the end customers according customer's requirement. In contrast, after the acquisition process, the next destinations for the products of reverse flow are unclear as the condition of

returned products are unknown. As the result, all the product of reverse flow need disposition process to decide their next destination.

- Pricing not uniform: Products of the same type from forward flow are uniform in term of quality, and this make the range of price for the product is uniform. For reverse flow, the condition of products after reprocessing are different, which leads the price for those products are vary depending on the deal of the firm with different brokers from different markets.
- Different importance of speed: The speed of forward flow in supply chain are important as it will affect the value of the product and the satisfaction of the customers. If the speed is slow, the value of the products will decline and the satisfaction of customers will decrease. On the contrary, the speed of reverse flow is not as priority as recovered value of the product, which is the main concern of firms and customers.
- Difference in nature and visibility of costs: The forward logistics is simpler as its inventory costs only including ordering, transportation, handling and holding costs, which make its costs are easier to predict and plan. Meanwhile, reverse logistics involves all the cost from forward logistics plus all the cost for collecting, sorting, remanufacturing, recycling and redistribution, which make its costs more difficult to predict and higher compared to forward logistics.

Cost	Comparison with forward logistics
Transportation	Greater
Inventory holding cost	Lower
Shrinkage (theft)	Much lower
Obsolescence	May be higher
Collection	Much higher – less standardized
Sorting, quality diagnosis	Much greater
Handling	Much higher
Refurbishment/repackaging	Significant for RL, non-existent for forward
Change from book value	Significant for RL, non-existent for forward

Figure 9: Reverse logistics costs capered to forward logistics costs (Tibben-Lemke, 2002)

- Inventory management not consistent: Inventory in forward logistics is vary depending on the demand from the market, which make the management of forward logistics easier as there are many proper inventory management methods for forward distribution. Meanwhile, the arrival of products in reverse

logistics are random and the distribution of products after remanufacturing are depending on many factors (brokers, season, etc.). As the result, all the inventory methods for forward logistics cannot apply for reverse logistics.

- Product life cycle issue more complicated: In reverse logistics, the life cycle of goods is much more significant than in forward logistics. The product will become secondary when it has completed its life cycle and has been sent to reverse logistics in order to reclaim as much of its value as possible. Remanufactured secondary product can be divide into two group: secondary product belongs to class of product that is no longer produced, which will be sold at a very low price, and secondary product belongs to class of product that still have high demand in the market, which can be sold at a higher price.



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Chapter 3: Barriers for implementation of reverse logistics in Vietnam

With a population of approximately 100 million people, Vietnam has experienced massive demographic and economic growth in recent decade. Vietnam's gross domestic product (GDP) has grown at the rate of roughly 6.5% over the last three years, outpacing the GDP of many SEA countries. In recent years, Vietnam has also had the high average income, with a GDP per capita of \$2600. With the high average income and 36% of the population living in urban area, the new of modern life style have been formed which relatively increased the demands and consumption of goods. Moreover, Vietnam is now having 4 main economic areas including agriculture, exploiting, manufacturing and retail, in which the share of economic sector in GDP of manufacturing and retail have remarkably increased within the last decade. According to the diagram below, the trend of agriculture is downward while the trend of manufacturing and retail show the remarkable increase which can tell Vietnam are on the trend of industrializing as turning from agricultural country to an industrial country. With the trend of industrialization and the increase in goods consumption, the amount of discarded products and waste has also rapidly increased which result in the big conflict between economic growth and environmental issues affecting the development of Vietnam in recent years.

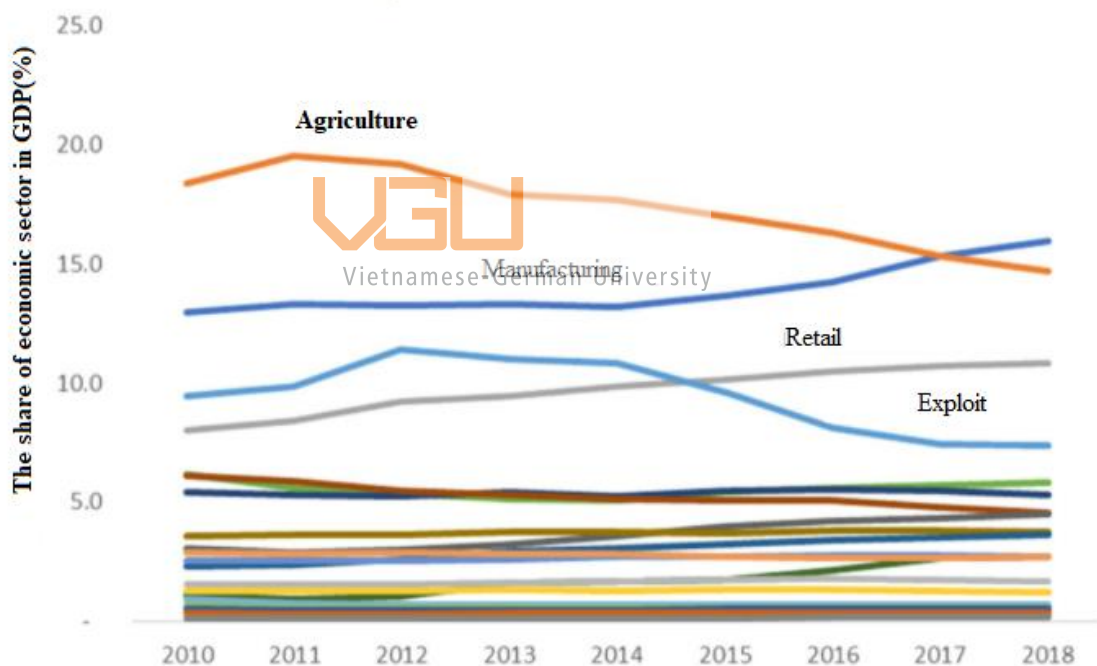


Figure 10: The share of economic sector in GDP (%) of Vietnam

(source: General Statistics Office of Vietnam)

Reverse logistics, also known as return management, appears to be a viable solution for resolving the contradiction between economic growth and environmental concerns as roles of reverse logistics are collecting, reuse, and recycling. However, the notion of reverse logistics is still relatively new in Vietnam, both in academia and business. Furthermore, environmental issues and reverse flow management appear to be less relevant in Vietnamese business management, as nearly 90% Vietnamese companies are small or medium size companies, focusing primarily on the value created by forward flow.

Beside those practices, the implement and development of reverse logistics in Vietnam are also effected by many others factors, which includes external factors and internal factors.

3.1 External factors influencing the development of reverse logistics in Vietnam

External factors are factors that come from outside the range of an individual company which include law and regulation, consumers' awareness, behaviors and demands, and collaboration among members in the reverse logistics network.

Law and regulation:

Legislation is considered as one of the key factors affecting the implementation of reverse logistics together with customers' awareness. Legislation has been enacted supported consumers' awareness, which will, in turn, affect the behavior of consumers. In recent years, the law of Vietnam became more restrictive with many regulations on the quality of the products and consumers' protection. The laws forbid the manufacturers and distributors to provide and sell products that have potential of harming people or surrounding environment, and make it mandatory for manufacturers to take responsibility to collect and dispose the harmful products properly. Moreover, vendors must also refund or exchange defective products returned by customers, according to the laws. These laws require both manufacturers and sellers to pay more attention and take responsibility on the after-sale service and return management of end-of-life products. Furthermore, the government provides variety investment opportunities to encourage businesses to invest and participate in collecting and recycling end-of-life products, which can be seen as the prerequisite for growth of reverse logistics in Vietnam. However, despite of all the laws and regulation are made, there is still a big challenge as the lack of enforcement of the laws which result in the unwillingness of customers and the reluctance of firms.

Customer awareness, behaviors and demands:

Along with legislation, customer awareness is additionally a key factor affecting the implementation of reverse logistics. In Vietnam, the awareness of Vietnamese people about environment has been increased in recent years as the result of the improving and specification of environmental laws and regulation as well as the massive amount of available knowledge and information about environmental issues. People now can have a clear view on the interdependent human-nature interaction, in which each individual human activity has impact on the nature, which in turn impacts the humans. However, a portion of Vietnamese population still lack of an appropriate understanding about this relationship, creating barrier for implementation of reverse logistics in Vietnam.

Consumers behavior is described as a unique independent factor of the reverse logistics network which can decide whether the returned and disposal of products are processed properly or not. From a bigger view, consumers are considered as supply source of returned products, since they can participate in recycling process by separating and delivering the discard items to the right pick up sites. In Vietnam, people normally separate products into two types: products with usage function and products without usage functions. For products with usage functions, people can repair for reuse, resell, return or exchange to appropriate collectors (e.g. secondhand market, retailers, etc.), or give to other people or charity. For products without usage functions, Vietnamese people

will directly discard products or resell to junk buyers for money. With the variation in the behaviors of consumers, it is a big challenge for a firm to collect the returned products of its own firm for further processes in reverse logistics.

Other than supplier, consumers are also potential sources of demand for future market of returned products. However, the awareness of consumers about the quality of products as well as the service have increased recently which created a big challenge for returned products to compete with brand new products in the future market.

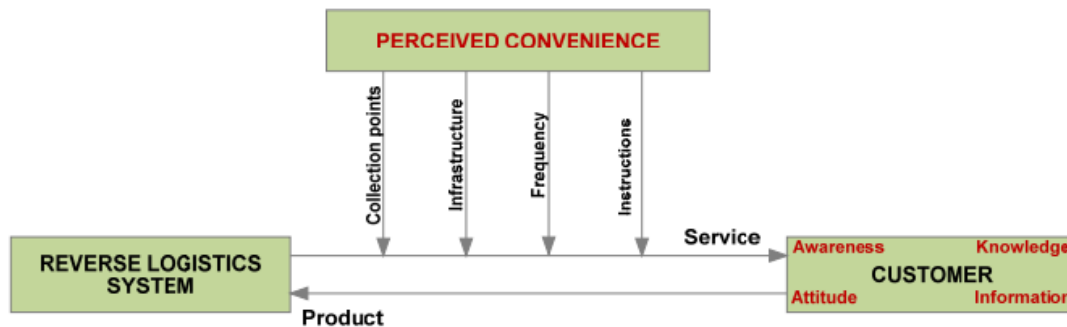


Figure 11: Customer interact with reverse logistics (Nguyen Ha,2012)

Collaboration among partners from reverse logistics network:

The collaboration among partners from have become more popular in recent time. The members of the network are varying and can be divided into two main group including internal members (e.g. suppliers, distributors, service providers and customers) and external members (e.g. independent organizations). The role of collaboration is to help decrease operation cost and the complexity in every states of reverse logistics processes. For acquisition processes, with a large amount of returned products from consumers coming from many destinations, it will cost a lot for the original company to collect the return products alone (e.g. cost for collecting facility, cost for warehousing and cost for logistics). On the other hand, with the involving of collectors (e.g. local waste management and collecting organization, retailers and service providers), the actual cost will be low as collectors have their own suitable facility for the acquisition processes. Similar for recovering processes, with the participation of manufacturing companies having recovery system will help the original firm save ton of money on setting up own recovery system. The effectiveness of network collaboration is also determined by factors such as the regularity of interactions, the sharing of information, expertise and technology, the opportunities of combing resources and developing capabilities between members in the network. These aspects will help improve the relationship between members, improve the plan for reverse logistics, make suitable and profitable deal between members and improve the service for consumers.

3.2 Internal factors influencing the development of reverse logistics in Vietnam

Internal factors are factors from the own original firm including the policy of the company, the support from the top management, the cross-functional integration and the utilization of resources.

Top management support:

The support from top management is considered to be one of the most critical internal factors in reverse logistics implementation. The supportive top managers will have high awareness about the complexity as well as the risk for commercial, the return of repairable, end-of-use or end-of-life products. They also integrate reverse logistics with other members in supply chain, create the reverse supply chain according to organizational logic, develop the appropriate level of supervision, make strategic decisions and distribute company resources for reverse logistics management. The lack of support and commitment for top management is a barrier for reverse logistics as it prevents firms from having a clear vision as well as the ability to adapt with reverse flow, which can be shown through unclear policies for reverse logistics, poor product recovery strategies and an ineffective resources distribution.

Company policy:

Company policy has a significant impact on reverse logistics implementation, particularly during the acquisition state, because it can directly influence the distribution of labor, money, resources, technology and the indication of firm's goal. To achieve a successful reverse supply chain management, company policies must be flexible enough to adapt to the requirements of laws, the consumers' demands and the possible benefits of returned products. For the case in Vietnam, there are about 120,000 firms working in the manufacturing industry but about 98% of them are small or medium size firms which result in less awareness about reverse logistics. Many firms' policies show less attention for reverse logistics, which can be shown through unclear return policies for consumers or no guide line for product disposition and recovery, as reverse logistics is not an important factor to earn profit for business.

Cross-functional integration:

The support of top management is necessary but insufficient for a wide range of activities in the chain, which lead to the need of integration of cross-functional for the implementation of reverse logistics. Within a firm, activities related to reverse logistics (e.g. return authorization, collection, disposition, product recovery, processing or credit funding) are intertwined with many cross-functional procedures from different departments (e.g. operations, logistics, marketing, sales, accounting and finance). The integration enables departments within a firm to share the information and knowledge which is used for analyzing, improving and developing all the activities in reverse logistics to make them operate more effectively and economically. Firms with closer cross-functional integration may be better at facilitating the internal knowledge and information, which create continuous innovation capabilities in reverse logistics management (Nguyen Ha, 2012).

Utilization of current resources:

The utilization of current resources can be seen as the priority factor in implementing reverse logistics as effective resource utilization helps reduce the overall operation cost. Resources in reverse logistics include equipment, labor, facility, and information technology. For equipment and facility, by utilizing current equipment and facility

effectively in recovering and distributing processes, firm can save lot of money spending on acquiring new equipment or facility, and on the independent external company to operate these processes. For labor, firms can utilize them for a minimum addition cost by giving a proper training on knowledge and skills so they can undertake the operation of reverse logistics at some processes. For information technology, this is the most precious resource for any firms. Due to the randomness of returned products and complexity of reverse logistics, information technology is now playing a critical role for the effective reverse logistics management. The main role information technology is collecting data from every states in reverse logistics network, integrating and sharing information with other members in the network, using collected data for analyzing and predicting the future trends which will be used as utilization for future planning, processes performance improving, decision making and more.



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Chapter 4. Forecasting of product distribution in different states

4.1 Problem defined

From chapter 3, there are many factors effecting the implementation of reverse logistics. We can also see that all the factors are relating to consumer in some aspects which make consumer behaviors a priority factor to be considered in every reverse logistics implementation. The behaviors of consumer for products are vary and random which make it hard to predict the flow of products. Markov chain model can be seemed to a suitable model to predict the random distribution of product based on the data collected at one specific period.

4.2 Markov chain model

The application of Markov chain is useful as it can be used to study the uncertainties of many repeated events. It is also used to study and analyze a stochastic system.

Suppose X_n with $n \geq 0$ denotes a random variable on the discrete space S . The sequence $\{X_n, n \geq 0\}$ is called a stochastic process. A stochastic process with finite state S is said to be a Markov process for any state i, j of the state space S and $n \geq 0$ if:

$$P\{X_{n+1}=j|X_0=i_0, X_1=i_1, \dots, X_{n-1}=i_{n-1}, X_n=i\} = P\{X_{n+1}=j|X_n=i\} = p_{ij}$$

The P is the probability is the probability of Markov chain for transitioning from state i to state j , which is also called as one- step transition probability. According Markov property, the probability of transitioning to the next state depends only of the present state and not on the previous states, which mean the probability to state j at time $(n+1)$ depends only on current state i at time (n) and not on time $0, \dots, n-1$.

The transition probability p_{ij} is said to be homogeneous if it satisfies the following conditions:

- $0 \leq p_{ij} \leq 1$
- $\sum_j p_{ij} = 1$

As discussed, the state space S is finite and countable which can be written as $S = \{1, 2, 3, \dots, k\}$. With this state space S , the transition matrix consists of all the transition probability and can be expressed as:

$$P = \begin{bmatrix} p_{11} & \cdots & p_{1k} \\ \vdots & \ddots & \vdots \\ p_{k1} & \cdots & p_{kk} \end{bmatrix}$$

P is considered as the stochastic matrix as the sum any row will be 1. A state in state space can be considered as transient if $p_{ii} < 1$ or absorbing if $p_{ii} = 1$. It is impossible for any entity to leave the absorbing state when it enters, and it is possible for any entity to approach absorbing state from any transient states.

Any Markov chain model is defined by state and transition matrix. If Markov chain have the initial state vector $v^{(0)}$ at the time $t=0$ and the transition matrix P_{ij} , the future state matrix after n transition at $t=n$, $v^{(n)}$, is calculated by multiplying the initial state vector $v^{(0)}$ by the transition matrix after n step P_{ij}^n :

$$v^{(n)} = v^{(0)} \cdot P_{ij}^n$$

4.3 Modeling and assumption

The model is used to consider the returned products through various state of reverse logistics. An independent state and transition matrix is considered to determine the future state in Markov chain. Each transition occurs at the fixed point of time and stop time is not considered for any states. To summarize, the procedure will include of 4 steps: defining returned based Markov chain model, defining state matrix, defining transition probability and calculating the possible returned products.

After being sold, products are described to undergo many different states before ending up at landfill. States can be summarized as:

- Consumer
- Collecting (second-hand market, collecting point, retailer, etc.)
- Sorting
- Recovering (repairing, remanufacturing, recycling, etc.)
- Disposal

Products is defined to move from one state to another states with different probabilities. The probabilities of a product disposed from consumers, collecting, sorting, recovering state can be denoted as P_d , P_{cd} , P_{sd} , P_{rd} , respectively. The probabilities of products transited from consumer to collecting and recovering state are denoted as P_{cc} , P_{cr} , respectively. The probabilities of products transited from sorting and recovering states to consumers are denoted as P_s , P_r , respectively. Finally, the probabilities of products transited from collecting to sorting state and from sorting to recovering state are denoted as P_{cs} , P_{sr} , respectively. With these probabilities, the transitions model is demonstrated as below:

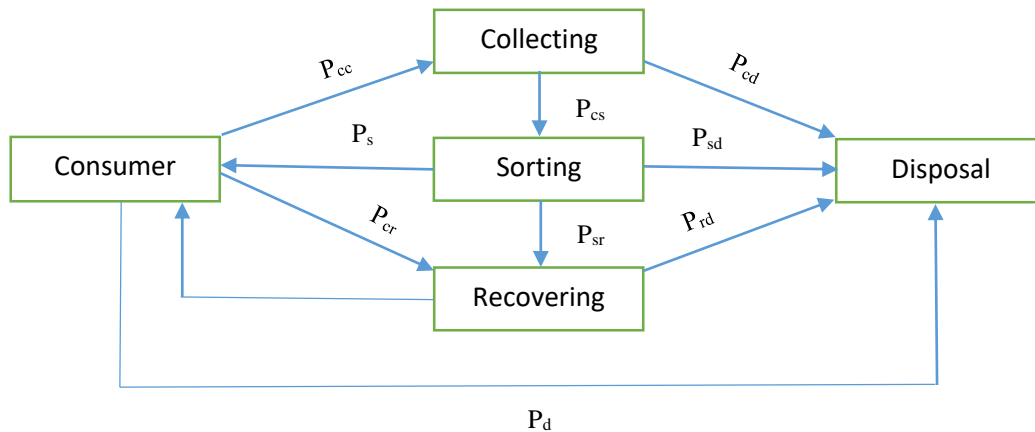


Figure 12: The overall transition model of a product

Following the transition model, some assumptions have to be made to determine states in the Markov chain:

- All transitions occur at a given moment in time and the duration time between states are not considered.
- Collecting, sorting, recovering are separated processes. But, in this model, we will consider them as one recovering state.
- The quality of products is not taken into account.
- In practical, consumers can give the products that they do not use anymore to another consumer. We will consider this case the same as self-use which means the product as consumer state will have the transition probability to consumer state.
- Disposal state is considered as the absorbing state.

With those above assumption, the model can be simplified to three state model of Markov chain including:

- Consumer
- Recovering (collecting, sorting, repair, remanufacturing, recycling, etc.)
- Disposal

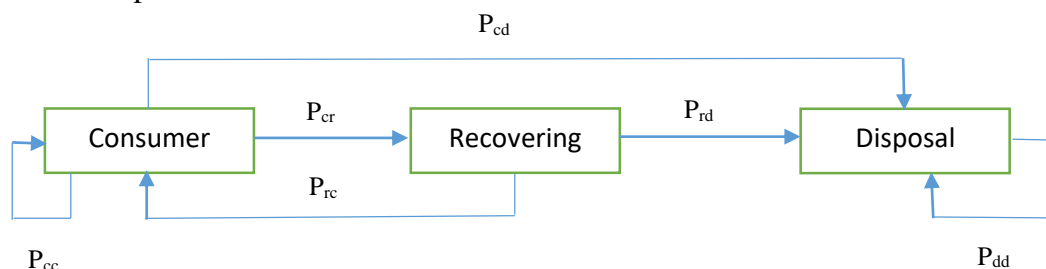


Figure 13: The simplified transition model of a product

With the demonstration of above simplified model, products move from consumers to recovering state and disposal state with the probabilities P_{cr} , P_{cd} , respectively. Available of using products can be sold or exchanged to another consumer like friends or relatives with the probability P_{cc} . And returned products, which have been collected, sorted and recovered, can be redistributed to consumer state or moved to disposal state with probability P_{rc} , P_{rd} , respectively.

With the simplified model, we will have a three states for a product to transition including consumer, recovering, and disposal. Therefore, the state space is of the form below:

$$S = \{ \text{consumer, recovering, disposal} \}$$

The transition matrix of product moving among states can be construct as a 3x3 matrix as below:

$$P = \begin{bmatrix} P_{cc} & P_{cr} & P_{cd} \\ P_{rc} & 0 & P_{rd} \\ 0 & 0 & P_{dd} \end{bmatrix}$$

As we have assumed above that the disposal state is an absorbing state, the value of P_{dd} will be “1”. Therefore, the transition matrix can be expressed as:

$$P = \begin{bmatrix} P_{cc} & P_{cr} & P_{cd} \\ P_{rc} & 0 & P_{rd} \\ 0 & 0 & 1 \end{bmatrix}$$



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4.4 Numerical example

In this numerical example, we assume to have 100 products sold to consumers at the beginning of the month $n=0$. These 100 products are considered to be tracked. We are now at the beginning of the month $n=1$. The table below shows the data of the transition of products from consumers to others states and from recovering state to others states at the time of one month after 100 products were sold.

	Consumer	Recovering	Disposal	Total
Consumer	33	47	20	100
Recovering	37	0	10	47
Disposal	0	0	0	0

Table 1: The distribution of 100 products at the month $n=1$

Theoretically, these data are collected by tracking the products at the point of the products were sold by members in the supply chain network. Members will share the data with others members which make products easier to be tracked.

From the data table, there are total of 100 sold products at the month $n=0$. At the beginning of month $n=1$, 33 products are still used by consumers, or exchanged and sold to another consumer, 47 products are returned or collected for recovering while 20 products are disposal by consumers. Out of 47 products returned for recovering, 37

products are redistributed to consumers while 10 products are disposal by recovering points.

There are 3 states including consumer, recovering and disposal in this model, therefore the state space is express as:

$$S = \{ \text{consumer, recovering, disposal} \}$$

The transition probability matrix of products switching state can be constructed as 3x3 matrix P. The transition probability will be calculated by dividing the number of product at each transition by the total number of products of the states. Except for disposal state, it is considered as absorbing state which result in the probability for disposal state will be 0, 0, 1, respectively.

$$P = \begin{bmatrix} 0.33 & 0.47 & 0.2 \\ 0.79 & 0 & 0.21 \\ 0 & 0 & 1 \end{bmatrix}$$

The initial state vector $v^{(0)}$ is the distribution of products among states at the beginning of month $n=0$. At that point of time, all the products are considered to be just sold to consumers. Thus, the transition probability at this point of time is 1 for consumer state, and 0 for both recovering and disposal state. From that, $v^{(0)}$ is expressed as:

$$v^{(0)} = (1, 0, 0)$$

As mentioned above, Markov chain model can help to estimate future state vector by multiplying the initial state vector $v^{(0)}$ by the transition matrix after n step P_{ij}^n . Thus, the state vector at the month $n=1$ is expressed as:

$$v^{(1)} = v^{(0)} \cdot P_{ij}^n$$

$$v^{(1)} = (1, 0, 0) \times \begin{bmatrix} 0.33 & 0.47 & 0.2 \\ 0.79 & 0 & 0.21 \\ 0 & 0 & 1 \end{bmatrix} = (0.33, 0.47, 0.2)$$

So, at $n=1$, 0.33 of 100 sold products will still be used by consumers, 0.47 will be returned, collected and recovered, and 0.2 will be disposal.

The transition will continue until all the products are in the disposal state.

The table below will show the distribution of products in upcoming months. The calculation will be performed using an online matrix calculation tool:

n	0	1	2	3	4	5	6	7
Consumer	1	0.33	0.48	0.28	0.27	0.19	0.17	0.13
Recovering	0	0.47	0.16	0.23	0.13	0.13	0.09	0.08
Disposal	0	0.2	0.36	0.49	0.6	0.68	0.74	0.79

n	8	9	10	11	12	13	14	15
Consumer	0.11	0.08	0.07	0.06	0.04	0.04	0.03	0.03
Recovering	0.06	0.05	0.04	0.03	0.03	0.02	0.02	0.01
Disposal	0.83	0.87	0.89	0.91	0.93	0.94	0.95	0.96

n	16	17	18	19
Consumer	0.02	0.01	0.01	0
Recovering	0.01	0.01	0	0
Disposal	0.97	0.98	0.99	1

Table 2: The transition vector at different month n

From the table, we can see 100 sold products start with consumers at the month $n=0$. During next transitions, we can estimate the amount of returned products for recovering at each periods for each value of recovering at each period. Moreover, we can see that after 19 time of transitions, 100 products are in disposal state which means that those products are completely broken and cannot be recovered. Thus, we can possibly estimate the maximum life cycle of a product using this model.

From the table above, we can also calculate the actual number of products at each stage in every month by multiply the percent of each state at each month with the total products which is 100 products in this example.

n	0	1	2	3	4	5	6	7
Consumer	100	33	48	28	27	19	17	13
Recovering	0	47	16	23	13	13	9	8
Disposal	0	20	36	49	60	68	74	79

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n	8	9	10	11	12	13	14	15
Consumer	11	8	7	6	4	4	3	3
Recovering	6	5	4	3	3	2	2	1
Disposal	83	87	89	91	93	94	95	96

n	16	17	18	19
Consumer	2	1	1	0
Recovering	1	1	0	0
Disposal	97	98	99	100

Table 3: The distribution of products at each month n

Chapter 5. Conclusion

5.1 Answers of thesis questions

Question 1: What is reverse logistics in supply chain?

Reverse logistics is a way of optimizing products movement in the reverse direction of ordinary logistics flow in order to recover the value of goods and reduce the amount of waste or scrap due to the environmental issues. The fundamental of reverse logistics was developed based on the new waste management method emphasizing the core concepts of closed-loop economy, which are reduction, reuse and recycling, and is used as the component of sustainable development. Traditionally, reverse logistics is a function within the organization dealing with returned products from end customers for many reasons. The process in reverse logistics include five key processes including product acquisition for collecting products, logistics for transporting and storing products, disposition for making decision for returned products to recover the most value of them, recovery for processing returned products based on disposition decision, and redistribution for delivering products to potential markets. With the purpose to optimize the supply chain performance, it is strategically to integrate normal supply chain with reverse supply chain (reverse logistics) and form closed-loop supply chain. However, the integration has added more complexity in the management of whole supply chain with all the issues of planning and organizing. With the approach at network level of reverse logistics, the reverse supply chain can flexible to be as an open loop where members in the supply chain network can actively join in any states of reverse flow to share the resource and the capability in managing, organizing and operating, which help to reduce the complexity of whole supply chain and make it achievable for both ecological and economic goals.

Question 2: How do external and internal factors affect the implementation of reverse logistics in Vietnam?

This topic was studied using theories about factors that influence reverse logistics implementation and development. According to theory, both external and internal factors are highly connected with the performance of reverse logistics.

For external factors, customer awareness and demand, and collaboration among partners from reverse logistics network seemed to be the most affective factor in the development of reverse logistics. Laws and regulations seem to be likely the driver for reverse logistics as they are made to orient and encourage firms to invest and participate in collecting and recycling end-of-life products. Customer awareness of Vietnamese people about the

environmental problem are remarked at low level which create a challenge for the implementation of reverse logistics. The suitable solution for this challenge can be the orientation and education about the importance of nature and the meaning of reusing and recycling habits, or the tactical policies and regulations of vendors to encourage consumer to participate in returning or exchanging products activities. As the result, we can see the improvement of consumers as their awareness and demand for after-sale service are remarkable increase. With this increase, firms have been motivated in the management of return products. Collaboration among partners in network are one of the best tools for return product management. With good collaboration, firms can minimize the cost and complexity in many states of reverse supply chain by the effect of dynamic networks for collecting, recovering, and recycling of returned and discarded products.

For internal factors, they can be seemed as mediate factor relate to the effect of external factors in the performance of reverse logistics. With the raise in awareness and demand of consumers about after-sale service, top management plays an important role in the implementation of reverse logistics. With a high awareness, top managements can flexibly change the company policies and regulations to make it clear and easy for consumers to approach the activities of returning and discard products. Top management also directly affect the distribution of firm's resource. By giving a clear guideline, resources including labor and facility can be utilized which will help the implementation of reverse logistics become smoothly and reduce the total operation costs. To support the top management, the integration of cross-functions in firm is necessary. Firms with closer cross-functional integration maybe better at facilitating the internal knowledge, information, and resource, which create continuous innovation capabilities in reverse logistics management. Finally, the utilization of resource is also an importance factors affect implementation of reverse logistics. Utilizing resources effectively can help firms to reduce a lot of operation time and cost. Moreover, sharing and exchange resources (e.g. facilities, information) among members in the network will help a lot in improving collaboration effectiveness.

5.2 Limitation and future studies


Limitation:

The model illustrated in chapter 4 are still including of many assumptions which make this model less complicated than the actual model. Moreover, the data, which we collected by information sharing among members in the network, are just in theory. In practice, it is hard to track an individual product from the beginning to the end of its life cycle. Additionally, not all members in the network are able to share the data with each other as every firms have its own policy and regulation.

Future studies:

Future studies can be made by reducing the amount of assumptions considered during the formulation of the model. For example, we can take into account all the related members in the network in the model instead of only having three state which are consumers, recovering, and disposal. Moreover, the quality of the product can be a scope for future studies as depending on different conditions of the products the transition to different states can be considered.

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