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A Review on Strategic, Tactical and Operational Decision Planning in Reverse Logistics of Green Supply Chain Network Design

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Abstract

The environmental impact has been a critical issue in supply chain network research. Handling it efficiently will help the firm reduce pollution and save cost. In order to improve the environmental effect on this supply chain network, recovery activity becomes a significant part in the reverse logistics network, due to complexity and heterogeneity. In a reverse logistics network, there are many decision problems to be taken into consideration such as facility location, capacity allocation, production planning and vehicle routing. Each of these problems can be categorized into three types of decision planning: strategic, tactical or operational, based on the time planning horizon. In this paper, we review the literature of supply chain network in an effort to achieve green through implementing reverse logistic practices, and classify the defined problems by the group of decision planning. In general, most of the literatures are focused on the strategic and tactical decision planning, only a few are operational-based. The objective of this paper is to analyze the decision planning being done in this area of research and provide future insights on how to design the reverse logistics network with different decision planning which will reflect the real life scenario.

Keywords

Reverse Logistics, Supply Chain, Strategic, Tactical, Operational

1. Introduction

Supply chain is one of the active application areas in operational research and management science. The success of a company depends on the efficiency of design, manufacture and product distribution in a network. The supply chain is designed to meet consumers' demands and satisfactions in a timely manner and as efficiently and profitably as possible. Dealing with the demands that need to match with the supply, reliability, and consistently in high quality at acceptable cost are the major problems in supply chain network design (SCND) [1].

The SCND is a network connecting facilities from different levels. The top level corresponding to the suppliers or plants while the bottom level corresponding to the consumers or demand zones. The paths joining between these facilities represent sequences of supply chain network activities to ensure the product or service is delivered. The network activities are referring to the economic activities which associated with the flow of products or services through the early raw material stage to the end user. The suppliers will provide the raw materials to the manufacturer where the production takes place. Then the product will be stored at distribution centres prior to despatch, which is dependent on a customer's specific delivery instructions. The SCND can have different stages or phases depending on the number of facilities being connected (see, Figure 1).

The origin for all activities is the predefined deterministic demand of the consumers, where the products are manufactured or transported only if requested by the subsequent members of the supply chain. However, it can be a stochastic demand with uncertainty. Supply and demand are rarely concentrated in the same place, therefore transportation is vital to ensure the reliable and affordable flow. The supply chain can be categorized as: lean, agile, green, closed-loop, sustainable and risk supply chain. Figure 2 shows the definition for each type of the SCND.

In a lean supply chain, elimination of waste or non-adding elements will reduce the cost. Increasing the efficiency through reduction of waste and cost of inventories by carrying small batches of production are two major features in lean manufacturing. Flexibility is the key characteristic of agile supply chain. From inside supply chain, flexibility means non-fixed configurations and structures. While from the point of consumer perspective, the supply chain must deliver products and services at the beginning of the usual short profit widows in less time [2].

In sustainable supply chain practices, all parties involved will conserve the natural resources for the next generation to avoid the overconsumption of resources [3]. It is a combination of economic and environmental issues, but it al

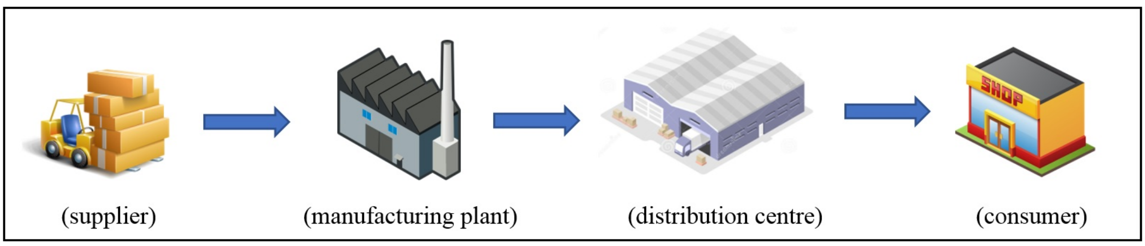

Figure 1. Supply chain network design.

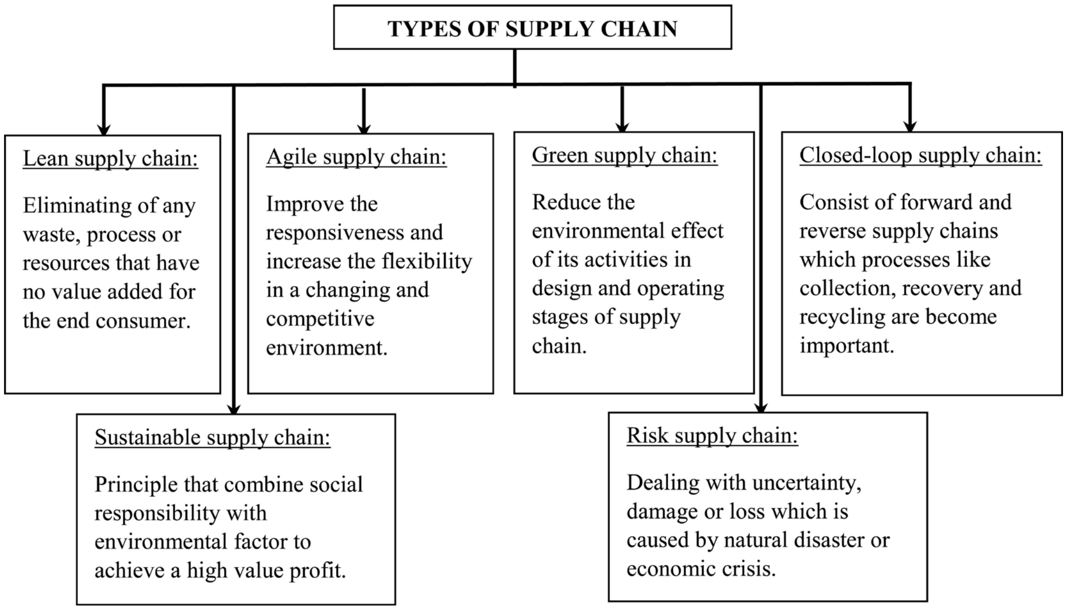

Figure 2. Type of supply chain network.

so adds social aspect into the consideration. Predicting and dealing with the various type of risk such as delay, inaccurate forecast, failures in procurement, disruption, system breakdowns and problem with capacity and inventory are risk management concerned in supply chain [3]. Hence, designing a robust network with efficient product flow management can handle the risks in the supply chain.

In a closed-loop supply chain, it combines both forward and reverse flows. The forward supply chain includes the activities of procurement, design, manufacture and distribution to consumer while reverse supply chain is related to process of inspecting, sorting, disassembly for the purposes of reuse, reprocessing and redesign.

The increases of waste disposal and limited space of landfill show that the environmental problem becomes a critical issue among the industries. The hazardous risk through the contamination and emission will affect the human health. Moreover, the waste disposal are costly since the location of landfills are commonly far away to be sent. Therefore, industries have started to integrate environmental factors throughout the organizations by implementing green supply chain. They integrate the green technologies into their product designs, production and distribution process. The green distribution involves efficient route planning, fuel reduction and promotes the eco-friendly products as well [4]. Green supply chain enhances the productivity and environmental performance for sustainable development to achieve a competitive advantage. In order to respond to the consumer for the environmental based products, the green aspect in supply chain has now become more significant among the industries. Besides, the environmental legislation forces the practitioners to set the environmental effect as one of the main objectives. The trade-offs between the cost and environmental objectives must be conducted to optimize both dimensions [5].

Due to the importance of the study, the main focus of this review is on the green supply chain network design (GSCND).

The remainder of this paper is organized as follows: Section 2 provides an introduction on the GSCND and the green processes involved. The network design, facilities and recovery process in reverse logistics are describe in Section 3. Section 4 review the strategic, tactical and operational planning in reverse logistics and Section 5 present the conclusions and future directions.

2. Green Supply Chain Network Design

The GSCND can be defined as "greening" one or some of the processes in SCND such as product design, material sourcing and selection, manufacturing operations and logistic of final products to the end consumers by considering the environmental effect with the support of the firm and enforced by the government regulations [6]. By implementing GSCND practices, it can improve the environmental performance of product and process.

Although GSCND has many benefits, there are also some challenges to be concerned. There must be a high level of uncertainty about the market position which means that green is not warranty for better income. To be green, there are many elements need to be tackled. Green product, green procurement, green manufacturing, green consumer, end-of-life management and green logistics are the key elements in GSCND [7]. Each of them has their own characteristics and decisions to be made.

Green product relates to the design and material of the product. The manufacturer needs to design the product to be environmental friendly and scored high in the life cycle assessment (LCA). LCA is the evaluation of the product that could affect the environmental and related resources through all phases of its life. It should be designed purposely for the continuity of the life-cycle process. In the process of making a product, green material minimize the content and types, packaging, energy consumption during usage and product development as well as the disposal at product ends-of-life. It is about material sourcing and selection. To be green, the firm needs to choose and use less polluting materials that can be recycled.

Green procurement is a supplier selection with the risk analysis. Hazardous and harmful substances accumulated throughout the process seek green suppliers to provide cleaning materials and components [7]. In a production process, the manufacturer implement green manufacturing by reducing energy consumption, production waste and the use of clean technologies. Remanufacturing is one of the processes that protecting the environment from pollution. It is the manufacturing of the recycling product. It offers a potential advantage such as increased profitability through reduction in the new raw material usage. Remanufactured parts can be used for assembly of new product or resold if the entire products are upgraded [8].

The end-of-life management contributed to the green supply chain. The recovery activities such as recycling, remanufacturing, refurbishing, repairing and reusing are the main areas in life-cycle process. The returned products can be reprocessed to bring quality back to a reusable level, obtain recoverable components and materials. It is much cheaper to use returned component and recycle material than using a new part.

Logistics associated with various products according to its size, weight, volume as well as the quality and safety. Implementation of green logistics is supported by consumer pressure, different type of logistics activity and the development of innovation. Green logistics is the integration of the environmental aspect into logistics activities, and it is significant in every decision making process across the logistics network. This practice becomes one of the critical issues among practitioners which are associated with climate change, air pollution, noise and other environmental effects. Green logistics approaches depending on the type of companies' service provided to the consumer and the size of the companies. Logistics can be "green" by considering the alternative mode of transportation, the energy usage during logistics activities and material usage along the route of the shipping [5]. It relates to the CO_2 and greenhouse gas emission. Reverse logistics can be defined as one of the green logistics which is the focus on this review study.

3 Reverse Logistics

Reverse logistics can be defined as the process of handling and collecting all the returned end-of-life equipment, materials, products or components from end user back to the point of origin. It is also for all operations related to the recovery process of any possible used products and materials. The process of collecting sometime faces difficulty depending on the willingness of the consumer and the strategic location of collection centre.

Reverse logistics can also be related to the process of planning the reverse flow network, implementing the process of recovery and controlling the related costs for the purpose of creating value or disposal [9]. It is known as all activities associated with a product or service after the point of sale and set up the goal to optimize the aftermarket activity development. In addition, it can save in inventory carrying transportation and waste disposal costs as well as improving consumer service [10].

Reverse logistics can be classify as a closed loop (see **Figure 3**) if it integrated with the forward logistics. When only the reverse flow is being considered, it is an open-loop supply chain. In an open-loop, the flow of materials and products are delivered starting from the point of consumer to the secondary user through the collection centre and processing centre.

3.1. Facilities in Reverse Logistics Network

In a reverse flow, there are four facilities or centers that need to be considered in the network: collection, disassembly, processing and disposal [11]. Collection centre is the place where all the returned products or used products being collected. There are two stages involved in collection centre which are the pick-up activities and the transportation of the returned products from one facility to

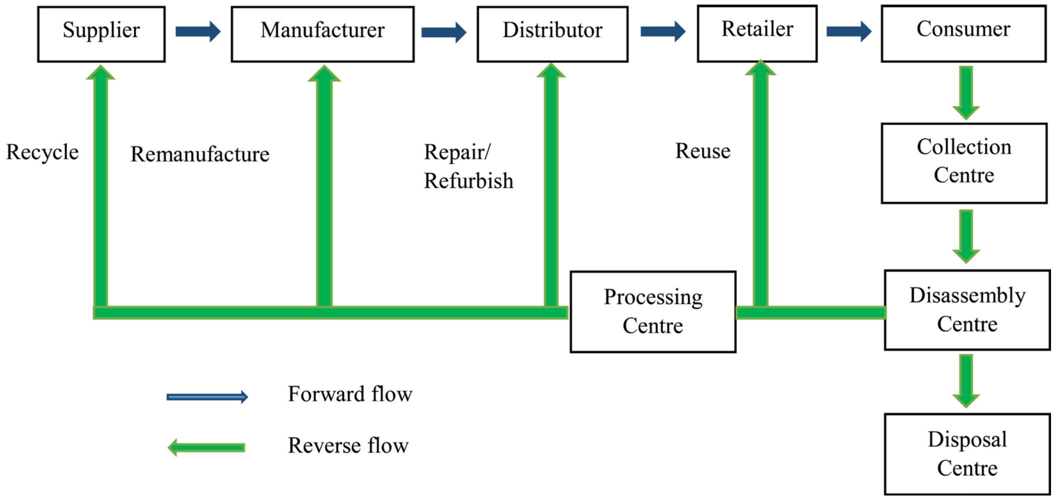

Figure 3. Closed-loop flow [11].

another. Usually, the products will be self-collected by the company. However, due to some reasons, the company may outsource to third party for collection or the products are returned by the consumers. The choice of collection method is depends on the cost, flexibility, location, complexity of the product, and the reason for returning it.

After all the returned products have been collected, the next process is to sort them according to the quality level of the products at the disassembly centre. Disassembly centre will first inspect and separate each product. During the sorting process, the conditions of the returned products are inspected concurrently. It determines either the returned products need to be recovered or sent to the disposal centre. It is important to ensure the right recovery process for the next stage. Inspection and separation process may include the disassembly, shredding, testing and sorting steps. In addition, the company should prepared guidelines for the returned products that meet the criteria, to be considered as an inventory and the intricacies of the sorting process.

Processing centre transformed a returned product into a usable product again. This is the place where all the treatment options are performed such as recycling, remanufacturing, repairing and repackaging of the returned products [12]. The activities such as cleaning and replacement may be involved too. The choices of recovery process are depended on the condition and the quality level of the returned products. Upon completion, the recovered products will be sent back to the facilities based on the type of recovery processes. For example, if the product is recycled, then it will be sent to the supplier. If a returned product cannot be recovered, it will be disposed at the disposal centre. The disposal centre is the exit of the reverse logistics system. A company would prefer to send the product to the disposal centre when there is no any beneficial value to the product.

3.2. Recovery Process in Reverse Logistics

Due to limited landfill capacity, waste disposal become a major concern among industries. At the same time, consumers are expecting that company will produce a green product to reduce the environmental pollution. At the processing centre, the recovery decision of the returned products is very crucial as it will be sent back to the facility after the product is recovered. Besides, product recovery may be attractive from an economical perspective as well [9].

Repair

Repairing can be defined as recovering the defected, broken or damaged in some parts of the product. It could be a failed working device, or deficiency of an item. The purpose of repairing is to ensure the returned product is functioning [13]. Repairing require lower capital investment and more to skill-based [6]. After the product has been repaired, it will be sent to the distributor.

Refurbish

Refurbishing is similar to the repairing but the process will upgrade the quality level of the product and usually less complicated process than a new production. It is more skill-based in order to make them almost as good as new [6]. Compared to the repairing process, refurbishing needs more attention since it involved disassembly process, inspection and replacement of critical parts. Commonly, it is closely related to the electronic or electric product that required testing before the product can be returned. Refurbished product is normally returned under warranty or unused consumer returns. It will be sent to the distributor after conducting a proper inspection.

Reuse

The reused products are sent to the retailer for the same function or for others activity. Reuse is the simplest process as it does not require any high technology tools. Hence, it can minimize the cost compared to other recovery processes.

Remanufacture

Remanufacturing is the process of rebuilding or reconstructing the product by using the combination of reused, repair and import of new parts. It requires the replacement of obsolete parts. It is more specific and challenging. To remanufacture it to a new product, it involved the process of disassembly, detailed inspection of all parts and finally assembled them properly. Remanufacturing process is quite different with other recovery processes in its completeness where the remanufactured product usually has the same quality as the new product. The remanufactured product will be sent back to the manufacturer to be sold at the same price [14].

Recycle

Recycling is a process of converting waste material to a new raw material. The recycled products will be sent to the supplier and enter the supply chain again as a raw material for new products [4]. The purpose of recycling is to reuse the material from the returned product that is cannot be remanufactured or repaired. In order to reduce the cost of raw material, recycling could be the best alternative. This process can reduce the environmental impact and it is a good alternative to save the material from been disposed.

4. Strategic, Tactical and Operational Decisions

The main area in reverse logistics are logistics distribution, production planning and inventory capacity. Reverse logistics, as part of supply chain management, provides useful quantitative models for network design in the management of end-of-life products [15]. Location-allocation problem is particularly relevant in a reverse logistics context that affects both costs and consumer service levels. Inventory also may become significant, especially in case of high valuable goods (e.g. electronic equipment) [16]. There are many others decision can be listed and each of it has a different level of planning horizon, which can be categorized into the following three levels:

i) strategic decision

ii) tactical decision

iii) operational decision

Decision planning can be integrated either "horizontal integration" or "vertical integration". Horizontal integration means by integration the same decision level of optimization problems while vertical integration combines two different levels of decision [17]. For example, strategic-tactical, strategic-operational or tactical-operational.

4.1. Strategic Decision Planning

Strategic decision planning is a long term decision planning between 2 to 5 year timeline. At this strategic level, the decisions made are high level because there are difficult to change. It is associated with the recovery process, especially during the design of the product. Coordination of supply chain network, capacity planning and designing of the remanufacturing systems with environmental consideration also fall under this category [11].

Product design plays an important role in a profitable prospect of product return for recycling and remanufacturing. The company should investigate the effect of product design, especially in a closed-loop network. However, during the process design, the impact of the product design has always been neglected. In order to be more practical, company should plan the appropriate design for their products to continue the recovery process of the returned products in reverse logistics flow. A company, who is actively practicing the remanufacturing in their network, should competence in defining the quality level of the reliability components. Original equipment manufacturer (OEM) could decide to permanently seal or weld a product, as opposed to using fasteners, during its initial assembly but this makes disassembly of the product (during recycling or remanufacturing) much more difficult and costly. Thus, product design decisions have a significant impact on a firm's strategic decisions regarding remanufacturing [18].

Before a company starts the production operation, they must develop the network for used products recovery [19]. The coordination of reverse logistics network design should be efficient in order to collect the used products in a cost-effective manner and gives profitable to the remanufacture. Reverse logistics network consist of network design of collection activity and its physical transportation to support the system. One of the critical components in the network design is the decision on capacity and location of each facility. The facilities should be placed in a strategic location to maximize the flexibility and responsiveness of consumers. Recently, some industries prefer to have a hybrid system where two activities are concurrently working in one location as they share the same component and processing. By implementing this, the operating and transportation cost can be reduced. However the complexity to handle hybrid system will be increased. In this case, the sufficient space in the facilities must be well organized.

The challenging part faced by company is to decide on how to build the reverse logistic network such that it meets the objective and constraints. Besides, a company needs to set up a reverse logistics network based on the requirement of environmental legislation to ensure the proper disposal of its products [18]. The role of environmental legislations could affect the company's remanufacturing decision in a long term. Based on [12], return policy is also one of the strategic planning in reverse logistics. One study has been found where the decision is to obtain optimal policies for price and return policy with the aim of maximizing the profit [20].

As mentioned earlier, the researchers pointed out that at the strategic level decision; the design of the recovery network has to be decided first. Therefore, some researchers proposed the network design for reverse logistics such as: design of collection network for take-back of white goods for remanufacturing [21], design of generic reverse logistics model considering distribution and recovery network [22], design of integrate traditional and reverse supply chain model [23], model of the reliable network for facility location [24], model of a reverse SCND problem considering specified returns [25], planning a forward/reverse logistics considering capacity expansion and dynamic transportation link [26] and develop optimal model for cross-stage reverse logistics [27]. Among these, only [24] deal with the multi-objective and uncertainty. The objectives of their study are to minimize the total cost and expected transportation cost after failure of facility. They used fuzzy multi-objective programming together with robust optimization and queuing theory to solve the problems.

Most of the studies in this review deal with the decision on how to locate the facilities, the optimal number of facilities to be opened, the capacity of production for each facility and the products flow between facilities. This can be found in the following multi-objective problems. Monte-Carlo simulation was chosen to solve the cost and environmental risk minimization under uncertainty [28]. The heuristic (scatter search) and dual simplex method are used for multi-objective total cost and total tardiness of cycle time minimization [19]. The bi-objective of minimizing total cost and at the same time maximizing the consumer responsiveness been solved by using multi-objective memetic algorithm [17]. Corley method which is the hybrid of weighted-sum and ε-constraint methods, has been used in order to maximize the on-time delivery from supplier as well as maximizing the total profit [29] and multi-objective particle swarm optimization is used to minimize the total cost and CO_2 emission [30].

The facility location-allocation problems with single objective have been found in many literatures [8] [9] [15] [31] [32] [33] [34]. Among them, [32] proposed forward and reverse logistics to extend the single product unlimited capacity to multi-product capacitated. Reference [35] focused on the optimal capacity in the production of manufactured and remanufactured products for forward and reverse flow supply chain while [36] proposed mathematical model for reverse logistics handling product returns. They use GAMS software to solve the problems.

Since some problems in location-allocation are considered large scale problem and exact methods are not appropriate to obtain the optimal solution for this size, the researchers decided to use heuristic and/or metaheuristic approaches. Jenkins' heuristic is used by [9] to solve piecewise linear in generic facility location for product recovery. Reference [37] solved the location and material flows for take back and the recovery of end-of-life vehicle (ELV) by using heuristic method based on greedy algorithm. Genetic algorithm is widely used in facility location problem such as reverse logistics problem involving product returns [33], dynamic modeling approach for 3rd party logistic provider (3PLs) [38], location-allocation problem of repair facilities for 3PLs [39], and optimization of location of collection points based on RFID [40]. Priority-based encoding simulated annealing with special neighbourhood search mechanism has been used to solve multi-stage reverse logistics problem [41]. Others metaheuristic methods such as ant colony optimization for nonlinear dimension factor called SCAnt-NL Design [42], hybrid genetic algorithm with particles warm optimization [34] and hybrid discrete artificial bee colony [43] are also been studied.

Dynamic location-allocation model with forward/reverse under uncertainty also has been proposed. This problem has been solved by using integrated sample average approximation and simulated annealing [44], scenario-based stochastic approach using stochastic programming model [45], and multi objective differential evolution to minimize both total cost and CO_2 emission cost for fuzzy programming [46].

4.2. Tactical Decision Planning

The tactical decision problem is a medium term decision. It takes 1 to 2 year timeline and generally it comes after the strategic decision planning. The decisions are related to the production planning and inventory management as well as procurement and integrated management of product returns with the overall organization. Return forecasting, product return handling and aggregate production planning are related to the product returns activities [11].

A company that decides to remanufacture their products has some issues of tactical decision. They need to plan on the number of used products that should be recovered and decide on the capacity limit of the recovery products for each time period. The decision is more complex compared to the traditional forward supply chain. In a forward supply chain, the components or materials are purchased from the supplier with the exact amount. The number of materials is predetermined since the target unit of the final products to be produced is decided earlier. In contrast with the reverse flow, the production planning is necessary to be organized systematically since there are many unpredictable quality levels as well as a capacity constraint in product return of the remanufacturing process. The variation of quality level may due to the different ways of the product maintenance conducted by the owner. Some products required additional costs to remanufacture and not all the products can be recovered. The functionality of production planning is to determine the optimum quantity of each unit for each period to be processed. This decision is crucial in order to obtain the cost-saving effectively. Different demands and limitation on the number of processed unit in each period would influence the successes of the whole planning [18].

Since the returned products will have different levels of quality, the disposition decision must be made. The highest quality level of returned products are the least expensive to remanufacture. The disposition decision in the reverse supply chain allocates returned products to an appropriate processing option. This decision is important in order to reduce pollution during the recovery processes.

In inventory planning, there are two main areas. First is the management of uncertainty of product returns and secondly is the management of inventory of new components when both regular procurement and recovered components can satisfy the demands. Aggregate planning concerned with the amount of inventory to be held in stock and backlogged for each period. This planning is considered as a tactical decision planning. A safety stock planning approach in reverse logistics is provided in [47]. An optimal inventory policy on changes of manufacturing, remanufacturing and disposal rate in reverse logistics is proposed by [48]. Both studies aim to reduce the holding cost in their objective. Other researchers proposed inexact reverse logistics in planning the inventory control, waste disposal and distribution [49]. The collection of returnable combines with recovery modules has been solved by [50].

The general framework of remanufacturing system has been developed by [51]. They applied the framework with some numerical examples in making a decision on the quantity of parts needed to remanufacture and number of parts needed to purchase from the subcontractor. This followed by other researchers where the decision is to determine the optimal capacity of manufacturing and remanufacturing product units per period [14]. In the study, a variable neighborhood descent heuristic algorithm is applied for solving a multi-product dynamic lot-sizing problem.

Besides the inventory control, the hazardous waste treatment and transportation problem are also included under tactical planning. About the problems of waste treatment and management, [52] formulated a discrete-time linear analytical model to determine the time-varying and hazardous waste in reverse logistics. An activity-based model is presented by [53] to allocate the discarded product, disassembly activity and fraction of waste of electrical and electronic equipment (WEEE) treatment. An incremental risk-induced penalty is used by [54] to estimate the risk for multi-objective linear programming. The study is conducted to minimize both reverse logistics operational cost and risk-induced penalties.

Multi-objective can be found in transportation model proposed by [5]. They aim to determine the dependencies of transport cost, emission and fuel consumption. The optimization model is calculated by computer program LOMP. Others researchers use priority-based encoding genetic algorithm (priGA) and heuristic approach for transportation flow problem [10].

Tactical planning can be integrated with strategic decision planning. Usually, the researchers will combine the decision of location and capacity planning of facilities with the optimal inventory capacity to be held or purchased. The generalized algebraic modeling system (GAMS) is used by [55] to solve 0 - 1 mixed integer programming. Reference [56] determined the location of third checking sites and inventory policy for B2C (business to consumer) e-market and modeled it as a bi-level programming problem while [16] used technique of differential evolution and incorporated the MINLP with queuing model for inventory. Other software are also been used such as XpressSP software for multi-stage stochastic demand [57] and CPLEX to tackle product returns in multi-period reverse logistics [58]. Differential evolution also been proposed by [59] to deal with the stochastic delay due to uncertainty.

The facility location-allocation problem can be combined with disposition decision. A bi-level optimization model was coded in GAMS 21.2 with CPLEX 7.5 [6], and a two-stage stochastic mixed-integer solved by ILOG CPLEX 10.1, has been used to solve these problems [60]. They considered the multi-objective in their problem which is minimizing the operating cost and minimizing the obnoxious effect caused by the reverse network. Meanwhile, the decision of disassembly and processing centers to be opened with the transportation strategy has been solved by priGA [61].

4.3. Operational Decision Planning

Operational decision planning is a short term planning which is on a day-to-day decision. Vehicle planning and scheduling are under operational planning decision. The majority of remanufacturing shops are low volume job-shop type operations [18]. The remanufacturing operations become more challenging as the uncertainty in the supply and the large variance along the possible routing are increased compared to the traditional forward production. The issues under the scheduling planning are the decision of optimal disassembly sequences, the parts should be released to the floor, the rules for shop floor and the route of the products [18].

Operational decisions come as consequences of the strategic and tactical decisions. Dynamic control of product recovery operations and dynamic pricing of products are included in operational planning decision [11]. Some other interesting operational issues are warehousing operations problems such as order batching and picking, routing pickers in warehouse are also considered in this operational planning [62].

Operational planning found in this review study is mostly related to vehicle routing problem. Vehicle routing and scheduling problem may have issues on mixed pick-up and deliveries and time windows for delivery. A heuristic construction procedure is used by [63] where the initial solution obtained by a local search to solve the vehicle routing problem with simultaneous delivery and pickup. The same vehicle routing problem as in [63] is solved by [64] using tabu search to calculate the transportation route for recycling. An integrated ant colony and tabu search algorithm is also proposed by [65] for the same problem. Both papers have the same objective which is to minimize the total distance and cost by determining the route of vehicle.

Recently, many researchers integrated the operational decision planning with strategic or tactical decision planning. The decision on multi-stop vehicle route with return policy and optimal quantity of return material to be picked up been solved by heuristic approach [66]. Location and critical path of WEEE intermediate storage points are determined using CPLEX 9.1 [67]. A framework is proposed by [68] that separated into operational and strategic flexible measure for 3PLs performance outcome and solved it by novel neighborhood rough set approach. A vehicle routing problem and location-allocation problem is solved by [69] by implementing greedy adjustment in a novel discrete artificial bee colony algorithm. The artificial immune system and particle swarm optimization are used by [4] to obtain the vehicle routes and quantities to be produced at each facility.

The integration of tactical and operational decision planning which is defined by the service area of each depot and scheduling of collection route has been found [70]. The study solved the combination of three objectives: minimize distance, CO_2 emission and working hours by the augmented ε-constraint method. The paper balances the economic factor with environmental issues and social aspect. The approximation to the Pareto front is obtained to solve the multi-objective problem. To the best of our knowledge, only one paper integrated all three planning: facility-inventory-routing problem in their study [71]. They used a hybrid ant colony optimization algorithm to minimize the total cost in reverse logistics. To summarize, all the collected articles published since 1999 that related to the reverse logistic problems based on the strategic, tactical and operational planning are listed in **Table 1** below.

Table 2 below shows the distribution of decision planning of the selected articles in the reverse logistics. It clearly shows that most of the studies are in the strategic decision planning. Compared to the strategic and tactical decision planning, operational decision planning is the lowest. Before the operational decision can been made, the strategic and tactical planning should be decided first. Since the strategic and tactical decision should be determined first, it becomes a constraint for operational decision [42]. Besides, among these three decisions planning, operational give less effect to the entire performance of supply chain since it is a short term planning. Due to this, most of the researchers are more

Table 1. Classification of strategic (S), tactical (T) and operational (O) planning based on the decision problems.

Authors	Decision Problems	S	T	O
[55]	• Location of distribution/remanufacturing facilities. • Optimal inventories quantities of remanufactured products. • Transportation of cores between facilities.	✓	✓	
[63]	• Vehicle routing with simultaneous delivery and pick-up			✓
[9]	• Location of plant and distribution warehouse and allocation of goods flows between facilities.	✓		
[47]	• Production and inventory for safety stock planning.		✓	
[31]	• Number of location for storage and treatment facilities • Optimal physical flow of end-of-life products.	✓		
[52]	• Time-varying collection and treatment amount of hazardous waste		✓	
[48]	• Optimal inventory policies in reverse logistics.		✓	
[20]	• Optimal price and return policies.	✓		
[53]	• Optimal allocation of WEEE treatment in reverse logistics system.		✓	
[28]	• Location and allocation at various facilities. • Optimal waste quantity travelling.	✓		
[51]	• Quantity parts to be processed and purchased from subcontractor.		✓	
[9]	• Transportation model (dependencies of cost, emission and fuel consumption)		✓	
[33]	• Location of collection and repair facilities for 3PLs under capacity limit.	✓		
[32]	• Warehouse location-allocation model.	✓		
[66]	• Multi-stop vehicle route design with return policy. • Optimal quantity of return material to be pick up along delivery route.	✓		✓
[21]	• Collection network design for take-back of white goods for remanufacturing.	✓		
[34]	• Capacitated location model of warehouse and repair centre. • Allocation of customer within capacity limitations.	✓		
[16]	• Facility location-allocation problem. • Assign optimal flow of returned goods including inventory in reverse logistics.	✓	✓	
[22]	• Design generic reverse logistics model considering distribution and recovery network.	✓		
[54]	• Time-varying amount of physical flow for treatment hazardous waste.		✓	
[56]	• Location and inventory policy in B2C firms.	✓	✓	
[36]	• Location facilities problem. • Optimal production and transportation quantities of manufacture and remanufacture products.	✓		
[19]	• Location-allocation for installing repair facilities and collection sites. • Transportation flows between collection sites and facility sites.	✓		
[37]	• Location of collection centres and dismantlers. • Optimal material flows of end-of-life vehicle (ELV).	✓		
[35]	• Location-allocation of repair facilities for 3PLs.	✓		
[6]	• Location-allocation and capacity decision for facilities. • Disposition decision for various grade of returned products.	✓	✓	
[15]	• Facility location of end-of-life vehicle (ELV) collection network.	✓		
[64]	• Capacitated vehicle routing problem.			✓
[40]	• Dynamic location and allocation model in reverse logistics.	✓		
[38]	• Location problem for collection points. • Optimal quantity of products to be shipped.	✓		
[10]	• Transportation problem of recycling process.		✓	

Continued

[39]	• Optimal location and capacities of various facilities. • Allocation of material flows between facilities.	✓		
[67]	• Location of WEEE intermediate storage points. • Critical path of WEEE considering intermediate storage points.	✓		✓
[57]	• Facility location, production of each facilities and transported quantity between locations. • Optimal inventory to be held at each period.	✓	✓	
[60]	• Location problem with choice of technology.	✓		
[17]	• Facility location and capacity of distribution, production/recovery and disposal centres. • Optimal product flows between facilities.	✓		
[41]	• Facility location of hybrid distribution/collection, production/recovery and disposal centres. • Optimal quantity flows between network facilities.	✓		
[42]	• Number and location of collection/inspection centres. • Optimal quantity of flow between facilities.	✓		
[8]	• Location of collection and return centre. • Allocation of product flow between facilities.	✓		
[23]	• Design integrated traditional and reverse supply chain model.	✓		
[49]	• Production, inventory and transportation planning for the waste management.		✓	
[58]	• Location and capacity decision of inspection centres and remanufacturing facilities. • Optimal inventory to be held or purchased at remanufacturing plants.	✓	✓	
[25]	• Model a reverse supply chain network design problem considering specified returns.	✓		
[50]	• Optimize quantity of new and recovered products.		✓	
[59]	• Location and flow allocation of products for each facilities integrated with queuing relationship.	✓	✓	
[24]	• Design and model the reliable network for facility location.	✓		
[68]	• Flexible measure of performance outcomes for 3PLs in reverse logistics framework.	✓		✓
[26]	• Design and planning forward and reverse logistics.	✓		
[27]	• Develop optimal cross-stage reverse logistics model.	✓		
[69]	• Location-allocation problem of reverse logistics. • Vehicle routing problem.	✓		✓
[70]	• Service area establishment for each depot. • Scheduling of collection routes for each vehicles.		✓	✓
[61]	• Subset of disassembly centres and processing centres to be opened. • Transportation strategy that satisfy demand by manufacturing centres and recycling centres.	✓	✓	
[65]	• Vehicle routing problem with simultaneous delivery and pick-up.			✓
[46]	• Optimal location and products assign for each facilities.	✓		
[14]	• Optimal number of manufacturing and remanufacturing product per period.		✓	
[44]	• Design and planning the facility location and allocation.	✓		
[43]	• Facility location and capacities.	✓		
[29]	• Facility location problem. • Optimal flow of products between facilities.	✓		
[71]	• Location-inventory-routing problem.	✓	✓	✓
[4]	• Optimal vehicle routing. • Optimal quantities of production to be produced and obtained from the supplier.	✓		✓
[30]	• Facility location, capacity expansion and transportation quantity between facilities.	✓		
[45]	• Location-allocation problem in reverse logistics.	✓		

Table 2. The number of publication of different decision planning in reverse logistic.

Decision planning	Number of Publication
Strategic	33
Tactical	11
Operational	3
Strategic and Tactical	8
Strategic and Operational	5
Tactical and Operational	1
Strategic, Tactical and Operational	1

focusing on the strategic and tactical decisions planning as compared to the operational. Only one paper has been found that proposed the combination of all three different decision planning.

5. Conclusions and Future Directions

This paper reviewed the strategic, tactical and operational decision planning in the reverse logistics supply chain network design problem. The review shows the proportion of each decision planning and the trends of the reverse logistics problem studied between 1999 and 2017.

From the literature review, the future work in reverse logistics can be identified. Integration of the three different decisions planning (strategic, tactical and operational) should be further explored. The combination of these will give significant impact to the research of the reverse logistics network design problem in terms of the cost reduction and environmental impact. Operational decision planning requires more attention since only a handful of researches are conducted. The possibilities of integrating two different decisions planning should also be considered.

Instead of concentrating only to one flow which is the reverse flow, the network should be integrated with the forward flow to form a closed-loop. The integration of the forward and reverse flows will increase the problem complexity. In order to obtain a realistic reverse logistics problem implemented in the industry, all stages of closed loop supply chain must be considered.

Most of the previous studies focused on the uncertainty in demand and supply but very few studies investigated the uncertainty product returns. The main issue in reverse logistics is the process of the recovery which relates to product return. Researchers should investigate the uncertain quality and quantity of the recovery and returned products respectively. The model will be set as a stochastic model and can be solved using fuzzy or stochastic algorithm.

To be more practical, the researchers should consider multi-objectives that combine the economic factor with the environmental impact as well as the social aspect. Since the objective of the total cost reduction and profit maximization are commonly used in the supply chain, other objectives such as maximizing the consumer satisfaction and responsiveness and minimizing the environmental impact caused by the pollution from the transportation and cleaning process should also be highlighted.

A more realistic network design problem should also consider multi-period, multi-product and multi-facilities problems. During the setup of the network facility location, the network with multi collection and disassembly centers should be taken into account. The recovery operations should be well planned too. These decisions will give significant impact to the cost and the reduction of the gas emission from the production process. In multi-period problem, the impact of transportation lead time and time horizon for demand are worth to explore.

When taking the environment issue into consideration, the main factor is due to the transportation. Researchers should consider different transportation decision variable such as the mode of transportation, the fuel consumption of transportation and freight weight capacity of transportation. These decisions will bring insights on how transportation is needed in generating large enough volume of recycling and remanufacturing process.

References

[1] MacCarthy, B.L. and Ramanathan, R. (2007) Recent Developments in Operations Strategy, Supply Chain Design and Production Systems. *International Journal of Production Economics*, **110**, 1-4. https://doi.org/10.1016/j.ijpe.2007.02.010

[2] Lu, D. (2011) Fundamentals of Supply Chain Management. Ventus Publishing ApS, Frederiksberg.

[3] Farahani, R.Z., Rezapour, S., Drezner, T. and Fallah, S. (2014) Competitive Supply Chain Network Design: An Overview of Classifications, Models, Solution Techniques and Applications. *Omega*, **45**, 92-118. https://doi.org/10.1016/j.omega.2013.08.006

[4] Kumar, V.N.S.A., Kumar, V., Garza-Reyes, J.A. and Simpson, M. (2016) Resolving Forward-Reverse Logistics Multi-Period Model Using Evolutionary Algorithms. *International Journal of Production Economics*, **183**, 458-469. https://doi.org/10.1016/j.ijpe.2016.04.026

[5] Logozar, K., Radonjic, G. and Bastic, M. (2006) Incorporation of Reverse Logistics Model into In-Plant Recycling Process : A Case of Aluminium Industry. *Resources, Conservation and Recycling*, **49**, 49-67. https://doi.org/10.1016/j.resconrec.2006.03.008

[6] Srivastava, S.K. (2008) Network Design for Reverse Logistics. *Omega*, **36**, 535-548. https://doi.org/10.1016/j.omega.2006.11.012

[7] Wang, H.F. and Gupta, S.M. (2011) Green Supply Chain Management—A Product Life Cycle Approach. McGraw-Hill Education, New York.

[8] Sasikumar, P., Kannan, G. and Haq, A.N. (2010) A Multi-Echelon Reverse Logistics Network Design for Product Recovery—A Case of Truck Tire Remanufacturing. *International Journal of Advance Manufacturing Technology*, **49**, 1223-1234. https://doi.org/10.1007/s00170-009-2470-4

[9] Fleischmann, M., Beullens, P., Bloemhof-ruwaard, J.M. and Wassenhove, L.N.V. (2001) The Impact of Product Recovery on Logistics Network Design. *Production and Operations Management*, **10**, 156-173. https://doi.org/10.1111/j.1937-5956.2001.tb00076.x

[10] Lee, J., Gen, M. and Rhee, K. (2009) Network Model and Optimization of Reverse

Logistics by Hybrid Genetic Algorithm. *Computers & Industrial Engineering*, **56**, 951-964. https://doi.org/10.1016/j.cie.2008.09.021

[11] Sheriff, K.M.M., Gunasekaran, A. and Nachiappan, S. (2012) Reverse Logistics Network Design : A Review on Strategic Perspective. *International Journal of Logistics Systems and Management*, **12**, 171–194. https://doi.org/10.1504/IJLSM.2012.047220

[12] Lambert, S., Riopel, D. and Abdul-Kader, W. (2011) A Reverse Logistics Decisions Conceptual Framework. *Computers & Industrial Engineering*, **61**, 561-581. https://doi.org/10.1016/j.cie.2011.04.012

[13] Srivastava, S.K. (2007) Green Supply-Chain Management: A State-of-the-Art Literature Review. *International Journal of Management Reviews*, **9**, 53-80. https://doi.org/10.1111/j.1468-2370.2007.00202.x

[14] Sifaleras, A. and Konstantaras, I. (2015) Variable Neighborhood Descent Heuristic for Solving Reverse Logistics Multi-Item Dynamic Lot-Sizing Problems. *Computers & Operations Research*, **78**, 385-392. https://doi.org/10.1016/j.cor.2015.10.004

[15] Cruz-Rivera, R. and Ertel, J. (2009) Reverse Logistics Network Design for the Collection of End-of-Life Vehicles in Mexico. *European Journal of Operational Research*, **196**, 930-939. https://doi.org/10.1016/j.ejor.2008.04.041

[16] Lieckens, K. and Vandaele, N. (2007) Reverse Logistics Network Design with Stochastic Lead Times. *Computers & Operations Research*, **34**, 395-416. https://doi.org/10.1016/j.cor.2005.03.006

[17] Pishvaee, M.S., Farahani, R.Z. and Dullaert, W. (2010) A Memetic Algorithm for Bi-Objective Integrated Forward/Reverse Logistics Network Design. *Computers & Operations Research*, **37**, 1100-1112. https://doi.org/10.1016/j.cor.2009.09.018

[18] Ferguson, M. (2010) Strategic and Tactical Aspects of Closed-Loop Supply Chains. *Foundation and Trends in Technology, Information and Operations Management*, **3**, 101-200. https://doi.org/10.1561/0200000019

[19] Du, F. and Evans, G.W. (2008) A Bi-Objective Reverse Logistics Network Analysis for Post-Sale Service. *Computers & Operations Research*, **35**, 2617-2634. https://doi.org/10.1016/j.cor.2006.12.020

[20] Mukhopadhyay, S.K. and Setoputro, R. (2004) Reverse Logistics in e-Business: Optimal Price and Return Policy. *International Journal of Physical Distribution & Logistics Management*, **34**, 70-89. https://doi.org/10.1108/09600030410515691

[21] Kara, S.Ã., Rugrungruang, F. and Kaebernick, H. (2007) Simulation Modelling of Reverse Logistics Networks. *International Journal of Production Economics*, **106**, 61-69. https://doi.org/10.1016/j.ijpe.2006.04.009

[22] Salema, M.I.G., Barbosa-povoa, A.P. and Novais, A.Q. (2007) An Optimization Model for the Design of a Capacitated Multi-Product Reverse Logistics Network with Uncertainty. *European Journal of Operational Research*, **179**, 1063-1077. https://doi.org/10.1016/j.ejor.2005.05.032

[23] Banyai, T. (2011) Optimisation of a Multi-Product Green Supply Chain Model with Harmony Search. DAAAM International Scientific Book, 15-30. https://doi.org/10.2507/daaam.scibook.2011.02

[24] Vahdani, B., Tavakkoli-moghaddam, R., Modarres, M. and Baboli, A. (2012) Reliable Design of a Forward/Reverse Logistics Network under Uncertainty : A Robust-M/M/c Queuing Model. *Transportation Research Part E: Logistics and Tranportation Review*, **48**, 1152-1168. https://doi.org/10.1016/j.tre.2012.06.002

[25] Che, Z.-H., Chiang, T.-A. and Kuo, Y.-C. (2012) Multi-Echelon Reverse Supply Chain Network Design with Specified Returns using Particle Swarm Optimization.

International Journal of Innovative Computing, Information and Control, **8**, 6719-6731. http://www.ijicic.org/ijicic-10-09080.pdf

[26] Cardoso, S.R., Barbosa-póvoa, A.P.F.D. and Relvas, S. (2013) Design and Planning of Supply Chains with Integration of Reverse Logistics Activities under Demand Uncertainty. *European Journal of Operational Research*, **226**, 436-451. https://doi.org/10.1016/j.ejor.2012.11.035

[27] Chiang, T., Che, Z.H. and Cui, Z. (2014) Designing a Multistage Supply Chain in Cross-Stage Reverse Logistics Environments: Application of Particle Swarm Optimization Algorithms. *The Scientific World Journal*, **2014**, Article ID: 595902. https://doi.org/10.1155/2014/595902

[28] Ahluwalia, P.K. and Nema, A.K. (2006) Multi-Objective Reverse Logistics Model for Integrated Computer Waste Management. *Waste Management & Research*, **24**, 514-527. https://doi.org/10.1177/0734242X06067252

[29] Amin, S.H. and Baki, F. (2017) A Facility Location Model for Global Closed-Loop Supply Chain Network Design. *Applied Mathematical Modelling*, **41**, 316-330. https://doi.org/10.1016/j.apm.2016.08.030

[30] Chen, Y., Wang, L., Wang, A. and Chen, T. (2017) A Particle Swarm Approach for Optimizing a Multi-Stage Closed Loop Supply Chain for the Solar Cell Industry. *Robotics and Computer Integrated Manufacturing*, **43**, 111-123. https://doi.org/10.1016/j.rcim.2015.10.006

[31] Shih, L. (2001) Reverse Logistics System Planning for Recycling Electrical Appliances and Computers in Taiwan. *Resources, Conservation and Recycling*, **32**, 55-72. https://doi.org/10.1016/S0921-3449(00)00098-7

[32] Salema, M., Povoa, A. and Novais, A. (2006) A Warehouse-Based Design Model for Reverse Logistics. *Journal of Operational Research Society*, **57**, 615-629. https://doi.org/10.1057/palgrave.jors.2602035

[33] Min, H., Jeung, H. and Seong, C. (2006) A Genetic Algorithm Approach to Developing the Multi-Echelon Reverse Logistics Network for Product Returns. *Omega*, **34**, 56-69. https://doi.org/10.1016/j.omega.2004.07.025

[34] Soleimani, H. and Kannan, G. (2015) A Hybrid Particle Swarm Optimization and Genetic Algorithm for Closed-Loop Supply Chain Network Design in Large-Scale Networks. *Applied Mathematical Modelling*, **39**, 3990-4012. https://doi.org/10.1016/j.apm.2014.12.016

[35] Demirel, N.Ö. and Gökçen, H. (2008) A Mixed Integer Programming Model for Remanufacturing in Reverse Logistics Environment. *International Journal of Advance Manufacturing Technology*, **39**, 1197-1206. https://doi.org/10.1007/s00170-007-1290-7

[36] Mutha, A. and Pokharel, S. (2009) Strategic Network Design for Reverse Logistics and Remanufacturing using New and Old Product Modules. *Computers & Industrial Engineering*, **56**, 334-346. https://doi.org/10.1016/j.cie.2008.06.006

[37] Mansour, S. and Zarei, M. (2008) A Multi-Period Reverse Logistics Optimisation Model for End-of-Life Vehicles Recovery Based on EU Directive. *International Journal of Computer Integrated Manufacturing*, **21**, 37-41. https://doi.org/10.1080/09511920701685325

[38] Ko, H.J. and Evans, G.W. (2007) A Genetic Algorithm-Based Heuristic for the Dynamic Integrated Forward/Reverse Logistics Network for 3PLs. *Computers & Operations Research*, **34**, 346-366. https://doi.org/10.1016/j.cor.2005.03.004

[39] Min, H. and Ko, H. (2008) The Dynamic Design of a Reverse Logistics Network from the Perspective of Third-Party Logistics Service Providers. *International Jour-*

nal of Production Economics, **113**, 176-192.
https://doi.org/10.1016/j.ijpe.2007.01.017

[40] Lee, C.K.M. and Chan, T.M. (2009) Development of RFID-Based Reverse Logistics System. *Expert Systems with Applications*, **36**, 9299-9307.
https://doi.org/10.1016/j.eswa.2008.12.002

[41] Pishvaee, M.S., Kianfar, K. and Karimi, B. (2010) Reverse Logistics Network Design using Simulated Annealing. *International Journal of Advance Manufacturing Technology*, **47**, 269-281. https://doi.org/10.1007/s00170-009-2194-5

[42] Viera, P.F., Viera, S.M., Gomes, M.I., Sousa, J.M.C. and Barbosa-póvoa, A.P. (2015) Designing Closed-Loop Supply Chains with Nonlinear Dimensioning Factors Using Ant Colony Optimization. *Soft Computing*, **19**, 2245-2264.
https://doi.org/10.1007/s00500-014-1405-7

[43] Li, J., Wang, J., Pan, Q., Duan, P., Sang, H., Gao, K. and Xue, Y. (2017) A Hybrid Artificial Bee Colony for Optimizing a Reverse Logistics Network System. *Soft Computing*, 1-18. https://doi.org/10.1007/s00500-017-2539-1

[44] Lee, D. and Dong, M. (2009) Dynamic Network Design for Reverse Logistics Operations under Uncertainty. *Transportation Research Part E: Logistics and Tranportation Review*, **45**, 61-71. https://doi.org/10.1016/j.tre.2008.08.002

[45] Pishvaee, M.S., Jolai, F. and Razmi, J. (2009) A Stochastic Optimization Model for Integrated Forward/Reverse Logistics Network Design. *Journal of Manufacturing Systems*, **28**, 107-114. https://doi.org/10.1016/j.jmsy.2010.05.001

[46] Saffar, M.M., G, H.S. and Razmi, J. (2015) A New Multi Objective Optimization Model for Designing a Green Supply Chain Network under Uncertainty. *International Journal of Industrial Engineering Computations*, **6**, 15-32.
https://doi.org/10.5267/j.ijiec.2014.10.001

[47] Minner, S. (2001) Strategic Safety Stocks in Reverse Logistics Supply Chains. *International Journal of Production Economics*, **71**, 417-428.
https://doi.org/10.1016/S0925-5273(00)00138-9

[48] Dobos, I. (2003) Optimal Production—Inventory Strategies for a HMMS-Type Reverse Logistics System. *International Journal of Production Economics*, **81-82**, 351-360. https://doi.org/10.1016/S0925-5273(02)00277-3

[49] Mei, Y., He, G. and He, L. (2011) An Inexact Reverse Logistics Model for Municipal Solid Waste Management Systems. *Journal of Environmental Management*, **92**, 522-530. https://doi.org/10.1016/j.jenvman.2010.09.011

[50] Das, K. and Chowdhury, A.H. (2012) Designing a Reverse Logistics Network for Optimal Collection, Recovery and Quality-Based Product-Mix Planning. *International Journal of Production Economics*, **135**, 209-221.
https://doi.org/10.1016/j.ijpe.2011.07.010

[51] Kim, K., Song, I., Kim, J. and Jeong, B. (2006) Supply Planning Model for Remanufacturing System in Reverse Logistics Environment. *Computers & Industrial Engineering*, **51**, 279-287. https://doi.org/10.1016/j.cie.2006.02.008

[52] Hu, T. and Sheu, J. (2002) A Reverse Logistics Cost Minimization Model for the Treatment of Hazardous Wastes. *Transportation Research Part E: Logistics and Transportation Review*, **38**, 457-473.
https://doi.org/10.1016/S1366-5545(02)00020-0

[53] Walther, G. and Spengler, T. (2005) Impact of WEEE-Directive on Reverse Logistics in Germany. *International Journal of Physical Distribution & Logistics Management*, **35**, 337-361. https://doi.org/10.1108/09600030510607337

[54] Sheu, J. (2007) A Coordinated Reverse Logistics System for Regional Management

of Multi-Source Hazardous Wastes. *Computers & Operations Research*, **34**, 1442-1462. https://doi.org/10.1016/j.cor.2005.06.009

[55] Jayaraman, V., Guide Jr, V.D.R. and Srivastava, R. (1999) A Closed-Loop Logistics Model for Remanufacturing. *Journal of Operational Research Society*, **50**, 497-508. https://doi.org/10.1057/palgrave.jors.2600716

[56] Wang, Z., Yao, D. and Huang, P. (2007) A New Location-Inventory Policy with Reverse Logistics Applied to B2C e-Markets of China. *International Journal of Production Economics*, **107**, 350-363. https://doi.org/10.1016/j.ijpe.2006.09.012

[57] El-Sayed, M., Afia, N. and El-Kharbotly, A. (2010) A Stochastic Model for Forward-Reverse Logistics Network Design under Risk. *Computers & Industrial Engineering*, **58**, 423-431. https://doi.org/10.1016/j.cie.2008.09.040

[58] Alumur, S.A., Nickel, S., Saldanha-da-gama, F. and Verter, V. (2012) Multi-Period Reverse Logistics Network Design. *European Journal of Operational Research*, **220**, 67-78. https://doi.org/10.1016/j.ejor.2011.12.045

[59] Lieckens, K. and Vandaele, N. (2012) Multi-Level Reverse Logistics Network Design under Uncertainty. *International Journal of Production Research*, **50**, 23-40. https://doi.org/10.1080/00207543.2011.571442

[60] Fonseca, M.C., García-sánchez, Á., Ortega-mier, M. and Saldanha-da-gama, F. (2010) A Stochastic Bi-Objective Location Model for Strategic Reverse Logistics. *Top*, **18**, 158-184. https://doi.org/10.1007/s11750-009-0107-2

[61] Roghanian, E. and Pazhoheshfar, P. (2014) An Optimization Model for Reverse Logistics Network under Stochastic Environment by Using Genetic Algorithm. *Journal of Manufacturing Systems*, **33**, 348-356. https://doi.org/10.1016/j.jmsy.2014.02.007

[62] Dekker, R., Fleischmann, M., Inderfurth, K. and van Wassenhove, L.N. (2013) Reverse Logistics: Quantitative Models for Closed-Loop Supply Chains. Springer Science & Business Media, Berlin.

[63] Dethloff, J. (2001) Vehicle Routing and Reverse Logistics : The Vehicle Routing Problem with Simultaneous Delivery and Pick-Up. *OR Spectrum*, **23**, 79-96. https://doi.org/10.1007/PL00013346

[64] Kim, H., Yang, J. and Lee, K. (2009) Vehicle Routing in Reverse Logistics for Recycling End-of-Life Consumer Electronic Goods in South Korea. *Transportation Research Part D: Transport and Environment*, **14**, 291-299. https://doi.org/10.1016/j.trd.2009.03.001

[65] Zhang, T. and Chaovalitwongse, W.A. (2014) Integrated Ant Colony and Tabu Search Approach for Time Dependent Vehicle Routing Problems with Simultaneous Pickup and Delivery. *Journal of Combinatorial Optimization*, **28**, 288-309. https://doi.org/10.1007/s10878-014-9741-1

[66] Alshamrani, A., Mathur, K. and Ballou, R.H. (2007) Reverse Logistics : Simultaneous Design of Delivery Routes and Returns Strategies. *Computers & Operations Research*, **34**, 595-619. https://doi.org/10.1016/j.cor.2005.03.015

[67] Achillas, C., Vlachokostas, C., Aidonis, D., Moussiopoulos, N., Iakovou, E. and Banias, G. (2010) Optimising Reverse Logistics Network to Support Policy-Making in the Case of Electrical and Electronic Equipment. *Waste Management*, **30**, 2592-2600. https://doi.org/10.1016/j.wasman.2010.06.022

[68] Bai, C. and Sarkis, J. (2013) Flexibility in Reverse Logistics : A Framework and Evaluation Approach. *Journal of Cleaner Production*, **47**, 306-318. https://doi.org/10.1016/j.jclepro.2013.01.005

[69] Guo, K.U.N. and Zhang, Q. (2014) A Discrete Artificial Bee Colony Algorithm. *International Journal of Information Technology & Decision Making*, **13**, 1-19.

[70] Ramos, T.R.P., Gomes, M.I. and Barbosa-póvoa, A.P. (2014) Planning a Sustainable Reverse Logistics System: Balancing Costs with Environmental and Social Concerns. *Omega*, **48**, 60-74. https://doi.org/10.1016/j.omega.2013.11.006

[71] Deng, S., Li, Y., Guo, H. and Liu, B. (2016) Solving a Closed-Loop Location-Inventory-Routing Problem with Mixed Quality Defects Returns in e-Commerce by Hybrid Ant Colony Optimization Algorithm. *Discrete Dynamics in Nature and Society*, **2016**, Article ID: 6467812. https://doi.org/10.1155/2016/6467812

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