1874-4478/21

Send Orders for Reprints to reprints@benthamscience.net

256


The Open Transportation Journal

Content list available at: https://opentransportationjournal.com

TECHNICAL NOTE

# The Role of Transport in Reverse Distribution Chains

Mohd. R. Shaharudin[1,*]

[1]*Smart Manufacturing Research Institute (SMRI), Universiti Teknologi MARA, 40450 Shah Alam Selangor, Malaysia*

**Abstract:**

Reverse distribution operations have become significant to the manufacturers in supporting the firms to achieve the circularity of products in the reverse flow chains. There are four main components of the reverse distribution chains; inbound and outbound transportation, collection of returns, centralised returns centres, and recovery process. Transport is essential by reducing the lead time and transportation cost of the used and the recovered products. Therefore, it is pertinent that the manufacturers continue endeavouring for the sustainable transportation process in each of the components to ensure the success of the reverse distribution chains.

| Article History | Received: May 20, 2021 | Revised: September 2, 2021 | Accepted: September 28, 2021 |
|---|---|---|---|

## 1. INTRODUCTION

All entities in supply chains are concerned about product return handling, which require producers to deal with the strategic return flow process such as recycling, reuse, refurbishing, remanufacturing, or remarketing [1, 2]. The implication of product return management is imperative for developing a sustainable product life cycle structure in the circular economy. Previous studies on product return management demonstrated a wide range of causes on why customers are returning products [3, 4], for which the reasons might be ambiguous [5]. The complexity of product returns can impede manufacturers from making the right reverse logistics strategy. A sound product return system is crucial given its significant contribution in influencing the reverse flow chains in the circular supply chain. This is prevalent because on average, 6% of everything clients buy is returned to the system, allowing corporations to push additional commercialization efforts for the returned items. [6]. In view of the importance of the reverse flow operations to the practicality and sustainability performance, the study in this area has gained substantial growth from year to year until today [7]. Nevertheless, until this point in time, there were not many studies that have specifically concentrated on the transportation role in the reverse distribution chains, despite its significant contribution to the reverse logistics operations [8].

Product returns are unavoidable due to customer dissatisfaction with product quality, unmatched product specifications, changed minds, and end-of-life products [9]. Past study denoted that there are three main reasons for returning the products, which the highest is caused by the damaged products (20 percent), received wrong items (23 percent), and the inconsistency between the expected image online and the actual product received (22 percent) [10]. Every year, it is estimated that more than 120 million units of products with a value of more than USD13 billion pass through the reverse flow networks [11]. Exacerbating this situation, the online sales ignited thirty percent of the product returns compared with the traditional stores of only eight percent of the returns [10]. This circumstance signified the importance of managing the product returns to achieve a higher competitive level than competitors and sustainability advancement in the circular economy.

Reverse distribution is the process of transporting returned items from the point of use to the point of disposal in order to recover the value or provide proper disposal treatment. [12]. The activity involves transportation, warehousing, distribution, and managing inventory. Generally, transportation contributes to the prime cost in reverse distribution costs [13] due to its significant role in the reverse distribution process. It can be implemented either through the focal company or through the third-party logistics service provider. Ideally, reverse distribution is managed separately from the forward distribution due to the complexity of routing during the transportation of the goods [14]. Therefore, success is defined not only by the acquisition of product returns, but also by the entire process from collection through the conversion of returns into another output via the appropriate recovery procedure.

The importance of transportation in reverse distribution is explicitly evidenced from the two significant roles; inbound and outbound operations and cost of transportation in the reverse flow chain. The heart of reverse distribution operations is inbound and outbound transportation, which ensures correct

* Address correspondence to this author at Smart Manufacturing Research Institute (SMRI), Universiti Teknologi MARA, 40450 Shah Alam Selangor, Malaysia; E-mail: rizaimy@uitm.edu.my

DOI: 10.2174/1874447802115010256, 2021, *15*, 256-259

movement of returned items from the site of collection to the final destination of the returns and the delivery of recovered products to new consumers [15]. Moreover, the total transportation cost in reverse distribution is essential in determining the viability of product recovery initiatives. If the total recovery cost is higher than producing the products with fresh materials, then there is no economic advantage for implementing the reverse distribution system [16].

## 2. INBOUND AND OUTBOUND TRANSPORTATION IN REVERSE DISTRIBUTION CHAINS

The reverse distribution is initiated when product returns are present in the reverse flow chain. Product returns emerges from various origins, such as customer returns, distribution returns, shelves redistribution, unsaleable products, and product recalls. It is part of the manufacturer's obligation to implement the customer extended product responsibility (EPR), which includes after-sales service, take back, recovery, and disposal [7]. The product returns moving in the reverse distribution flow differ depending on the type of returns and the related business process that triggers the return request [17]. In this case, the product will be handed over to the shipper, service providers, and manufacturers. The process signified the use of inbound transportation in reverse distribution channels. Fig. (**1**) shows the overall flow of reverse distribution and the transportation process along the chain.

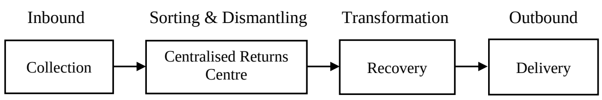


**Fig. (1).** Components of the Reverse Distribution Chains.

As shown in Fig. (**1**), the reverse distribution chains consist of inbound transportation, sorting and dismantling, transformation, and outbound transportation processes. Similarly, as with the forward supply chain, reverse logistics also require the inbound and outbound transportation to complete the transformation process from the used products to the recovered products and supply to the primary or secondary market demands. Inbound transportation is primarily used in the collection process of the product returns from many collection channels of the retailers, distributors, and customers. In the following process, the used products delivered to the centralised returns centre (CRC) are sorted based on the quality of the used products. The quality inspection is subsequently carried out, and the usable goods, either in the form of parts or components, are dismantled to separate between the usable and non-usable materials. Then, using internal transport, the usable materials are delivered to the recovery facilities, and the recovery process is applied depending on the type and quality of the used materials. The recovery is the process of transforming the used materials into parts, components, or products that can be sold, such as recycling, remanufacturing, refurbishing, reusing, and repairing. Finally, the recovered products enter the final distribution stage using outbound transportation to deliver to the primary or secondary markets, either industrial or end customers.

## 3. COLLECTION OF RETURNS

The collection is the first process of obtaining the returned products from multiple sources such as end-users, retailers, and distributors. It includes several specific activities of acquiring product returns from customers, inspection, and transportation of returns to the owner of the requested return for further recovery process [7]. The strategy in collecting the product returns is considered one of the significant factors in the reverse distribution. Noteworthy, the major source of returned products originates from the forward flow chain, such as defective or damaged products; from the reverse flow chain of products affected under market-driven systems; or from the waste chain, such as unwanted and discarded products [18]. Typically, the products are delivered by the same channel in the forward flow and subsequently back into the channel in the reverse flow chains [19].

Transportation is the major component in the collection process. Thus, to save cost, it is imperative to select a suitable mode of transportation to move the returns from sources to the owner [20]. Collection strategy includes the consideration of locating the collection centre at a specific economic location to minimise the transportation cost and support an adequate information flow [21]. This includes outsourcing transportation to the third-party service provider, which can perform much better due to the availability of resources or expertise [22]. Hence, attention is needed to monitor and control the transportation costs, as any increase in the particular price can incur additional charges to the manufacturer's operations and the product costs [23].

## 4. CENTRALISED RETURNS CENTRES (CRCS)

In reverse distribution, several studies deliberated about using the in-house distribution centres and centralised returns centres (CRCs) [24]. The issue behind the two concepts is whether firms mix both forward and reverse flow product processes in the same place or separate the reverse flow product processes in a central location with total independent facilities. Concerning this, several authors have highlighted the crucial part of CRCs in reverse distribution. Firstly, CRCs can increase the efficiency in transporting returns, handling, sorting, and repacking activities [24, 25]. Secondly, CRCs allow firms to possess specialised assets to manage a larger volume of product returns [26]. Thirdly, the split process enables the personnel to focus on the job rather than meddle with forward-flow product issues [4, 24]. Fourthly, all the process' benefits, goals, and outcomes can be directly channelled exclusively for CRCs. Lastly, through centralisation, managers can gain more experience when dealing with different product recovery strategies. Nevertheless, above all the benefits mentioned, the decision on whether to use in-house or CRCs depends on many factors such as the strategic priorities, including handling and transportation costs [24, 27].

The previous study highlighted the product return management is subjected to inevitable uncertainties derived from the differences in the quality, quantity, and timing of the returned products [5]. This situation can pose an operational complex in CRCs, especially when the amount returned and timing are uncertain and unpredictable. Another issue related to the transportation in reverse distribution is with regards to the two-stage facility-location issues. The two-stage facility location involves finding out the optimum depot locations that can serve the customers well, allocating an optimum number of customers to the depots, and establishing an optimum flow of products from the factory to the depots [28, 29]. In this case, the decision must be reached on the location of depots from several areas to reduce the transport cost [30]. Hence, the effectiveness of product returns is evident throughout the reverse logistics process, from the collection of returned items to CRCs through the subsequent process of recovery and distribution to consumers.

## 5. RECOVERY PROCESS

At this stage, product returns are transformed from their current state into reusable products.It comprises several activities that are subject to the disposition choices [31]. Literature has identified six recovery options: reuse, repair, refurbishing, remanufacturing, retrieval, and recycling [32, 33]. On the other hand [31], previously conducted study described the six recovery options as reuse, repair, refurbishing, recycling, incineration, and landfilling. In relation to this, there are several processes involved in determining the recovery options. For example, if return testing indicates that the disposal choice should be upgraded to material recovery, the goods are selected for additional suitable disposition processes such as repair, refurbishment, remanufacturing, and recycling [19]. In managing the movement of used products for recovery, the lead time for used products and the transportation cost can be reduced by locating the recovery facilities closer to the CRCs or by implementing the recovery operations in the field or near the user's site.

## CONCLUSION

To summarize, transportation in the reverse distribution provides the value chain of product return management by linking the customer and the manufacturer in the circularity of products in the supply chain. It directly impacts supply chains by facilitating the movement of product returns directly from the consumer end to the manufacturer to meet the returned quantity and timing of the product recovery schedule. Despite its advantage, inbound and outbound transportation in the reverse distribution can impose a higher cost of managing returns exacerbated by the larger sales volume in forwarding distribution. It is suggested that the manufacturers should focus on the returned process and resources, establish solid organisational structures, adopt effective performance measurement, and maintain lower reverse distribution costs. This circumstance should pave the way for the manufacturers to continue endeavouring for sustainable transportation process in managing the uncertainties of the returns' volume and diversity that enter the reverse distribution chains.

## CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.


## ACKNOWLEDGEMENTS

Declared none.


## REFERENCES


[1] S.K. Srivastava, "Green supply chain management: A state-of-the-art literature review", *Int. J. Manag. Rev.,* vol. 9, no. 1, pp. 53-80, 2007. [http://dx.doi.org/10.1111/j.1468-2370.2007.00202.x]

[2] M.W. Toffel, "Strategic management of product recovery", *Calif. Manage. Rev.,* vol. 46, no. 2, pp. 120-141, 2004. [http://dx.doi.org/10.2307/41166214]

[3] M. Mannella, "What your returns are telling you", *APICS—The Performance Advantage.,* vol. 13, no. 7, pp. 38-44.

[4] D.S. Rogers, and R. Tibben-Lembke, "An examination of reverse logistics practices", *J. Bus. Logist.,* vol. 22, no. 2, pp. 129-148, 2001. [http://dx.doi.org/10.1002/j.2158-1592.2001.tb00007.x]

[5] M.R. Shaharudin, K.C. Tan, V. Kannan, and S. Zailani, "The mediating effects of product returns on the relationship between green capabilities and closed-loop supply chain adoption", *J. Clean. Prod.,* vol. 211, pp. 233-246, 2019. [http://dx.doi.org/10.1016/j.jclepro.2018.11.035]

[6] V. Jayaraman, and Y. Luo, "Creating competitive advantages through new value creation: A reverse logistics perspective", *Acad. Manage. Perspect.,* no. May, pp. 56-73, 2007. [http://dx.doi.org/10.5465/amp.2007.25356512]

[7] M. Alkahtani, A. Ziout, B. Salah, M. Alatefi, A.E.E. Abd Elgawad, A. Badwelan, and U. Syarif, "An insight into reverse logistics with a focus on collection systems", *Sustainability,* vol. 13, p. 548, 2021. [http://dx.doi.org/10.3390/su13020548]

[8] R. Casper, and E. Sundin, "Reverse logistic transportation and packaging concepts in automotive remanufacturing", *Procedia Manuf.,* vol. 25, pp. 154-160, 2018. [http://dx.doi.org/10.1016/j.promfg.2018.06.069]

[9] M.R. Shaharudin, S. Zailani, and K.C. Tan, "Barriers to product returns and recovery management in a developing country: Investigation using multiple methods", *J. Clean. Prod.,* vol. 96, pp. 1144-1156, 2015. [http://dx.doi.org/10.1016/j.jclepro.2013.12.071]

[10] K. Saleh, "E-commerce product return rate – statistics and trends", *Invesp.,* 2021. Available from: https://www.invespcro.com/blog/ecommerce-product-return-rate-statistics/

[11] HDA, "The role of reverse distribution", *HDA Research Foundation.,* . Available from: https://pharmalinkinc.com/wp-content/uploads/2018/11/2018-Role-of-Reverse-Distribution.pdf

[12] D.L. Bayles, *E-commerce logistics and fulfillment.,* Prentice-Hall: Upper Saddle River, NJ, 2001.

[13] J.R. Stock, *Development and implementation of reverse logistics programs.,* Council of Logistics Management: Oak Brook, IL, 1998.

[14] M. Jamshidi, *Reverse logistics. In: logistics operations and management: concepts and models.,* 2011, pp. 247-266. [http://dx.doi.org/10.1016/B978-0-12-385202-1.00013-X]

[15] D. Bloomberg, S. LeMay, and J. Hanna, Bloomberg, *Logistics. Upper Saddle River, NJ: Prentice-Hall,* 2002.

[16] M.R. Shaharudin, K. Govindan, S. Zailani, K.C. Tan, and M. Iranmanesh, "Product return management: Linking product returns, closed-loop supply chain activities and the effectiveness of the reverse supply chains", *J. Clean. Prod.,* vol. 149, pp. 1144-1156, 2017. [http://dx.doi.org/10.1016/j.jclepro.2017.02.133]

[17] V.D.R. Guide Jr, and L.N. Van Wassenhove, "Managing product returns for remanufacturing", *Prod. Oper. Manag.,* vol. 10, no. 2, pp. 142-155, 2001. [http://dx.doi.org/10.1111/j.1937-5956.2001.tb00075.x]

[18] C. Prahinski, and C. Kocabasoglu, "Empirical research opportunities in reverse supply chains", *Omega,* vol. 34, no. 6, pp. 519-532, 2006. [http://dx.doi.org/10.1016/j.omega.2005.01.003]

[19] K.N. Reddy, A. Kumar, and E.E.F. Ballantyne, "A three-phase heuristic approach for reverse logistics network design incorporating carbon footprint", *Int. J. Prod. Res.,* vol. 57, pp. 6090-6114, 2019. [http://dx.doi.org/10.1080/00207543.2018.1526422]

[20] K. Park, J. Kim, Y.D. Ko, and B.D. Song, "Redesign of reverse logistics network with managerial decisions on the minimum quality level and remanufacturing policy", *J. Oper. Res. Soc.,* vol. 72, no. 7, pp. 1564-1577, 2020. [http://dx.doi.org/10.1080/01605682.2020.1745702]

[21] S. Dowlatshahi, "The role of transportation in the design and implementation of reverse logistics systems", *Int. J. Prod. Res.,* vol. 48, no. 14, pp. 4199-4215, 2010. [http://dx.doi.org/10.1080/00207540902998356]

[22] M. Aichlmayr, "Logistics conquers a brave new world", *Transport. Distribut.,* vol. 41, no. 8, pp. 29-36, 2000.

[23] T. Gooley, "The who, what and where of reverse logistics", *Logistics Management,* vol. 42, no. 2, pp. 38-44, 2002.

[24] R. Kopicki, M. Berg, L. Legg, V. Dasappa, and C. Maggioni, *Reuse and recycling—reverse logistics opportunities.,* Council of Logistics Management: Oak Brook, IL, 1993.

[25] R.S. Tibben-Lembke, "Life after death: reverse logistics and the product life cycle", *Int. J. Phys. Distrib. Logist. Manag.,* vol. 32, no. 3, pp. 223-244, 2002. [http://dx.doi.org/10.1108/09600030210426548]

[26] M. Fleischmann, P. Beullens, J.M. Bloemhof-Ruwaard, and L.N. Van Wassenhove, "The impact of product recovery on logistics network design", *Prod. Oper. Manag.,* vol. 10, pp. 156-173, 2001. [http://dx.doi.org/10.1111/j.1937-5956.2001.tb00076.x]

[27] A. Bruns, A local search heuristic for the two-stage capacitated facility location problem. *Advances in Distribution Logistics.,* Springer: Berlin, Heidelberg, New York, 1998, pp. 143-164. [http://dx.doi.org/10.1007/978-3-642-46865-0_6]

[28] A. Klose, "A Lagrangean heuristic to solve the two-stage capacitated facility location problem", *Proc. Second International Workshop Distribution Logistics,* 1995pp. 33-37 Oegstgeest, The Netherlands

[29] F. Schultmann, B. Engels, and O. Rentz, "Closed-loop supply chains for spent batteries", *Interfaces,* vol. 33, no. 6, pp. 57-71, 2003. [http://dx.doi.org/10.1287/inte.33.6.57.25183]

[30] S. Kumar, and P. Malegeant, "Strategic alliance in a closed-loop supply chain, a case of manufacturer and eco-non-profit organization", *Technovation,* vol. 26, no. 10, pp. 1127-1135, 2006. [http://dx.doi.org/10.1016/j.technovation.2005.08.002]

[31] M. Thierry, M. Salomon, J. Van Nunen, and L. Van Wassenhove, "Strategic issues in product recovery management", *Calif. Manage. Rev.,* vol. 37, no. 2, pp. 114-134, 1995. [http://dx.doi.org/10.2307/41165792]

[32] M. Fleischmann, J.M. Bloemhof-Ruwaard, R. Dekker, E. van der Laan, J.A.E.E. van Nunen, and L.N. Van Wassenhove, "Quantitative models for reverse logistics: A review", *Eur. J. Oper. Res.,* vol. 103, no. 1, pp. 1-17, 1997. [http://dx.doi.org/10.1016/S0377-2217(97)00230-0]

[33] M.P. De Brito, and R. Dekker, A Framework for Reverse Logistics.*Reverse Logistics. Quantitative Models for Closed- Loop Supply Chains.,* Springer-Verlag, 2004, pp. 3-27.