Towards Reverse Logistics Archetypes to Stimulate Manufacturers' Usage of End of Life and End of Use Products

Serhan Alshammari and Peter Ball

Abstract There is an increasing need to recover value from products from their end of use and end of life phase as a result of issues of mitigating against resource scarcity, increasing legislation and emerging business models. Reverse logistics is a core process for recovery. There are economic and environmental drivers for such an activity. The challenge for industry is the absence of models to support the development of reverse logistics operations. This absence is both in practice and in the literature. Here we develop generic archetypes for the reverse logistics activity that capture the common structure and the main. The work has been developed through adopting supply chain structures in literature and interviews with industrial experts. The three main archetypes developed here are: low value extended producer responsibility, service parts logistics, and advanced industrial products recovery. The reverse logistics archetypes definition will help firms to identify their key drivers for their reverse logistics structure and help to plan the activities within this process.

Keywords Reverse logistics · Circular economy · Recovery · EPR

1 Introduction

Reverse logistics processes that support product value recovery serve the development of industrial systems both economically and environmentally sustainable [8]. In order to resolve the problem of environment pollution and realize sustainable development, the concepts of circular economy and reverse logistics are both very important. In essence, reverse logistics is the key to the circular economy, while the

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circular economy development will promote the development of reverse logistics [17]. Circular economy is the approach where we maximize the reuse of finite resources through changes in business structure of industrial systems in terms of design and eco-efficiency [10].

Firms find themselves hindered in the adoption of circular economy concepts through lack of definition of the type of reverse logistics that they have to in turn seek best practice. In order to understand the types of reverse logistics, we need to understand the reverse logistics drivers and factors that construct those types.

This paper provides a simple definition of reverse logistics archetypes that work as guides for understanding and planning reverse logistics. The structure is as follows: first we introduce the reverse logistics concept, after that we will introduce the research method and design employed, and then we discuss the reverse logistics archetypes developed based on literature review of reverse logistics.

2 Reverse Logistics Context

Terms like Reverse Channels or Reverse Flow appeared in the scientific literature in the 1970s, but consistently related to recycling [4]. The reverse logistic throughout the 1980s was about the movement of material against the primary flow [3]. The Council of Logistics Management (CLM) published the first known definition of Reverse Logistics in the early nineties as in [4] "…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 relating to logistics activities carried out in source reduction, recycling, substitution, reuse of materials and disposal." In the late 1990s Rogers and Tibben-Lembke defined reverse logistics as "The process of planning, implementing, and controlling the efficient, cost- effective flow of raw materials, in-process inventory, finished goods, and related information from the point of consumption to the point of origin for the purpose of recapturing or creating value or proper disposal" [12]. About the same time Dowlatshahi [5] defined reverse logistics as a process by which a manufacturing entity systematically takes back previously shipped products or parts from the point- of-consumption for possible recycling, remanufacturing, or disposal. A reverse logistics system in Dowlatshahi's definition constitutes a supply chain that is redesigned to systematically manage the flow of parts and products intended for remanufacturing, recycling, or disposal activities. With this definition, systems will be capable of effectively using resources that were not previously considered or utilised.

Generally the scope of reverse logistics has increased with the development of the topic as we see in Fig. 1. We can spot that also using the last two definitions stated, since the later one considered reverse logistics as an abstract process where the former one has extended the terms to be close to the original definition of supply chain management. The reverse logistic is closely related to product recovery management practices and strategy which have been used 20 years ago [11, 13]. The American Production and Inventory Control Society (APICS) dictionary

Fig. 1 Reverse logistics definitions evolution

defines reverse logistics as “a complete supply chain dedicated to the reverse flow of products and materials for the purpose of returns, repair, remanufacture, and/or recycling” [2].

Alshammari and Ball [1] presented a framework that captures five stages of reverse logistics parameters which are; user, collection channel, processes, new life, and commercial. The user stage covers the motivation of reverse logistics, retrieval points, and what is recovered presented and retrieval level. The collection channel stage covers where and how related parameters to collection. The reverse logistics related processes cover the enablers to the reverse logistics system and disposition choices for recovery. The new life stage presents where the recovered product can be deployed. Then the commercial stage presents prising parameters, cost, and potential benefits to such a process. In each stage they presented the key parameters that significantly impact the shape of reverse logistics. The key parameters are intended to capture the shape of any reverse logistics operation; however, not all will be present in a given operation thereby giving rise to distinction between types. That work was the potential starting point in developing reverse logistics archetypes that could be the basis for defining the set of significant factors that shape the reverse logistics success for firms. Across industrial sectors it is expected that operations can be clustered into a number of archetypes that typify different reverse logistics operations.

3 Research Methodology and Design for RL Archetype Development

To undertake the empirical research a literature review was undertaken to identify key parameters and dimensions that affect the reverse logistics process design. The research identified five stages for the parameters of the process as Alshammari and Ball [1] published earlier. Those stages formed the basis of discussion with participant to articulate semi-structure interviews about reverse logistics design with senior industrial experts with reverse logistics operations. Four companies were approached for the interviews that represent range of manufacturers including automobile industry, electrical, and electronics along with third-party logistics provider with expertise in reverse logistics operation. The results from those interviews were collected and coded to map the design of reverse logistics at each case. Then the results were clustered to generically represent the reverse logistics design archetypes. A total of 4 individual interviews lasting for 1 h were conducted, and 2 conference calls for participants were conducted to share thoughts about the proposed archetypes. After that a workshop were carried out for 2 h in collaboration with Ellen MacArthur Foundation for circular economy where the archetypes were presented to audience ranging from industrial experts and academics to further validate the archetypes. The feedback from the 20 participants in workshop session was positive and embedded in the model.

As described above, since the nature of the phenomena is based on description and explanation of conceptual modeling, a qualitative research with multiple case studies were deployed [9]. This is also as Yin [16] suggested because the phenomena cannot be explained in isolation of its social complexity; and it is needed to consider multiple subjective perspectives.

4 Reverse Logistics Archetypes

The study of reverse logistics archetypes is crucial since it provides the basis to design the reverse logistics activity. Developing reverse logistics archetypes could be the foundation for defining the set of significant factors that shape the reverse logistics success for firms. Across industrial sectors it is expected that operations can be clustered into a number of archetypes that typify different reverse logistics operations. This paper will present three, which are low value extended producer responsibility, service parts logistics, and advanced industrial products recovery.

By reverse Logistics archetypes we mean; prototypical model of how reverse logistics can be done in a very high level. Gobbi [7] have developed a mathematical model based on the value recovery of product benchmarking with Fisher's structure for the supply chain of innovative and functional products [6]. Gobbi's work concluded the same approach that Fishers proposed and we are using their classification to develop the reverse logistics archetypes. The main conclusion from Gobbi's design is that if the return is legislation driven then the reverse logistics need efficient design, whereas if the return is value driven it needed to be responsive which is analogous to Fisher's model.

Another researcher proposed different types of reverse logistic types related to the retail sector and the managing of legislated material. Triantafyllou and Cherrett [14] proposed four types of reverse collection, namely: Integrated outbound and returns network, non-integrated outbound and returns network, third party return management, and return to supplier collection system. In this approach the researcher assigned number of characteristics for each type. However, in our attempt to define the reverse logistics approach we defined generically the overall structure of the process without limiting the structure to the collection stage.

Fisher and Gobbi introduced features of responsive and efficient supply chain and reverse supply chain models. However, the data collection process of systems that exists based on responsive and efficient models do not distinguish the practices and structure. After analyzing data, this research revealed three typical structures of reverse logistics, hence archetypes for each were created. Two of the archetypes align closely to Fisher's and Gobbi's models and design but third one is revealed to capture the structure of complex model which needs to compromise effectiveness and efficiency. The defined archetypes captures the structure of the reverse logistics in the four main stages which are; user, collection, processing, and new life (re-marketing) as proposed by Alshammari and Ball [1].

4.1 Archetype 1: Advanced Industry Goods Recovery

This archetypes or reverse logistics is similar to Fisher's [6] responsive supply chain model. This archetype is designed around service quality, and seeking early disposition decision. The other key factors that shape this archetype are; high value of the products which result in high touch requirement in terms of de-installation, packaging and item security, low volume, and the need for direct trusted dedicated collection. This archetype commonly decentralized with direct or trusted collection. The visibility if required for this product type through monitoring or leasing model to increase it, or coordinate the take back program to increase volume. The primary focuse of this archetype is to maximize product return value. It also compromise between maximizing utalization of recovery infrastructure and requirement for minimizing leat time as Gobbi [7] mentioned in his design for reverse supply chain. Common examples of this archetype are Network, IT, Telecom equipment, Medical Equipment. Figure 2 has representation of the archetype.

4.2 Archetype 2: Products with Low Residual Value and EPR

The second archetypes is also similar Fisher's [6] efficient supply chain model where the key objectives are minimizing cost and maximising volume to get the

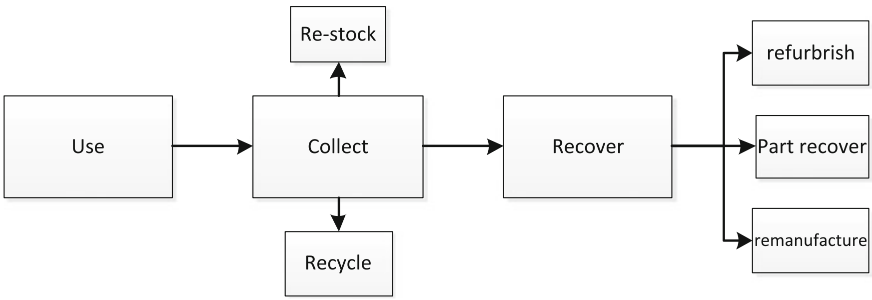

Fig. 2 Archetype 1 advanced industry goods recovery

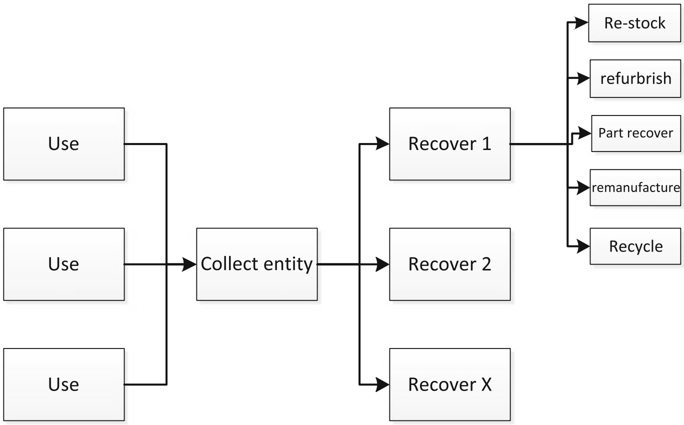

Fig. 3 Archetype 2 products with low residual value and EPR

economics of scale. The drivers for this approach are to recover raw material and fulfil extended producer responsibility (EPR) obligation. The return volumes are usually high, and have low residual value. Also there is not much of a concern for packaging, handling, and security. So for an effective structure it is better to standardise as much as possible. Develop centralised collection channel that capture items from multiple customer and consolidate for different recovery partner. The collection may come through municipal waste, point of sale, or drop-off. One key enabler for this model, especially for sectors that needs to comply with EPR, is to collaborate with partners who have similar interest. The primary areas of focus of this archetype are maximize recovery target as well as recycle efficiently the incoming volumes. Also maximize utilisation of recovery infrastructure, and reducing lead time as long as it does not increase the cost significantly as Gobbi [7] mentioned in his design for reverse supply chain. Common examples of this archetype are tires, consumer electronics, and shipping pallets. Figure 3 has representation of the archetype.

4.3 Archetype 3: Service Parts Logistics

This archetype could be seen as sub archetype where you can find dedicated transport and service partner who services multiple OEM as in archetype 2. The key different is that this model is between the previous two archetypes where collection could come from multiple customers through multiple or dedicated service provider. This archetype represents recovery of parts with significant residual value mainly at volume. It is established to ensure supply of replacement parts and services and as a formal process for remanufacturing. There is a potential for consolidation and pre-sorting before the recovery point. Key enablers for this

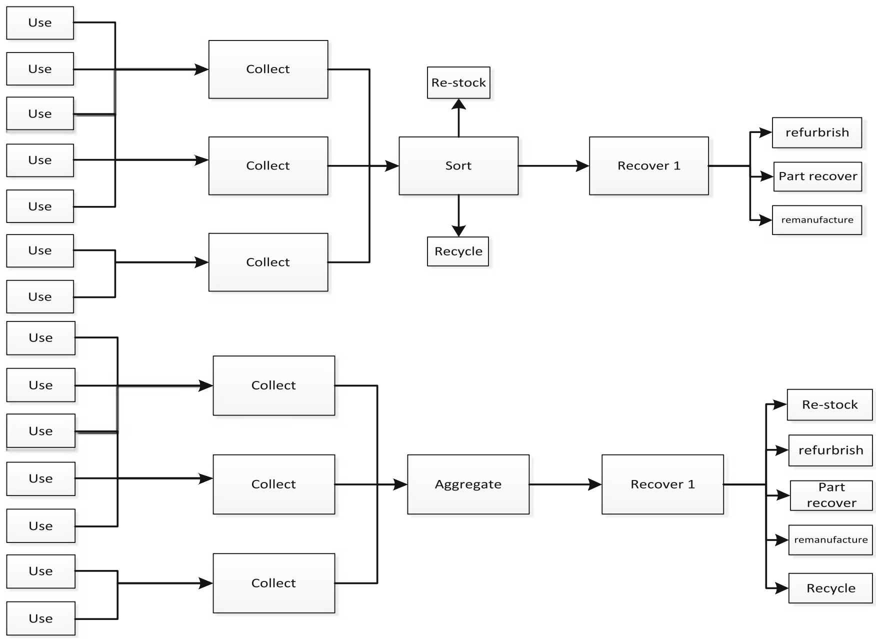

Fig. 4 Archetype 3 service parts logistics

structure are effective traceability of items and buy/take back scheme to make the economics of the system, and long term partnership in regulated markets [15]. The primary focus of this archetype varies based of the business model, product complexity, and level of competitiveness in that market. Common examples of this archetype are Machinery and heavy equipment parts, automotive parts, other spare parts, recyclable waste. Figure 4 has representation of the archetype.

5 Conclusion

The reverse logistics analysis tools are not available or not well structured [11]. Majority of the work is on exploration of the subject, however in order to establish the tools we need to accurately address the processes through modelling and standardising the activities. From these base models, we can develop the analysis tools that fulfil the need of this area. The challenge for industry is the absence of models to support the development of reverse logistics operations. This absence is both in practice and in the literature.

In this paper we developed reverse logistics archetypes as a basis for defining the significant factors that shape the reverse logistics success for firms. Across industrial sectors operations can be clustered into a number of archetypes that typify different reverse logistics operations, for example products with low residual value and advanced industrial goods recovery could be operated in the same company.

The purpose of the archetypes is to capture the dominant factors that shape the reverse logistics design and support communication of the topic through referring to proposed archetypes and amend the structure as necessary.

Ultimately, by collecting data on reverse logistics operations against those archetypes it is expected that different levels of maturity will be uncovered. In turn, companies could use this to understand where they stand in relation to what has been achieved in other businesses and use this as a tool to question where they should change practice in order to improve performance.

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