Article:

Vlachos, IP (2014) Reverse food logistics during the product life cycle. International Journal of Integrated Supply Management, 9 (1-2). 1. 49 - 73. ISSN 1477-5360

https://doi.org/10.1504/IJISM.2014.064356

Reverse Food Logistics during the Product Life Cycle

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Acknowledgements:

The author gratefully acknowledges the constructive comments provided by the Editor and three anonymous reviewers as well as the contribution of Ms. Maria Isabel Cardona in data collection.

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Abstract

This study aimed to examine reverse logistics across the food product life cycle. The literature review of reverse logistics factors in food industry produced a set of supply chain performance measures. Using a survey, questionnaires were sent to 200 practitioners with experience in food supply chain operations. In total, 48 usable questionnaires were returned, resulting in 24% response rate. The contribution of this study lies in extending the body of knowledge of reverse food logistics during product life cycle. It offers practical advice to manage reverse food logistics. Results indicate that customer expectations are more significant during the introduction and growth stages. The effectiveness of the return process in the introduction stage will determine the future of the product and companies need to manage quality problems effectively. The paper discusses managerial implications and offers recommendations for future research.

Keywords: Reverse Logistics, Food Industry, Product Life Cycle

1. Introduction

Reverse logistics is a relatively new business concept and firms tend to dedicate their assets and resources on the forward operations, often overlooking reverse logistics operations and the value they can generate (Bernon, Rossi and Cullen, 2010). Forward logistics strategies cannot be applied to reverse logistics due to the enormous differences between them. Reverse logistics are hard to forecast, require more distribution points and specialised equipment, packaging is often damaged, pricing is vague, product life cycle is not determined, and transparency and traceability are low (Vaidyanathan and Yadong, 2007; Pokharel and Mutha, 2009). The lack of strategic view of reverse logistics limits even further the ability of the companies to respond effectively to customer demands and create value for money. Petersen and Kumar (2009) estimated return rates to be greater than 25% of total sales which accounts for approximately $100 billion in lost sales in US and a reduction in profits by 3.8% per retailer or manufacturer. The strong drive for reverse logistics is fuelled by current patterns of customer behaviour which result in volatile food markets and shorter product life cycles. Beyond returns of faulty goods, liberal returns policies shape competition in many markets including online retailing, which is another indicator of a growing demand for reverse logistics.

The significant of reverse logistics in the food industry is evident in the requirement to provide quality and safe food to consumers without posing any threat on human health, wellbeing and the environment. Food industry is far from being efficient. For example, Gustavsson and Otterdijk (2011) estimated global food losses and waste to 1.3 billion tons of food per year, corresponding to 95-115 kg/year per capita in Europe and North America and between 6 and 11 kg/year in Sub-Saharan Africa and South/Southeast Asia. Food wastes can be attributed to a number of factors such as excess buying, premature harvesting, inadequate labelling and storage instructions, poor storage facilities and transportation, production errors, trial runs, packaging defects, and wrong weights and sizes (Fotopoulos, Vlachos, and Maglaras, 2010;

Gustavsson and Otterdijk, 2011). Household wastes are about 14-26% of food sales in USA and almost 27% in UK whereas the percentage of food products returns was 1.2% to 1.8% of total sales in 2010 (Nestle, 2011; Terreri, 2010).

Despite the importance of reverse logistics in handling growing amount of food product returns reverse operations during the product life cycle have received little attention. This study examines reverse logistics practices across the different stages of food product life cycle. The unit of analysis is the firm. Results from a global survey of food professionals shed light on how reverse food logistics performance indicators (speed, flexibility, reliability, quality, and sustainability) fluctuate during life cycle stages (introduction, growth, mature, and decline). The research scope of this study is the food companies and it has several research and practical contributions. The research contribution of this study is to review the relevant literature and propose a framework of indicators to test the research objective of this study. The contribution to practice of this study is that it offers specific managerial implications and suggestions to manage reverse food logistics that helps reduce waste throughout the food supply chain and increase value from returned products.

The paper is organized as follows: The next section reviews the literature on reverse logistics in food industry with a focus on product life cycle. Research methodology is explained in Section 3 and findings are presented in Section 4. The final Section 5 discusses conclusions, presents managerial implications and provides recommendations for future research.

2. Literature Review

Firstly, reverse logistics in food industry is described and its main characteristics are outlined. Then, the product life cycle in reverse food logistics is discussed. Finally, the supply chain performance metrics are discussed.

2.1. Reverse Logistics in Food Industry

The major challenge for reverse logistics in the food industry relies on the perishable nature of food and agricultural products which have short shelf life and require fast and efficient logistics operations. Even the smallest deviation in an organoleptic characteristic may create a food safety incident and subsequently pose a possible threat to consumer's health. The recent horsemeat scandal, while there was no absolute threat to consumer health, is a clear indication that deviations from the promised food quality may harm public confidence and generate distrust even among loyal customers. Poor reverse logistics can have devastating legal and economic repercussions. Referring to the horsemeat scandal, on the 15th of January 2013, The Food Safety Authority of Ireland (FSAI) announced that horse meat was found in frozen beef burgers at several Irish and British supermarkets, including Tesco, Asda, Dunnes Stores, Lidl, Aldi and Iceland. On the next day, Tesco dropped 360 million EUR in market value (O'Hora, 2013). Despite the fact that there was no issue of food safety, Tesco immediately withdrew all of its burgers, both fresh and frozen, from its shelves regardless of whether they contained traces of horse DNA. In horsemeat case, as in many other instances of food crises, reverse logistics had to perform effectively to protect consumer trust in a moment of crisis. The performance of reverse logistics is affected by many factors, which we found useful to review them under five research streams: food specific features, cost, competitive advantage, regulation and legislation, and information management.

2.1.1. Food Specific Features

Physical features of food products, such as sensitive sensory and physic-chemical properties, determine to a large extend how reverse logistics should operate. Food features affect logistics performance including: Shelf life time, production throughput time, temperature control transportation, and production seasonality (Vlachos, 2003; Aramyan et al. 2006; Hsiao et al., 2010). Gustavsson and Otterdijk (2011) asserted that mechanical damage or spillage during harvest and postharvest, processing, distribution and consumption points result in food losses and waste. Poor handling during logistics operations may result in degradation of food quality and in turn stimulate “return avoidance” which is a critical factor in reverse logistics process (Stock and Mulki, 2009). Firms like Nestlé have managed return avoidance by reducing waste to 3.1% and increasing reuse or recovery to 4.2% (Nestle, 2011). Nevertheless, most companies are far from achieving high return avoidance rates (Gustavsson and Otterdijk, 2011).

2.1.2. Cost

Coelho, Castro and Gobbo (2011) pointed out that the economic performance of reverse logistics relies on re-capturing value from raw materials which lowers customer prices due to recycling and decreased waste costs. Remanufactured products incur 40-60% less costs than new products and save 85% of the energy needed to start from scratch since remanufacturing expands the life cycle of the product (Kumar and Putnam, 2008). Optimization of resources increases supply chain efficiency and reduces reverse logistics costs.

2.1.3. Competitive Advantage

Product return policies and processes differ among supply chain partners. For example, retailers aim to avoid the risk of unsold goods, yet manufactures may follow liberal return policies, resulting in high product returns (Bernon and Cullen, 2007; Stock and Mulki, 2009). Lower product returns contribute directly to competitive advantage since they incur lower reverse logistics costs. Further, supply chain collaboration contributes to overall supply chain performance and reverse logistics cannot be an exemption (Karalis and Vlachos, 2004). For example, H-E-B Grocery Co. reported 50% reduction in unsold products by implementing joint policies such as “Store Damage Allowance” and “Unsaleables Recovery Program” (Karolefski, 2007). Supply chain collaboration is one effective way in reducing logistics costs by making supply chain partners to join forces in finding and removing waste across the supply chain. For example, retailers working closely with food manufactures can remove the damaged unit from the case, and then repack and sell the rest of it (Karolefski, 2007).

2.1.4. Regulation and Legislation

CIAA (2011) reported that the competitiveness of EU food industry is highly influenced by strict regulations. As a result, legislative factors force companies to adopt reverse logistics strategies in order to become more sustainable (Nikolaou, Evangelinos and Allan, 2011).

A business-wise regulatory environment would help food companies to deal with unsustainable business practices, food security, and fair trade. Olugu, Wong and Shaharoun (2011) developed of a set of holistic measures for evaluating the performance of the automobile green supply chain and suggested that Different legislations and regulations in most developed countries such as the European community have made the manufacturers accountable for their products, throughout their entire product life cycle and beyond. Environmental initiatives include recycling, reuse, and composting activities. Companies are also motivated to form alliances with food manufactures to collect defective or returned packaging and transform it into new products.

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2.1.5. Information Management

The management of information flows in one of the key successful drivers in forward logistics as well as in reverse logistics operations (Georgiadis, Vlachos, and Iakovou, 2005). Terreri (2010) argued that poor data measurement and lack of appropriate capturing, using, and analysing information are the major concerns during the customer return activity. The implementation of information technology and applications and their integration with reverse logistics operations contribute significantly in reducing product returns (Vlachos, 2002; Karim, Smith and Halgamuge, 2008). Karolefski (2007) pointed out that data coding in food labels constitutes another problem since customers do not fully understand well food dates and storage information. Confusion on data labels, combined with modern consumer lifestyles generate about three million tons of food and drink wasted by consumers before ever being cooked or served (WRAP, 2011). Data and information on food labels can facilitate reverse processes and reduce waste before and after consumption.

2.1.6. Logistics System

The design or reverse logistics operations depend on the return rates (Stock and Mulki, 2009). Low return rates force companies to use forward logistics facilities in order to serve reverse operations. On contrast, high return rates require the development of specialised facilities for the reverse logistics operations. Srivastava and Srivastava (2006) pointed out that the decisions about the logistics facilities i.e. warehouse and transportation are based on a number of factors such as estimated returns, costs, competitors' behaviour and operations strategies. Capacity management becomes even more complex as regulatory and consumer demands are becoming part of the reverse logistics equation.

Doughton (2008) pointed out that the sustainable impact of reverse logistics is highly linked to the design of the distribution networks. A centralized reverse logistics facility may include benefits such as (i) the elimination of landfill costs, (ii) reduction of carbon footprint by shipping to regional distribution return centers, (iii) use of economies of scale by maximizing recovery and (iv) the optimization of other activities such as repacking and refurbishing, centralized collection of product return data.

2.2. Product Life Cycle (PLC) in Reverse Food Supply Chains

Madaan and Wadhwa (2007) proposed PLC analysis as a tool to design reverse logistics operations and extract value from returned prodcuts. Figure 1 illustrates the general classification of reverse logistics strategies per PLC stage.

Van der Vorst, Tromp and Van der Zee (2009) sustained that food quality management affects the supply chain performance. Food quality elements are affected by many logistics functions such as packaging, loading techniques and handling, temperature-controlled transportation and warehouses. Referring to the food industry, Kumar and Nigmatullin (2011) argued supply chain performance is dependent on how effectively uncertainty is managed at three levels of the supply chain: (i) the retailer, which is influenced by demographic changes, competitive forces and inflation; (ii) the distributor and manufacturer, which are affected by bullwhip effect, and (iii) customer demand, which can have unpredictable patterns.

De Koster, De Brito and Van de Vendel (2002) suggested that one of the most common practices in the food sector is using a central distribution centre to receive product returns. A centralised supply chain design provides suppliers and retailers with a better visibility and control of return products, thus reducing wastes (Terreri, 2010). Kumar and Putnam (2008) considered that reverse logistics reserve special attention when products reach the end of their life because a product with poor quality has value to extract and the reverse logistics add cost than create value (Bernon, Rossi and Cullen, 2010). Food returns from customers to retailers create higher recovery rates for retailers than the rest supply chain members (Stock and Mulki, 2009). As a result retailers are in better position to govern the reverse logistics operations for all supply chain members.

2.3.Supply chain performance metrics

Improving supply chain performance has become a challenge for companies aiming to sustain their competitive advantages (Cai et al., 2009; Estampe et al., 2013). Performance measurement has evolved during the last decades from accounting and budgeting variables to non-financial measures such as competition, supplier evaluation, and customer satisfaction (Chae, 2009). Slack, Chambers, and Johnston (2001) proposed five performance objectives: quality, speed, dependability, flexibility, and cost. Two widely used performance measurement models are the supply chain operations reference (SCOR) and the balanced score card (BSC). Bigliardi and Bottani (2010) applied the BSC model for measuring performance of food company supply chains using both financial and nonfinancial metrics. Since its introduction in 1996, the SCOR model has been increasingly adopted by companies to improve their supply chains (Huang et al. 2005). The SCOR model emphasises the operational process and includes customer interactions, physical transactions, and market interactions. Blackburn et al. (2004) examined the reverse supply chains for commercial returns and proposed performance metrics for reverse logistics, giving emphasis to "time value" of product returns.

- **Responsive strategies**

Richey et al., (2004) argued that responsive firms fix problems proactively and create supply chain savings by reducing product returns and integrating backward and forward logistics services. Olugu, Wong and Shaharoun (2011) included responsiveness in their supply chain performance metrics. Aramyan et al. (2007) argued that responsive strategies can eeffectively manage issues related to product lateness, lead times, and transportation mistakes.

- **Speed**

In general, food products have short product life cycles, which make lead times a critical parameter of reverse logistics operations (Vaidyanathan and Yadong, 2007). Guide et al. (2006) argued that delays on reverse logistics can have multiple repercussions such as: making reuse impossible, reducing returned product value, and generate inventory costs. Bernon, Rossi and Cullen (2010) suggested that network configuration should be a trade-off between speed and cost efficiency.

- **Flexibility**

Gonzalez-Benito (2010) defined flexibility as the business ability to change business operations in order to meet customer expectations including the development of innovative ways of reverse logistics operations. Flexibility poses a significant challenge for food companies, especially when one considers the unpredictability of the food business environment. Madaan and Wadhwa (2007) asserted that In order to develop green process as a competitive initiative, various elements have been proposed including the calculation of ecological impacts factor i.e. Green Impact Factor GIF for reverse logistics system. Ecological impact should be calculated in terms of their resource conservation factor, waste emission factor, and energy conservation factor (Madaan and Wadhwa, 2007). Wadhwa, Madaan and Verma (2009) proposed a semi or partially flexible decision process model that facilitates flexible decision and information sharing (DIS) functions in product returns, which can be encapsulated by Reverse Enterprise System (RES) to improve firm profitability and system performance.

- **Food Quality and Reliability**

Aramyan et al. (2007) argued that product quality includes all physical attributes dictated by socio-economical factors, government regulations and consumer behaviour. Gustavsson and Otterdijk (2011) pointed out that consumers buy products out of appearance and hedonic attributes as long as it is safe and tastes good. Aramyan et al. (2007) argued that manufacturing practices strongly impact the relation between quality and management performance, thus, in turn, they also influence reverse logistics practices as well as the level of product returns.

- **Sustainability**

Despite the various definitions of sustainability, there is a widely acceptance of the 'triple bottom line' of sustainability: economic, environmental and social dimensions of sustainability (Sarkis, Helms, and Hervani, 2010). Nikolaou, Evangelinos and Allan (2011) argued that firm performance is related to economic sustainability and offered a number of sustainability indicators such as: sales of reuse, resalable and recyclable, cost of returned materials, and subsidies associated to reverse logistics. Coelho, Castro and Gobbo (2011) asserted that the environmental effect of a reverse logistics system can be evaluated using metrics such as: energy use, CO2 emissions, water pollution, and urban traffic congestion perspective. From a social view of reverse logistics, Sarkis, Helms, and Hervani (2010) reviewed social responsibility studies in reverse logistics and proposed a categorisation of indicators including: internal human resources, employment stability, employment practices, health and safety, and human capital of external population. Nikolaou, Evangelinos and Allan (2011) suggested health and safety, human capital, community capital and stakeholder as KPIs of labour indicators. Table 1 summarises the KPIs listed in the literature review.

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3. Survey Methodology

3.1. Research Design

A survey was conducted to examine the impact of reverse logistics to supply chain performance moderated by product life-cycle. To build the target group for the survey, first, we randomly selected food professionals listed in various social and professional groups. We targeted food managers working on different business functions such as: distribution, purchasing, sales, and supply chain. We sent a link to the online questionnaire to these managers along with a personalized message with explaining the aim of the study. The survey took place in mid-2012. The questionnaire was sent to 200 practitioners and, in total, 48 usable questionnaires were returned, resulting in 24% response rate. Statistically, a sample size of at least 30 units is considered as "large sample", thus 48 responses were adequate for the type of data analysis conducted in this study (Hogg and Tanis, 2013). Table 2 presents sample distribution by the industry and supply chain.

Non-response bias was assessed. A large number of non-responders may cause bias in the risk estimation due to confounding factors associated with the tendency to not respond. Many reasons can contribute to non-participation among respondents, yet not all of these reasons may contribute to response bias. Questions that address a sensitive subject (e.g., financial performance) may increase the potential for response bias. Therefore, this study avoided collecting sensitive data and information. Further, anonymous surveys, such as this one, may partially assist in minimising non-responses (Marquis, Marquis, & Polich, 1986). In this study, there was adequate coverage from North America, South America, Asia, Western Europe and Central America and Australia but other important regions, in terms of business and economic issues like Eastern Europe, and South Africa were not covered. The small sample size was the reason of under-covering some regions, yet developed regions were adequately covered. Finally, respondents may not trust the value of the study. For this reason, a cover letter explaining the value to all contacted respondents was sent. All of these issues were considered when designing the survey to minimise the systematic non-response bias. After data collection, to ensure that the respondents were comparable to non-respondents, analyses of variances were conducted between these groups. The non-response bias was assessed by comparing demographic variables (region, company size) among non-respondents, early respondents and late respondents (Armstrong and Overton, 1977). No significant differences were found.

------------- Insert Table 2 about here ----------------

3.1.Sample Demographics

Regarding the professional profile of the participants, 32% of them were on operations, 14% on logistics, 11% on various managerial positions and 24% on Research and Development (R&D). Regarding the type of companies, they included distribution (34%), retailing (27%) and manufacturing (21%). 42.55% of companies operate in North America, followed by 8.51% in South America, 6.38% in Asia, 4.26% in Western Europe and 6.38% in Central America and Australia. 31.82% of the participating companies employed less than 100 employees, 20.45% more than 500 and 13.64% between 100 and 500 personnel. The analysis of company size vs. job functions and areas of operation delineate a higher percentage of operation functions from small companies with less than 50 employees, especially in North America. However, the number of operation functions among company size categories is constant, followed by managerial functions in companies with less than 50 and managerial and logistics functions in companies with more than 500 employees. Other categories such as quality, sales and distribution, distributed in other regions like South America, show a particular connotation of companies smaller than 500 people.

4. Findings

4.1. Forward to Reverse Logistics Comparison

We run a 2-tailed, paired samples test between forward and reverse logistics across the seven performance measures (Table 3). There were significant differences in all three dimensions of sustainability (economical, environmental, and social sustainability) ($p<0.05$). There was no difference between forward logistics and reverse logistics in the rest performance indications at 5% confidence interval, yet flexibility and reliability showed significant differences at 1% level. This finding supports the argument that reverse logistics operations do not receive the required attention from managers who tend to focus on forward chains (Vaidyanathan and Yadong (2007).

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4.2. KPI in reverse food logistics

Participants were asked to choose the five most important KPIs from a list of indicators that were found in the literature (Table 1). Results are summarized in Table 4. Customer satisfaction (20.12%) and product compliance in terms of quality and safety (15.38%) received the higher scores. Waste and energy consumption (10.65%) as well as supply chain and recycling costs (10.06%) were also ranked high in the list of key performance indicators for food reverse operations. Economic performance was found a significant performance goal for the reverse flow, yet asset recovery (2.37%) received a lower score while social responsibility received the least score (0.01%). This finding was also confirmed by the analysis which associated each KPI with performance objectives for reverse logistics and the following ranking was obtained:

1. Customer Satisfaction (20.12%) - Flexibility
2. Product compliance (15.38%) – Quality and Reliability
3. Level of waste and energy consumption (10.65%)- Environment
4. Supply chain and recycling costs (10.06%) – Economic performance
5. Lead times (7.10%) – Speed
6. Product information and labelling (7.10%) - Quality and Reliability

-------------Insert Table 4 about here--------------------------

4.3.Reverse Logistics and PLC

In order to evaluate reverse logistics according to product life cycle, respondents were offered with a common terminology. Each stage of the product life-cycle was described depending on the volume of returns and sales as follows: (a) Introduction Stage: sales volume start low and return volume is also low; (b) Growth Stage: Sales increase and customer returns increase as well; (c) Maturity Stage: Demand starts to level off and customer returns continue to come in; (d) Decline Stage: New product models start to lead the market and sales are almost null. We run the Kruskal-Wallis Test and the Jonckheere–Terpstra test for both Monte Carlo and found asymptotic distributions with no significant differences between the life cycle stages.

Results confirm the relevance of quality and reliability, especially during the introduction and growth phases of the PLC. The maturity and decline stages on the other hand, were differentiated by sustainability indicators, especially economic performance, with an interesting resilience of social and environmental performance in the decline phase (Table 5). Specifically, the performance objectives of reverse logistics during introduction stage are flexibility (71%) followed by quality and reliability (35%) and speed (31%). During growth stage, it is quality and reliability (38%) which is more important food reverse logistics performance objective, followed by sustainability (31%), and flexibility (29%). During maturity stage companies turn their attention to cost (54%) and speed (50%). Finally, during decline stage sustainability (69%) becomes important followed by cost (32%) and quality and reliability (19%).

--------------Insert Table 5 about here--------------------------

5. Discussion and Conclusions

5.1. Discussion

Reverse logistics is a relatively new business concept for most firms whose primary focus is getting product to the end consumer. However, companies are turning to reverse logistics to improve the bottom line since return rates are estimated to 25% of total sales which accounts for approximately $100 billion in lost sales in US (Petersen and Kumar, 2009). In the food and beverage sector, the majority of product returns are unsaleables like damaged and expired products. However, food companies are realizing the importance of reverse logistics when they are faced with a product recall, especially when it attracts public attention and regulatory oversight. For example, the horsemeat scandal was the cause for food retailers loose significant amounts in market value. Reverse logistics had to perform effectively to protect consumer trust in a moment of crisis. Despite the importance of reverse logistics, reverse operations during the product life cycle have received little attention. This study contributes by proposing a framework of reverse logistics indicators across the product life cycle. Results from a global survey of food professionals shed light on how reverse food logistics performance indicators (speed, flexibility, reliability, quality, and sustainability) fluctuate during life cycle stages (introduction, growth, mature, and decline). This study examined Dairy Products (18.58%), Bakery (15.93%), Frozen Food (10.62%), Snacks (17.70%), Meat (16.81%), and other food categories. The research framework is generic enough for the food industry yet due to the nature of different food products it may needs adaptations when applied to specific food categories like fresh produce, frozen food, or dietary food. Specifically, the performance of food reverse logistics is affected by many factors, which were reviewed under five research streams: food specific features, cost, competitive advantage, regulation and legislation, and information management. Physical features of food products, which determine to a large extend how reverse logistics should operate, are not the same across different food categories. For example, shelf life time and production seasonality vary considerably between dairy products and frozen food. However, all food products go through the same stages of product life cycle, which include: Introduction Stage, characterised by low sales and low return rates; (b) Growth Stage, characterised by increasing sales and customer returns; (c) Maturity Stage, characterised by steady demand levels as well as customer returns; (d) Decline Stage, characterised by new products entering the market resulting in decline sales of existing products.

Although performance has been extensively studied in forward logistics, there is scarce evidence about performance indicators across the product life cycle in reverse logistics (Tibben-Lembke, 2002; Madaan and Wadhwa, 2007; Kumar and Nigmatullin, 2011; Van der Vorst, Tromp and Van der Zee, 2009; Terreri, 2010; Bernon, Rossi and Cullen, 2010). This study contributes by examining the reverse logistics performance. Anecdotal evidence in the food sector report environmental and economic repercussions of food product recalls. To our knowledge, this is the first study to report the key reverse logistics indicators across the different stages of food life cycle. We discuss the key reverse logistics indicators empathising how they are applied across the different stages of food life cycle.

- **Speed.** Speed is critical to products with short shelf life. Products that deteriorate easily and lose their physical, chemical and/or microbiological attributes need fast reverse logistics operations. Survey results showed that during the maturity phase speed shows a higher effect than in the other stages. Products with short shelf-life time need product design to occur in a fact pace following by similar marketing activities.
- **Flexibility.** Survey results indicate that flexibility is critical especially during the first two stages of the product life-cycle. During growth stage, flexibility allows companies to differentiate their products from competitive ones since a growing market attracts more competition (Olugu, Wong, and Shaharoun, 2011). Bai and Sarkis (2013) argued that an effective way to manage uncertainty and variance in operational and organizational reverse logistic systems is by introducing greater flexibility. Bai and Sarkis (2013) proposed two types of reverse logistics flexibility: operational flexibility, which includes a variety of dimensions such as product and volume flexibility across various reverse logistics operational functions and strategic flexibility, which was categorized into network and organizational design flexibility dimensions. Wadhwa, Madaan and Verma (2009, p.15) claimed that "*with an adequate integration of flexible product recovery activities, in an economic or environmental context, organizations will be able to notice a double effect with their reverse supply chain*".
- **Quality/Reliability.** Quality varies during the different PLC stages and is more critical in the introduction and growth stages. The sooner a company identifies quality problems, the sooner they can be dealt with. Therefore, an effective logistics system should include quality monitoring and evaluation as early as from the product design phase (Karim, Smith, and Halgamuge, 2008). Some organizations already have set up a mechanism in place to

improve customer service processes. Reverse logistics cannot work in isolation from forward logistics and customer service. The reverse logistics mangers can gather comments and feedback from customers in order to improve product design and functionality as early as possible. Companies can use technology to gather information in real time from customers who contact customer service and in this way companies could fix quality issues early in the product life cycle. The purpose of quality and reliability is to reduce product returns rather than manage them more efficiently. However, in cases of food product recalls, customers need to be sure that the fault products have been removed from retailers' shelves. In this way, customers feel confident and reliable for the companies and brands they are loyal to.

- **Sustainability.** Findings demonstrate a higher impact of economic performance over environmental and social factors. For many companies, reverse logistics incur high operation costs. To effectively reduce costs and achieve better customer service, reverse logistics should be included in the sustainable strategy. Referring to sustainable reverse logistics, companies need to seek ways to differentiate themselves from competitors and thus possess competitive advantage. Since all logistics activities incur costs, the economic sustainability has become a priority over the environmental and social dimensions of sustainability (Mollenkopf, Russo, and Frankel, 2007). As product mature to the final stage of their life cycle, branded products benefit when their product life is lengthened to an extend that makes them sustainable. Sarkis, Helms and Hervani (2010, p.347) argued that "*Recycling and reuse initiatives help to reclaim recyclable materials, therefore generating additional revenue streams while simultaneously reducing the level of cost of waste disposal*".

5.2. Limitations and recommendations for future research

One limitation of the findings is the use of self-report questionnaires to collect data on all measures. This limits our ability to draw conclusions about the causal nature of the relationships. Another limitation of the study is its focus on the reverse logistics. We suggest further research to clarify the causal relationship between reverse logistics and product-life-cycle in other products except food. We used managers' perceptions about the reverse logistics concepts and measures we examined. Future research can examined the extent to which individual perceptions match up with objective organizational reports.

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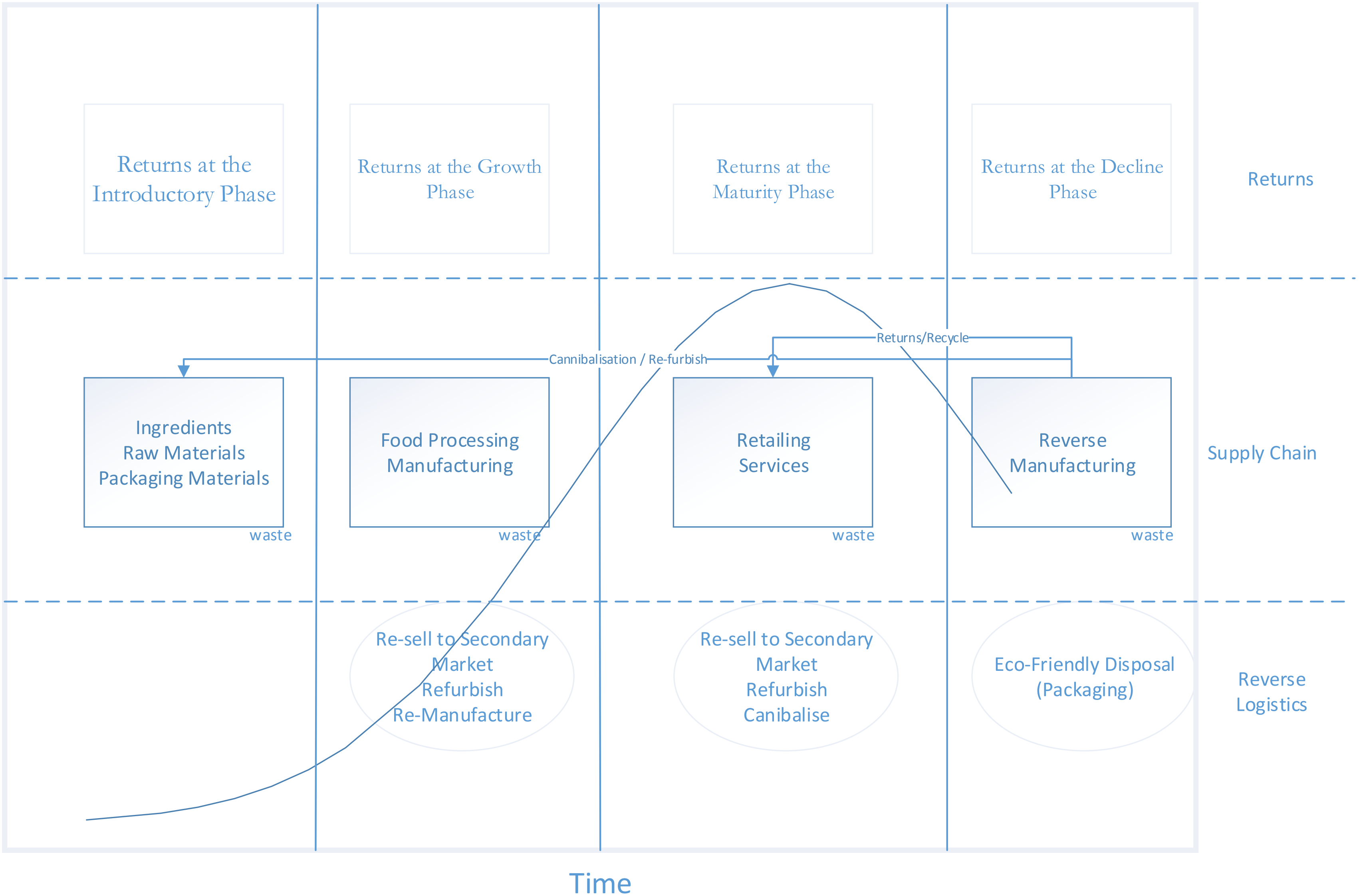

Figure 1 PLC Position of the returned Products

Source: Adopted from: Madaan and Wadhwa (2007, p. 03)

Table 1 Performance Objectives and KPIs for Reverse Logistics in the Food Industry

<table>
<tr><th>Customer Trends</th><th>PO</th><th colspan="2">KPI'S</th><th>Sources</th></tr>
<tr><td rowspan="5">Value for money, playfulness, health, wellness and environment. (Efficient Strategies)</td><td rowspan="4">Sustainability
Economic performance</td><td rowspan="3">Supply chain and recycling costs</td><td>Greening costs:
- Environmental compliance
- Green materials
Recycling costs:
- Product recovery
- Processing
- Segregation
- Disposal
Supply chain costs:
- Delivery
- Inventory
- Information sharing
- Ordering</td><td>Olugu, Wong and Shaharoun (2011).</td></tr>
<tr><td>Costs of used and returned materials</td><td>Nikolaou, Evangelinos and Allan (2011).</td></tr>
<tr><td>Total Cost of returns
Cost of quality:
- Prevention costs
- Appraisal costs
- Internal failure costs
- External failure costs
Overall return operations cost:
- Transport, storage, repair, repackaging.
- Cost reporting and control</td><td>Bernon, Rossi and Cullen (2010)</td></tr>
<tr><td>Asset recovery</td><td>- Labor productivity
- Market concentration
- Import dependency</td><td>Yakovleva, Sarkis and Sloan (2010)</td></tr>
<tr><td></td><td></td><td>- Net sales of reuse, resalable and recyclable
- Percentage of contracts paid as agreed
- Geographic breakdown of markets
- Total payroll and benefits for staff
- Distributions to providers of capital
- Increase/decrease and retained earnings
- Taxes
- Subsidies
- Donations</td><td>Nikolaou, Evangelinos and Allan (2011).</td></tr>
</table>

	Sustainability: Environmental performance	Commitment	- Motivation - Available procedures for waste management - Collection centers - Supplier commitment	Olugu, Wong and Shaharoun (2011).
Value for money, playfulness, health, wellness and environment. (Efficient Strategies)	Sustainability: Environmental performance	Regulation compliance	- Environmental regulation	Olugu, Wong and Shaharoun (2011).
		Level of Waste and energy consumption	- Material and product features: - Level of waste - Recyclable materials - Recovery time	Olugu, Wong and Shaharoun (2011).
			- Waste management: - Energy Consumption - Water Consumption - Waste arising	Olugu, Wong and Shaharoun (2011); Yakovleva, Sarkis and Sloan (2010)
			- Number of returns	Srivastava and Srivastava (2006)
			- Percentage of waste materials - Energy use - Water use - Localization and size of land owned - Biodiversity and environmental impact of products and services - Green house emissions - Total amount of waste - Chemical spills - Products resold - Non compliance incidents - Hazardous wastes	Nikolaou, Evangelinos and Allan (2011).
	Sustainability: Social performance	Health, Safety, stakeholder and employment responsibility	- Customer involvement	Olugu, Wong and Shaharoun (2011).
			- Employment - Wages - Employment gender ratio	Yakovleva, Sarkis and Sloan (2010)
			- Demographic changes - New competition and inflation - Communication level	Kumar and Nigmatullin (2011)
			- Outsourcing	Bernon, Rossi and Cullen (2010)
			- Internal human resources: - Employment stability - Employment Practices - Health, safety and capacity development	Sarkis, Helms and Hervani (2010)

Value for money, playfulness, health, wellness and environment. (Efficient Strategies)	Sustainability: Social performance	Health, Safety, stakeholder and employment responsibility	- External Population: - Human Capital - Productive capital - Community capital - Stakeholder participation: - Information provision - Stakeholder influence - Macro social issues: - Socioenvironmental performance - Socioeconomic performance	Sarkis, Helms and Hervani (2010)
			- Labour indicators: - Breakdown of workforce - Net employment creation - Employment legislation compliance - Human resources: - Human rights - Discrimination prevention - Society: - Customer health and safety policies - Legislation and regulation compliance - Product responsibility: - Healthy and safe use of products - Product information and labeling - Number of complaints	Nikolaou, Evangelinos and Allan (2011).
Convenient and simple products at the right moment (Responsive Strategies)	Speed	Lead times	- Lead times	Olugu, Wong and Shaharoun (2011); Kumar and Nigmatullin (2011); Guide et al. (2006); Bernon, Rossi and Cullen (2010)
			- Product development and supply chain cycle times	Olugu, Wong and Shaharoun (2011); Smith, A.J.R. and Halgamuge, S. (2008); Bernon, Rossi and Cullen (2010)

Convenient and simple products at the right moment (Responsive Strategies)	Speed	Lead Times	- Facility Location	Bernon, Rossi and Cullen (2010)
			- Time value	Guide Jr. et al. (2006); Blackburn et al. (2004)
	Flexibility	Fill rate	- Flexibility in demand - Fill rate - Production flexibility	Olugu, Wong and Shaharoun (2011).
			- Return rates	Stock and Mulki (2009)
		Customer Satisfaction	- Customer Satisfaction	Nikolaou, Evangelinos and Allan (2011); Olugu, Wong and Shaharoun (2011).
	Reliability and Quality	Product compliance in terms of quality and safety	- Quality of packaging materials - Quality and completeness of the returned products	Bernon, Rossi and Cullen (2010)
		Defined policies and procedures for returns	- Predefined disposition and return strategies - Supply chain trust	Bernon, Rossi and Cullen (2010); Bernon and Cullen (2007); Stock and Mulki (2009)
		Information management and supply chain visibility, traceability and recall	- Information Technology - Supply chain visibility	Bernon, Rossi and Cullen (2010); Hobbs (2006)
		Product information and labeling	- Quality of information	Bernon, Rossi and Cullen (2010)
		Return avoidance	- Return avoidance programmes	Stock and Mulki (2009); Olugu, Wong and Shaharoun (2011)

Source: Cardona (2012)

Table 2 Percentage of Participation: Product Vs. Supply Chain Links

Product	Raw material	Manufacturing	Distribution	Retailing	Other	Total
Dairy Products	1.77%	5.31%	7.08%	4.42%	0.00%	18.58%
Bakery	0.00%	1.77%	7.08%	6.19%	0.88%	15.93%
Frozen Food	0.00%	0.88%	6.19%	3.54%	0.00%	10.62%
Snacks	0.88%	1.77%	9.73%	5.31%	0.00%	17.70%
Meat	2.65%	2.65%	5.31%	6.19%	0.00%	16.81%
Fruits and Vegetables	0.88%	0.88%	0.88%	0.88%	0.00%	3.54%
Beverages	0.00%	1.77%	3.54%	0.00%	0.00%	5.31%
Chocolate	0.00%	0.00%	0.88%	0.00%	0.00%	0.88%
Coffee	0.88%	0.88%	0.88%	2.65%	0.00%	5.31%
Other	0.88%	1.77%	1.77%	2.65%	1.77%	8.85%
Total	7.96%	17.70%	43.36%	31.86%	2.65%	100%

Table 3 Paired Samples Test between forward and reverse logistics

Paired Differences	Mean	Std. Deviation	t-value	Sig. (2-tailed)
Speed	0.892	1.125	4.822	0
Flexibility	0.324	1.334	1.478	0.148
Reliability	0.405	1.723	1.431	0.161
Quality	1	1.394	4.362	0
Sustainability-Economical	0.135	1.273	0.646	0.523
Sustainability- Environmental	0.081	1.534	0.321	0.75
Sustainability- Social	0.135	1.619	0.508	0.615

Table 4 Key Performance Indicators for Food Reverse Logistics

KPI	Importance
Customer satisfaction	20.12%
Product compliance in terms of quality and safety	15.38%
Level of waste and energy consumption	10.65%
Supply chain and recycling costs	10.06%
Product information and labelling	7.10%
Lead times	7.10%
Fill rate	6.51%
Regulation compliance	5.33%
Information management and supply chain visibility	5.33%
Defined policies and procedures for returns	5.33%
Return avoidance programmes (GMP, HACCP, etc)	4.73%
Asset recovery	2.37%
Social Responsibility	0.01%

Table 5 Reverse Performance by Life-cycle stage

Stage	Speed	Flexibility	Q&R	Cost	Sustainability
Introduction	31%	71%	35%	0%	0%
Growth	6%	29%	38%	14%	31%
Maturity	50%	0%	8%	54%	0%
Decline	13%	0%	19%	32%	69%

Q&R=Quality and Reliability

APPENDIX - QUESTIONNAIRE

1. Name of the Company (Optional): ____
2. Country(ies) where the company operates: ____
3. Number of employees: ____
4. Scope of your business:

Raw material ( )
Manufacturing ( )
Distribution ( )
Retailing ( )
Other, Please specify: ____

5. Product(s):

Dairy products ( ) Bakery ( ) Frozen food ( )
Meat ( ) Snacks ( ) Other, please specify: ____________________
____
____

6. Do you measure the effectiveness of your reverse flow of products (returns)?

Yes ( ) No ( ) If yes, which indicators do you use? __________________________________
____
____

7. How important are the following indicators on your forward flow of products (from supplier to customer) vs. your reverse flow (customer returns):
5: Essential 4: Very Important 3: Important 2: Almost Irrelevant 1: Completely irrelevant

PI	FORWARD				REVERSE		
	Supply	Manufacturing	Distribution	Retailing	Customer return*	Sorting	Disposition of returns
Production cost							
Profit							
Return on investment							
Inventory							
Customer Satisfaction							
Volume flexibility							
Delivery flexibility							
Fill rate							
Product lateness							
Lead time							
Customer response time							
Shipping errors							
Sensory properties and shelf life							
Product safety and health							
Product reliability and convenience							
Production system							
Environmental aspects							
Marketing							

*Customer return process: *the initial process, where the product is returned .It includes data collection, traceability and recall activities.*

8. Is there any other indicator(s) particular to your reverse activities? Please indicate the level of relevance.
   5: Essential 4: Very Important 3: Important 2: Almost Irrelevant 1: Completely irrelevant

PI	REVERSE			Remarks (if any)
	Customer return	Sorting	Disposition of returns	

9. Based on the following concepts:

Efficiency: How well the resources are utilized
Flexibility: Degree to which the supply chain can respond to a changing environment and extraordinary customer service request
Responsiveness: provide the requested products with a short lead time
Product quality: product safety and health, sensory properties and shelf life and product reliability and convenience

To what extent do you agree that the listed concepts are essential to determine the performance of your reverse activities (customer return, sorting and disposition)?

5: Completely agree 4: Agree 3: Indifferent 2: Disagree 1: Completely disagree

	Customers return	Sorting	Disposition	comments (if any)
Efficiency	( )	( )	( )	______________________
Flexibility	( )	( )	( )	______________________
Responsiveness	( )	( )	( )	______________________
Product quality	( )	( )	( )	______________________

10. Using the same concepts detailed in point number 9, please indicate the relevance of each indicator for the reverse activities based on the following scenarios:

    5: Essential 4: Very Important 3: Important 2: Almost Irrelevant 1: Completely irrelevant

PI	Sales are low, but increase slowly and returns volume is very low and constant	Sales increase and returns volume substantially increase. Different types of defects arise and firms must allocate additional disposition options for the products.	Sales are more constant but competitors grow and firms must concentrate in decreasing costs of returns and creating tax gain through donation	The cost of the product in the market and its customer demand decreases steadily. Return volume also increase.	Product becomes obsolete and the sales are basically null as product is replaced by new model(s). Returns are not longer requested.
Efficiency					
Flexibility					
Responsiveness					
Quality					
Other (if any) please mention it					

11. How proficient is your firm in the following reverse logistic activities:

    5: Expert 4: Proficient 3: Talented 2: barely capable 1: incapable

		Remarks (if any)
Traceability	( )	______________________________________
Recall	( )	______________________________________
Reception of Customer returns	( )	______________________________________
Data collection from Customer returns	( )	______________________________________
Disposition decision	( )	______________________________________
Refurbishing	( )	______________________________________
Remanufacturing	( )	______________________________________
Outlet sales	( )	______________________________________
Donation	( )	______________________________________
Recycling	( )	______________________________________
Landfill	( )	______________________________________
Other	( )	______________________________________