Research Paper

The Modeling of Reverse Logistics: Am Empirical Research of the Processes and Models That Are Used iGreek Mobile Sector

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ABSTRACT: *The usual management policies of traditional waste cannot be applied in the case of e-waste, since these wastes contain more toxic substances than conventional waste, endangering both the environment and public health, while at the same time they contain valuable materials that can be reused or at least recycled. Mobile phones contain many harmful chemicals, which have a long life and increased levels of toxicity, and are associated to cancer and disorders related to reproductive, neurological and developmental capacity of human beings. Through this paper an empirical research in telecommunication sector in Greece will be presented. The theoretical background as well as the gap will be analyzed at first place and then the results of the research will be discussed.*

Keywords: Reverse Logistics, e-waste, modeling, telecommunication sector

I. INTRODUCTION

In recent years, logistics in the supply chain has become a crucial factor in enhancing the performance of companies in terms of growth and profitability through improved products and services (Vasiliauskas & Jakubauskas, 2007), which allows the development strategy of these companies (Lambert et al., 2011). A trend in supply chain management is the development of reverse logistics (RL) to manage the flow of goods and services moving backwards through the supply chain (Handfield & Nichols, 1999; Bernon et al., 2011).

The extended supply chain by introducing RL allows the reduction of the environmental footprint of the company's activities, which may lead to increased economic activity (Vasiliauskas & Jakubauskas, 2007; Nenes & Nikolaidis 2012; Fei et al., 2013). A more analytical approach defines RL as the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, in process inventory, finished goods and related information concerning them, from the point of consumption to the point of origin in order to recover their value or their proper disposal (Rogers & Tibben-Lembke, 1998). A more comprehensive definition of RL that has been adopted for the purposes of this research is the following: RL can be defined as the set of all those processes of the supply chain related to recycling, recovery, reuse and replacement of materials and therefore the management of waste and hazardous materials (de Brito, 2003; Jayaraman & Luo, 2007).

Neira et al. (2006) report that mobile phones contain many harmful chemicals, which have a long life and increased levels of toxicity, and are associated to cancer and disorders related to reproductive, neurological and developmental capacity of human beings.

The supply chain with RL can be an important factor in the sustainability of society and the local community, as it encourages businesses to recycle and reduce environmental pollution (Miller & Sarder, 2012). Moreover, the trend towards RL stems from the increasing public concern regarding environmental protection (Gunasekaran & Choy, 2012). Another reason that justifies the adoption of RL from the companies is the higher customer satisfaction achieved through the process of returning goods (Chan et al., 2010). The strategic implementation of RL to improve the recovered products at the end of their useful life is an important dimension in the academic literature, since the environmental impact of the recovery, reuse and recycling to save landfill space, energy and cost are important for organizations (Sarkis et al., 2010). Furthermore, due to the increasing popular concern about the ecosystem, it is a challenge for the companies to find ways of environmentally friendly production (Gunasekaran & Choy, 2012).

The Gap In The Literature

Until recently, researchers in the field of logistics and supply chain emphasized the processes of production and distribution, known as the forward channel, which is composed of suppliers, manufacturers,

distributors, retailers and customers. However, traditional models of logistics and forward logistics have been replaced by models focusing on the collection and reconstruction procedures, the RL (Akçalı et al., 2008; Rubio et al., 2008; Chan et al., 2010). Moreover, the field of reverse logistics is one of the major trends of the 21st century in the field of logistics associated with sustainability (Chan, 2007). However, there is a relative lack of published research on the modeling and management procedures of RL, especially in the field of electrical and electronic equipment waste (e-waste) (Banomyong et al., 2008; Fei et al., 2013).

During 1995 - 2005 only 5.38% of researches related to RL focus on theoretical models, while the majority of studies include mathematical models (65.05%), followed by case studies (21,51%) (Rubio et al., 2008), while no model for the control of service performance of the RL has been proposed (Chanintrakul, 2009). Since 2005, there are studies focusing on the management of e-waste in the case of Brazil (de Oliveira et al., 2012), in the case of Macau in China with emphasis on addressing waste management on behalf of the consumers and how much they are willing to pay for recyclable products (Song et al., 2012), the implementation of reverse logistics for mobile phones in Spain (Ponce-Cueto et al., 2010) and Hong Kong (Chan & Chan, 2008), the management of mobile phones after they have completed their life cycle in the U.S.A. (Neira et al., 2006), the recycling and reuse of mobile phones in the UK (Canning, 2006), the implementation of reverse logistics management electronics in China (Lau & Wang, 2009) and the economic efficiency of reuse and recycling of mobile phones for 2003 and 2006 in the UK and the U.S.A. respectively (Geyer & Blass, 2010).
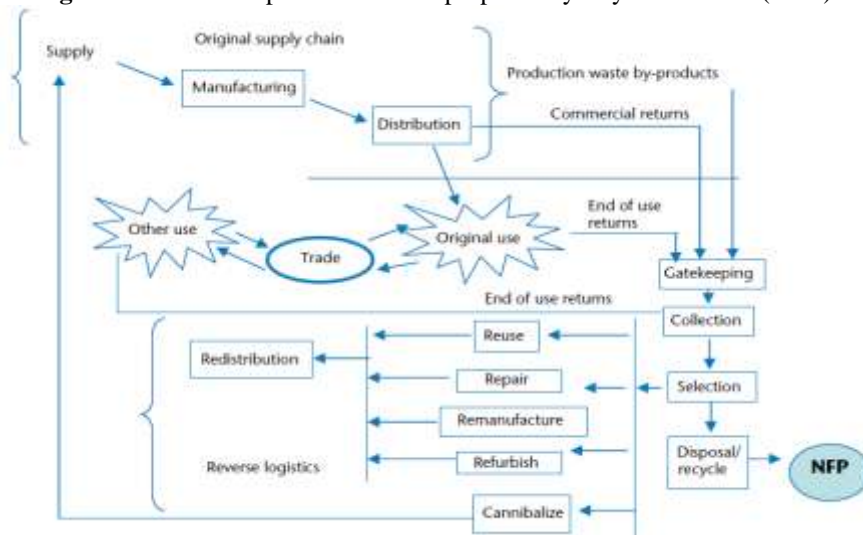
Finally, there is a lack of research in Greece on e-waste and RL in the telecommunications industry. More specifically, there is only one study on the optimization of RL in order to support the implementation of policies in the management of electronics and e-waste in Central Macedonia, (Achillas et al., 2010). However, this study uses a mathematical model through linear programming, instead of a comprehensive theoretical model.

Based on the above mentioned, that the management of e-waste and recycling as well as the design optimization of these services, as an important and integral part of the success of supply chain and logistics, has not been widely studied (Ferrer & Swaminathan, 2006; Pokharel and Mutha 2009; Chunguang and Sarkis, 2013). This study is expected to fill the gap in the Greek literature regarding the design, implementation and evaluation of RL in the telecommunication sector.

Theoretical Background

A detailed model of RL has been proposed by Reyes & Meade (2006), which includes the functions within RL, as depicted in the following figure. However, this model does not include the reasons for importing the products in RL, or the benefits for the company. Moreover, this model reports all RL logistics processes, but there is no reference to the quality of the process or the concept of feedback and redesign to improve the result.

Figure 1. Model and processes of RL proposed by Reyes & Meade (2006)
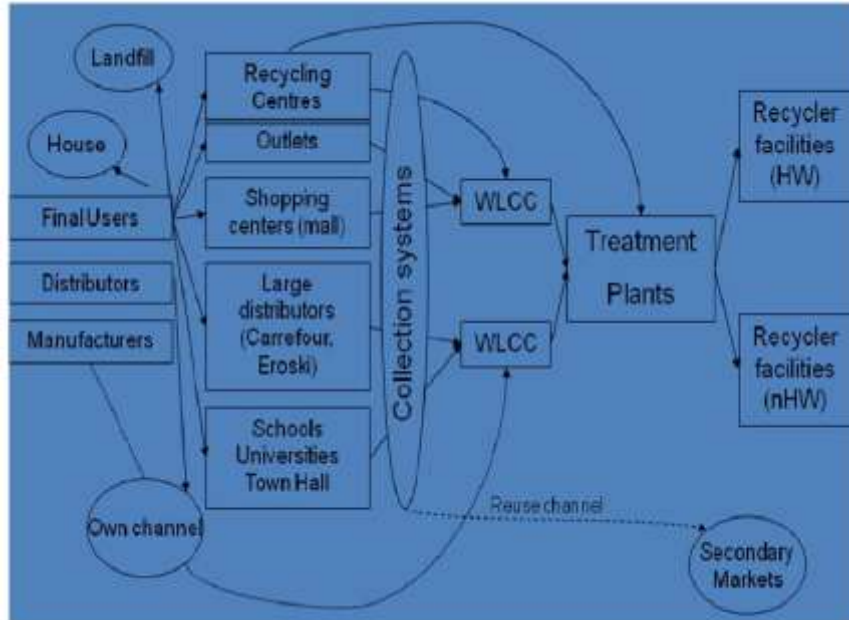

Source: Reyes & Meade, 2006, p. 41

Ponce-Cueto et al. (2010) studied RL in the case of mobile phones in Spain. The case of mobile phones presents an additional interest, as the overall composition varies depending on the model and the manufacturer. However, the main composition is almost similar and is illustrated in the figure below. The major weakness of this model according to Ponce-Cueto et al. (2010) is the low rate of recovery of such waste through the relevant

channels. One of the most important reasons that lead to this problem is the apathy and the reluctance of consumers to recycle their old device. One more factor is that mobile phones are usually replaced by a new model, even if the old one is still operating normally.
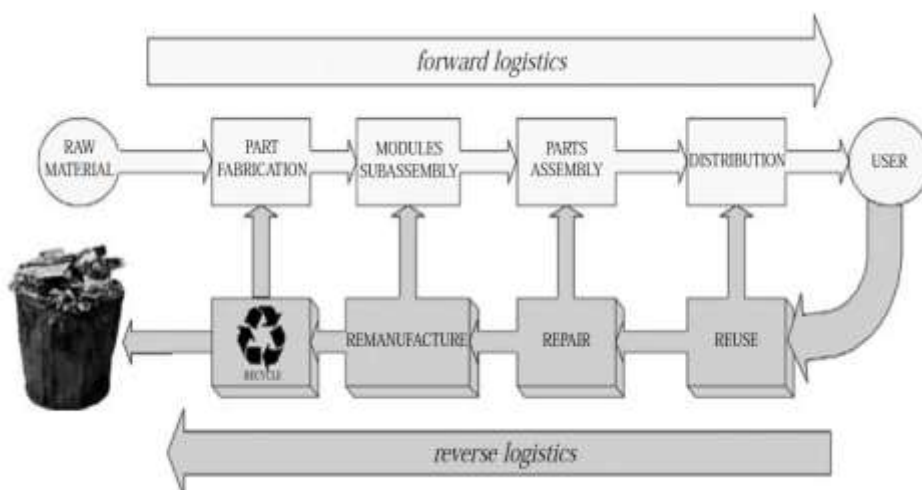
Figure 2. RL model for mobile phones in Spain proposed by Ponce-Cueto et al. (2010)

Source: Ponce-Cueto et al., 2010, p. 8

A general model of RL for products that have reached the end of their lives is illustrated below. This model gives emphasis on the processes of forward logistics in relation to the processes of RL and the relationship between each process and the process channel. This model of Hanafi et al. (2008) is quite general and simplified and its main purpose is to link the processes of forward and RL.
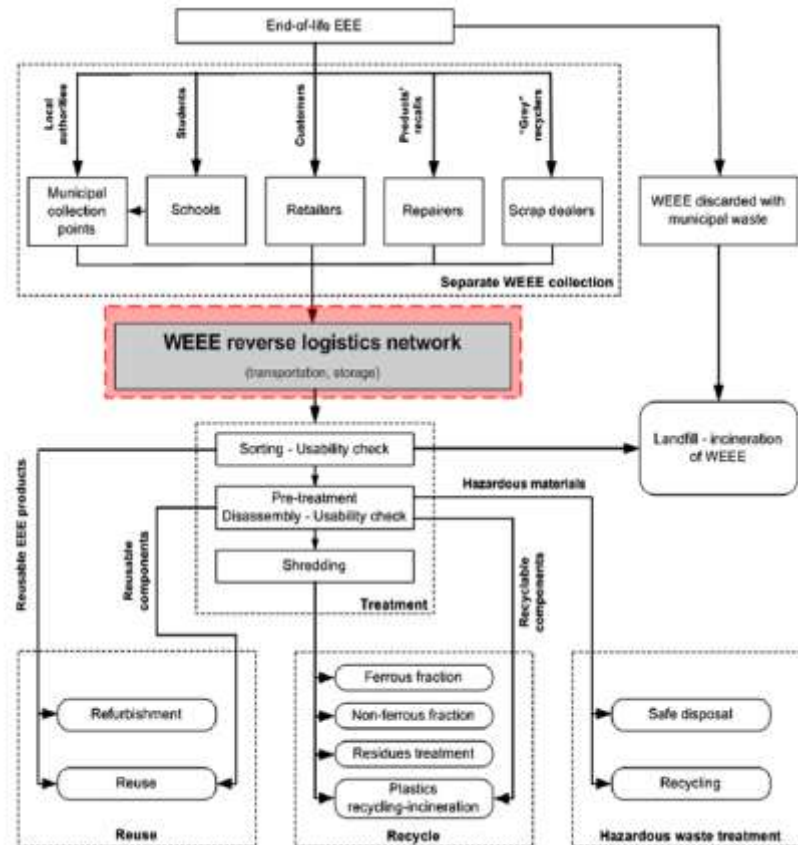
Figure 3. RL model proposed by Hanafi et al. (2008)

Source: Hanafi et al., 2008, p. 368

Applying the above general model in the field of electrical and electronics that have reached the end of their lives, Achillas et al. (2011) developed a more detailed model focused on the case of Central Macedonia, Greece. As can be seen in the figure below, one of the main features of this model is that it includes several stages and processes of RL.

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Figure 4. RL model for electronics proposed by Achillas et al. (2011)

Source: Achillas et al., 2011, p. 2593

The Proposed Model

The purpose of this research is to create a theoretical model of RL, which will contribute towards the identification of factors that force companies to adopt RL processes, the factors that contribute to the successful implementation of RL, and the methods and techniques that will allow the monitoring and evaluation of RL, focusing on telecommunication industry in Greece. The proposed model, which is given in Appendix I, was based on the following five axes:

• Factors leading to the introduction of RL procedures
• Requirements for the introduction of RL processes
• Benefits of introducing RL procedures
• Performance of RL procedures
• Redesigning of activities and technologies

The research objectives of this study are:

1. Identification of the incentives leading telecommunication and recycling companies of e-waste to adopt RL practices
2. Determination of the problems that the aforementioned companies have faced in introducing RL procedures
3. Study of the requirements that should be met for the complete and successful implementation of RL
4. Identification of the controls that should be carried out before the decision for the introduction of RL, and measurements that should be made for the successful operation of RL
5. Recording of the procedures that allow the alignment of the existing logistics processes and RL procedures, and the problems that may occur
6. Research regarding whether firms that manage returns of mobile phones have incorporated methods and techniques for monitoring the performance of RL system

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II.   METHOD

For the purposes of this research quantitative method was used. The methodological instrument was a questionnaire designed by the researcher exclusively for the purposes of this study, including both open-ended and close-ended questions. Cronbach's alpha was used for the internal reliability of this instrument. The sample consisted of 84 Greek companies, from which 5.9% operate in the mobile industry, 40.5% in the field of electronics and 53.6% are recycling companies. All the companies that took part in the research were selected randomly from the list of the Chamber of Commerce. The questionnaires were sent by both fax and email. If there was no response within one month, the researcher came to contact with these companies in order to send them again the questionnaires. The data were collected during the period May 2012 - November 2013. The statistical analysis was performed with SPSS 21.0.

III.   RESULTS

The average years that these companies have RL processes are 2.35 years (SD=1.502), with maximum five years. Through the analysis it was indicated that the companies are not fully aware of the term 'reverse logistics', as it is often confused with the term 'recycling'. Moreover, the companies do not apply to a great extent, or not at all, RL processes of reverse supply chain, due to lack of qualified staff, the workload and the cost of implementing RL, especially in an environment characterized by economic and political instability and uncertainty. The decision for the adoption and implementation of RL procedures was driven either from the volume of returns and the need for their management, or from the recent trend towards environmental awareness.

Regarding the procedures followed by the companies within RL, the study indicated the following: reconstruction and return of the product to the manufacturer (24.4%), remedy (30.5%) and incineration (29.3%). However, they do not seem to use recycling of products (26.8%), and selling of the returned products at reduced prices through internet, auction process or as an offering (25.6%). Moreover, the majority of the companies claimed that there is control of only faulty products, so as to demand the return to the supplier. One interesting finding of the research is that some companies do not a department responsible for the returns, while some other reported that the departments that manage the returns are the accounting, sales and distribution department. In addition, none of the respondents reported the existence of a particular information system for the management of returns.

According to the respondents, RL the application of a reverse logistics leads to the reduction of the total cost of the business (28%), reduction of the cost of raw materials in the production process (22%), and consumer satisfaction (22%). On the contrary, participants believe that the adoption and implementation of RL contributes only a little to increased profitability (24.4%), and not at all to the improvement of corporate image (28%). The biggest problem that is raised in the management of returns is that the products are forgotten in storage. Also, four respondents reported the errors in the recording of the returned products (number) being in the warehouses and therefore errors in the communication with the supplier. Regarding the obstacles in the adoption and implementation of RL practices, the respondents' answers indicated the following reasons: the business processes model (32.9%), the lack of available time for returns' management (26.8%), the reduced availability of financial resources (26.8%), and the difficulty of recycling due to the different materials (25.6%).

Some respondents pointed out the necessity and importance of quality measurements, but denied the existence of a specific procedure for measuring RL procedures. Some use the method of classification accuracy (25.6%), and data regarding employees' efficiency, such as the number of errors and correct decisions (28%). Furthermore, the majority of respondents responded that there is/there will be not a redesign of RL procedures, mainly because there is not a specific return management policy in order to have significant advantages from returns.

Apart from the above, it is believed that consumer behavior is influenced by the environmental awareness of buyers (23.2%), that customers would not be willing to buy a product at a higher price if they knew that it is environmentally friendly (20%), that they do not give great emphasis on the composition of the products and its friendliness to the environment (29.3%), that they are only a little sensitive to the environmental protection (25.6%) and that they do not have extended knowledge about RL and its benefits (28%).

IV.   DISCUSSION

Greek firms have not adopted practices associated with RL, as in other countries (Downlatshahi, 2000; Ritchie et al., 2000). The fact that the practice of RL is not widespread in Greece in comparison to other countries has been mentioned by Nagurney & Toyasaki (2005) and Lau & Wang (2009). This may stem from the lack of interest and information, as well as the absence of an appropriate legislative framework until recently.

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There are two main factors that lead companies to introduce and implement RL procedures. The first is the use of RL practices in the management of return, while the second is the ever increasing environmental awareness of consumers and businesses, which tend to respond to this request through environmental social responsibility, as noted by various scholars (Dowlatshahi, 2000; de Brito, 2003; Lau & Wang, 2009; Chan & Chan, 2010; Miller & Sarder, 2012). These findings are consistent with the literature and the results of previous studies. In particular, it is emphasized that the tendency of firms to adopt RL practices is driven primarily from the public environmental awareness (Gunasekaran & Choy, 2012), the fact that it leads to higher consumer satisfaction (Chan et al., 2010), and the contribution of RL to higher levels of profitability (Rubio et al., 2008).

However, it was not mentioned by the respondents that RL practices operate within the context of responsible business operations, which means that companies want to reduce the negative environmental impact of their activities and help in the protection of the environment, as indicated by other studies (Sarkis et al., 2010; Gunasekaran & Choy, 2012). In addition, it was not mentioned that RL constitute new business opportunities (Salema et al., 2006), and that RL is an incentive for the continuing of business operation in the long term (Pokharel & Mutha, 2009).

The lack of information systems is an obstacle in the implementation of RL procedures (Rogers & Tibben-Lembke, 2006). Apart from this, it has been also highlighted the lack of information (Rogers and Tibben-Lembke, 1998), the fact that recycling is sometimes difficult due to different materials (Neira et al., 2006), and the lack of training (Bernon & Cullen, 2007). However, the literature underlines the fact that the implementation of RL practices should be a priority for a company (Rogers & Tibben-Lembke, 2002), which is not true in the case of companies that took part in this research. Finally, the high cost is another obstacle according to the majority of the respondents and contrary to what is supported by previous study (Miller & Sarder, 2012).

According to the respondents, the introduction and implementation of RL contribute to the creation of competitive advantage, to the overall reduction of cost and consumer satisfaction. However, the advantages in terms of achieving a higher profitability and improved corporate image are ambiguous. Several researchers have reported that reverse logistics helps in the reduction of production costs (de Brito, 2003; Lee et al., 2012), the improvement of corporate image (Lau & Wang, 2009; Chan & Chan, 2010), and the enhancement of consumer satisfaction (de Brito, 2003; Chan et al., 2010).

V.   CONCLUSION

Based on the above findings, it can be concluded that there is a need for: a) information of business/senior executives regarding the benefits of RL, b) the creation of a stable economic and legal environment as motivation for the implementation of RL and c) consumer information regarding the benefits of RL. Consequently, businesses should be aware of the benefits of implementing RL processes in order to become a priority of business processes (Rogers & Tibben-Lembke, 2002; Chan & Chan, 2010), and to proceed to methods aiming at informing the consumers, while giving them incentives for recycling. Perhaps the integration of RL practices under the Developmental Law or corporate funding schemes could help towards this direction.

REFERENCES

[1].   Achillas, C., Vlachokostas, C., Aidonis, D., Moussiopoulos, N., Iakovou, E., Banias, G. (2011), "Optimising reverse logistics network to support policy-making in the case of Electrical and Electronic Equipment.", Waste Management, 30, 2592 – 2600

[2].   Akçalı, E., Çetinkaya, S., Üster, H. (2008). "Network Design for Reverse and Closed-Loop Supply Chains: An Annotated Bibliography of Models and Solution Approaches." Journal Networks, 53(3), 231 – 248

[3].   Banomyong, R., Veerakachen, V., Supatn, N. (2008). "Implementing leagility in reverse logistics channels". International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management, 11(1), 31 – 47

[4].   Bernon, M., Cullen, J. (2007). "An integrated approach to managing reverse logistics." International Journal of Logistics Research and Applications: A Leading Journal of Supply Chain Management, 10(1), 41-56.

[5].   Bernon, M.P., Rossi, S., Cullen, J., (2011). "Retail reverse logistics: a call and grounding framework for research.", International Journal of Physical Distribution and Logistics Management, 41, 484–510

[6].   Canning, L. (2006). "Rethinking market connections: mobile phone recovery, reuse and recycling in the UK." Journal of Business & Industrial Marketing, 21(5), 320 – 329

[7].   Chan, H.K. (2007). "A pro-active and collaborative approach to reverse logistics—a case study." Production Planning & Control: The Management of Operations, 18(4), 350 – 360

[8].   Chan, T.S.F. and Chan, H.K. (2008), "A survey on reverse logistics system of mobile phone industry in Hong Kong", Management Decision, 46(5), 702-708.

[9].   Chan, H.K., Yin, S., Chan, F.T.S. (2010). "Implementing just-in-time philosophy to reverse logistics systems: a review." International Journal of Production Research, 48(21), 6293 – 6313

[10].   Chanintrakul, P., Coronado Mondragon, A.E., Lalwani, C., Wong, C.Y. (2009). "Reverse logistics network design: a state-of-the-art literature review". International Journal of Business Performance and Supply Chain Modelling, 1(1), 61-81

[11].   Chunguang, B. and Sarkis, J. (2013), "Cleaner Production: initiatives and challenges for a sustainable world — CP Initiatives & Challenges", Journal of Cleaner Production, 47, 306–318

*Corresponding Author: Panousopoulou Pagona,
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[12]. De Brito, M.P. (2003). Managing Reverse Logistics or Reversing Logistics Management? ERIM PhD Series Research in Management, 35, Erasmus University Rotterdam

[13]. De Oliveira, C.R., Bernardes, A.M., Gerbase, A.E. (2012). "Collection and recycling of electronic scrap: A worldwide overview and comparison with the Brazilian situation" Waste Management, 32, 1592 – 1610

[14]. Dowlatshahi, S. (2000). Developing a Theory of Reverse Logistics. Interfaces, 30(3), 143 - 155

[15]. Fei Ye, Xiande Zhao, Carol Prahinski, Yina Li, (2013), "The impact of institutional pressures, top managers' posture and reverse logistics on performance—Evidence from China", International Journal of Production Economics 143(1), 132–143

[16]. Ferrer G., Swaminathan J., (2006), "Managing newand remanufactured products", Management Science, 52(1), 15-26.

[17]. Geyer, R., Blass, V.D. (2010). "The economics of cell phone reuse and recycling." International Journal of Advanced Manufacturing Technology, 47, 515 – 525

[18]. Gunasekaran, A., Choy, K.L. (2012). "Industrial logistics systems: theory and applications." International Journal of Production Research, 50(9), 2377 – 2379

[19]. Hanafi, J., Kara, S., Kaebernick, H. (2008). "Reverse logistics strategies for end-of-life products." The International Journal of Logistics Management, 19(3), 367 – 388

[20]. Handfield, R. B and Nichols, E. L. (1999) Introduction to Supply Chain Management, Englewood Cliffs: NJ: Prentice Hall Inc.

[21]. Jayaraman V, Luo Y., (2007), "Creating competitive advantages through new value creation: A reverse logistics perspective", Academy of Management Perspectives, 21(2), 56-73.

[22]. Lambert, S., Riopel, D., Walid, A.K. (2011), "A reverse logistics decisions conceptual framework", Computers & Industrial Engineering, 61, 561–581

[23]. Lau, K.H., and Wang, Y., (2009), "Reverse logistics in the electronics industry of China: a case study", Supply Chain Management: An International Journal, 14(6), 447-465.

[24]. Lee, J.E., Gen, M., Rhee, K.G., Lee, H.H. (2012). "Building a Reusable Reverse Logistics Model and Its Optimization Considering the Decision of Backorder/Next Arrival of Goods". Electronics and Communications in Japan, 95(5), 1009 – 1019

[25]. Miller, C.R., Sarder, M.D. (2012). Public Works Policy Implications of Sustainable Reverse Logistics Operations. Public Works Management & Policy, 17(1), 68-82

[26]. Nagurney A, Toyasaki F. (2005), "Reverse supply chain management and electronic waste recycling: A multitiered network equilibrium framework for e-cycling", International Journal of Logistics Systems and Management Transportation Research, Pat E329, 1, 1-28.

[27]. Neira, J., Favret, L., Fuji, M., Miller, R., Mahdavi, S., Blass, V.D. (2006). End-of-Life Management of Cell Phones in the United States. Master Thesis, University of California

[28]. Nenes, G., Nikolaidis, Y. (2012), "A multi-period model for managing used product returns", International Journal of Production Research, 50(5), 1360-1376

[29]. Pokharel, S., Mutha, A. (2009). "Perspectives in Reverse Logistics: A Review" Resources, Conservation and Recycling , 53, 175-182

[30]. Ponce-Cueto, E., Manteca, J.A.G., Carrasco-Gallego, R. (2010). Reverse logistics practices for recovering mobile phones in Spain. The 8th International Conference on Logistics and SCM Research, September 29, 30 and October 1st 2010, BEM Bordeaux Management School

[31]. Reyes, P.M., Meade, L.M. (2006). "Improving Reverse Supply Chain Operational Performance: A Transshipment Application Study for Not-for-Profit Organizations." The Journal of Supply Chain Management, 4, 38 – 48

[32]. Ritchie, L., Burnes, B., Whittle, P. & Hey, R. (2000) "The benefits of reverse logistics: the case of the Manchester Royal Infirmary pharmacy", Supply Chain Management: An International Journal, 5(5), 226–233.

[33]. Rogers, D., Tibben-Lembke, R. (1998) "Going Backwards: Reverse Logistics Practices and Trends", University of Nevada, Reno, Center of Logistics Management. Reverse Logistics Executive Council.

[34]. Rubio, S., Chamorro, A., Miranda, F.J. (2008). "Characteristics of the research on reverse logistics (1995–2005)." International Journal of Production Research, 46(4), 1099 – 1120

[35]. Salema, M.I., Póvoa, A.P.B., Novais, A.Q. (2006). "A Warehouse-Based Design Model for Reverse Logistics." The Journal of the Operational Research Society, 57(6), 615 – 629

[36]. Sarkis, J., Helms, M.M., Hervani, A.A. (2010). Reverse Logistics and Social Sustainability. Corporate Social Responsibility and Environmental Management, 17, 337 – 354

[37]. Song, Q., Wang, Z., Li, J. (2012). "Residents' behaviors, attitudes, and willingness to pay for recycling e-waste in Macau". Journal of Environmental Management, 106, 8 – 16

[38]. Vasiliauskas, A.V., Jakubauskas, G. (2007). Principle and benefits of third party logistics approach when managing logistics supply chain. Transport, 22(2), 68 – 72

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