A Conceptual Framework for E-waste Management through Reverse Logistics: A Case Study from Australia

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Increasing competition between the supply chains has persuaded companies to seek new dimensions of competitive advantage. Therefore, reverse logistics practices have become a focal point which empowers profit and revenue maximization. Furthermore, reverse logistics practices allow companies to manage the limited resources and recover the monetary value of end of life cycle products. Thus, it could be speculated that reverse logistics has become a fundamental element of economic competitiveness which enables the execution of proper environmental practices. However, in contrast to the e-waste generation only a low proportion is being reprocessed while majority ends up in landfill. This research investigates the role of reverse logistics in e-waste management within the Australian consumer electronics industry. A real world case study has been selected to develop a return management system which maximizes the performance in terms of recovery and efficiency which could be adopted by country wide organizations. Questionnaires and interviews were utilized for primary data collection and through the collected data it was evident that Australia cannot sustain by managing the forwards supply chain alone. Therefore, in order to reduce the e-waste generation, organizations within Australia must evaluate alternative value recovery operations and strategies adopted by countries which have implemented efficient e-waste management practices.

Keywords: Disposal, E-Waste, Reverse Logistics

INTRODUCTION

In today’s globalized and evolving economy, conventional business practices are being challenged and has forced companies to increase the supply chain efficiency to achieve the competitive advantage in a sustainable and ethical manner. Consumer demands have varied and anticipate further benefits from the manufacturers and service providers in terms of return policies, and from the company perspective companies seek
to acquire financial gains through the return products (Daugherty, Autry and Ellinger, 2001).

Due to the unprecedented growth of technology, major emphasis is placed upon the finite resource availability for manufacturing and the need for proper disposal methods for the end of life span products as shorter product life cycles have increased the e-waste generation. Globally, electronic waste generation is considered to be the fastest growing waste stream resulting 40 million tons per year and it is forecasted, by 2018 e-waste generation will exceed 50 million tons per year (Balde et al., 2015). This has allowed companies to identify reverse logistics as a dimension of competitive advantage which is both environmentally responsible and economically feasible.

Electronic waste management is a complex process due to the diversity of the hazardous materials composition which if not handled cautiously may pose adverse effects on aerial, terrestrial, aquatic environments as well as on living beings (Robinson, 2009). Therefore, efficient e-waste management requires a multi-stakeholder approach which involves consumers, manufacturers, service providers, supply chain professionals, academics and governments. Significance of e-waste management has led governmental and legislative authorities to enforce regulations and policies to ensure proper management of the returned used products and end of life cycle products. European Union is one of the few regions in the world which has a legislation regarding the e-waste collection and management. Australia is one of the top ten consumers of electrical and electronic products globally and with the obsolescence of technology, over 140,000 tonnes of e-waste is being generated per annum, yet only 4% of the total e-waste is being recycled (Phil, 2009). While regulatory measures have been implemented to ensure efficient e-waste management within Australia, the volume of e-waste disposed as landfill has significantly increased over the last few decades. In response to the e-waste issue, in 2011 Australian government published The Product Stewardship Act 2011 which contributes to the reduction of landfill and to increase the recycle rates to recover valuable material to manufacture new products and reduce the harmful substances which affects the environment (DSEWPC, 2011).

Globally, companies have realized through efficient and effective reverse logistics practices impact of dispersed electronic waste on the environment could be minimized while reclaiming revenue and enhancing profitability through alternative recovery methods. Therefore, increasing regulatory requirements, benefits associated with corporate image and monetary value of end of life span products necessitates the requirement for sustainable e-waste management practices through proper reverse logistics implementation within organizations.

LITERATURE REVIEW

Reverse logistics is the process of managing the reverse flow of recovered products upstream from consumer to the supplier. Due to the financial and operational constraints which may impact on the performance of the company, reverse logistics is a perilous process which requires the involvement of the top management to streamline the process smoothly. Multiple definitions regarding the reverse logistics could be found within the literature which differ from scope and limitations. The Council of Logistics Management defines 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 value or proper disposal” (Rogers and Tibben-Lembke, 1998). However, De Brito and Dekker (2002) argues reverse logistics does not always start from point of consumption and does not require to be returned to the point of origin as products may transfer backwards within the intermediate points of the supply chain. Similarly, Dowlatshahi (2000) implies that the process of reverse logistics includes the systematic acceptance of dispatched products or parts from the point of consumption for the purpose of remanufacturing, recycling or disposal. Although return
management creates opportunities for companies to gain competitive advantage through cost cutting and enhancing customer satisfaction, often it is being neglected (Norek, 2002).

Giving a much broader definition, Stock (2001) asserts reverse logistics comprises of internal and external activities which includes product returns, source reduction, recycling, material distribution, waste disposal, repair and manufacturing. De Brito (2004) suggests that organizations invest on reverse logistics for two main reasons; first, reverse logistics is a source of profit for the company as it enables value recapturing and second, due to the environmental rules and regulations which have been enforced by the governmental and legislative authorities. Similarly, Sasikumar et al., (2010) suggests organizations are increasingly investing on reverse logistics due to the impact on the environment, governmental regulations, corporate social responsibilities, resource reduction and economic factors. With the growing concern regarding the environmental impact due to waste generation and the exhaustion of natural resources, the rules and regulations aims to reduce single use and disposal through product recovery methods such as reuse, recycling and remanufacturing (Gungor and Gupta, 1999, Rose et al., 1998, Carter and Ellram, 1998). Moreover, Kroon and Vrijens (1995) asserts through reverse logistics hazardous and non-hazardous waste form packaging and products could be minimized.

Stock and Lambert (1987) has identified three problems within the reverse logistics process. First, majority of the supply chains are not equipped to handle the reverse flow as they only focus on the forward flow. Second, costs associated with reverse flow could be nine times higher than the forward flow. Finally, the requirement for the transportation, storage and handling of the returned products differ from the forward flow. It could be speculated that incompatibility between reverse and forward flow occurs mainly due to the lack of information availability.

In terms of the importance of reverse logistics, Melbin (1995) argues that implementation of reverse logistics within a firm will bring long term benefits such as proper environmental and ethical practices and loyal customer base which will increase revenue and profitability. Simultaneously, it will lead to enhanced customer service, public health and safety and efficiency in delivery times.

Implementation of reverse flow is vulnerable to uncertainties due to consumer behaviours regarding quality, quantity and timing of product returns. In value recovery process it is essential to focus on quantity and timing as well as the process visibility and speed to allow maximum recovery as some products may devalue if the recovery process is slow. Thus, the question remains to be asked is what are the economic and environmental measures which could be implemented through reverse logistics practices to minimize the e-waste generation. It is evident that a structural and a strategic change is required in order to fulfil the consumer demands and environmental regulations. Rather than classifying reverse logistics process as a liability, companies must recognize its economic and environmental value and should implement reverse supply chain practices through policies and procedures.

**Significance of reverse logistics**

While conventionally reverse logistics was perceived as a cost center which does not add any value to the supply chain, over the past decade significance of reverse logistics and its benefits has inspired academics as well as supply chain professionals to recognize the reverse flow as a strategic tool which could create the competitive advantage against the other organizations (Langley et al., 2008). Efficient reverse logistics practices within the supply chain does not only enhance the customer perception regarding the organizations but also impacts on costs and revenue.

**Strategic marketing and return policies**

Krumweide and Sheu (2002) argues that implementation of liberal return policies is a marketing strategy which is correlated with organizational competition and it has led to the
increasing demand for the efficient reverse logistics practices. This has given customers an opportunity to return the purchased items. And customers take advantage of the opportunity by returning the products for wrong or right reasons. Hence, the management of returned goods inventories has become a fundamental element due to the increasing rate of returns. As per a survey conducted by the Consumer Electronics Association (2008) it was found that 46% of the consumer returns within the consumer electronics industry has faced low or no enquiry regarding the returned products, and only 26% has faced against an inspection.

E-business

In an e-business approach, all the value chain activities are carried out through the utilization of information and technology. Exemption of physical retails outlets, accessibility throughout the globe and the increased customer and retailer collaboration are main key success factors in the adoption of the e-business approach. Due to the product uncertainties related to e-business such as errors which could occur during the ordering and picking processes as well as damages during the transportation and handling, organizations which follow the e-business approach provides a flexible return policy for the customers.

Park and Regan (2004) asserts that return rate for the products purchased through brick and mortar business models are around 5% while returns related to the transactions which have taken through e-business could reach up to 30%. Hence, providing flexible return policies alone are not sufficient, although returns provides financial benefits to the customer, repeated returns will reduce customer loyalty or the customer might purchase from another competitor within the market. Therefore, efficient reverse logistics management systems should be implemented to minimize the trade-offs of a physical outlet such as physical contact and distance between customers and retailers.

Legislative requirements on the environmental practices and sustainability

In order to motivate organizations to achieve sustainability through proper environmental practices, governments around the world has taken legislative actions regarding how organizations should operate within their respective supply chains. As per Krikke et al. (2001) Japan and majority of the European countries have imposed tariffs and bans related to waste transportation and emissions which enforce manufactures to responsibly manage the return flow. In Australia, the Australian Competition and Consumer Commission (ACCC) is responsible for facilitating the services necessary for the consumer returns and if the customer is not satisfied, customers are eligible for a refund, exchange or repair (ACCC, 2001).

Barriers and obstacles of using reverse logistics in electronics industry

While reverse logistics indeed allows organizations to achieve strategic objectives, it is often challenged by obstacles and barriers which creates negative effects on the organizations.

Shorter life span and loss minimization through speedy recovery

In order to gain optimal value through return management, speed of value recovery is essential as products with shorter life span such as electrical and electronic products have a high depreciation rate. Therefore, with the expanding markets and ever increasing e-waste, it is imperative to differentiate the products which require speedy value recovery process (De Brito and Dekker, 2003; Fleischmann, Nunen and Grave, 2002; Rogers et al, 2003). De Brito and Dekker (2002) argues decisions related to product recalls should be taken after careful consideration regarding the corporate image, goodwill and customer trust with the minimum time, cost and resource damage.

Lack of information management systems

Availability and accessibility to real time information within the supply chain through proper information and communication technology is a key element in efficient reverse
logistics management. Kokkinaki et al (2003) states while organizations have implemented multipurpose generic systems which have been extended for value recapturing, there are no dedicated software or systems for the effective management of reverse logistics. Similarly, Caldwell (1999) emphasises that commercial software which are design for the purpose of reverse logistics management are minimum. Hence, lack of necessary systems increases both risk and cost of recycling due to information unavailability (Nagel and Meyer, 1999; Zhao, 2001). Spiegel (2000) asserts lack of automation and technological incompetence causes issues related to returned material accuracy within the reverse logistics channel. Lee, McShane and Kozlowski (2002) argues inability to recognize the inaccurate returns will result illegal results and it could have adverse effects on the profits of an organization due to the rework and waste associated with resources.

**Limited forecasting**

Inaccurate reverse logistics forecast poses drastic implications upon the strategic, operational and financial planning. Ravi, Shankar and Tiwari (2005) suggests in order to gain the competitive advantage it is crucial to identify the long term goals and objectives of reverse logistics. Through effective forecasting and planning, revenue and cash flow could be maximized. Moreover, cost saving could be achieved through resource allocation by ensuring value recovery and proper disposal of returned products.

**Poor performance management systems**

Measuring the true performance of the reverse logistics process is complex and thus, the concealed benefits of reverse logistics are often neglected due to the lack of attention given in contrast to other business processes (Rogers and Tibben-Lembke, 1998; Rogers et al, 2003). However, it is essential to recognize the importance of performance management systems as it enables the implementation of investments and policies by providing the tools which are necessary for the decision making process.

**Poor outsourced service management**

Organizations are continuously pursuing strategic decisions for effective returns management and thus the trend of outsourcing the reverse logistics operations has enabled organizations to focus on the core business and save time and financial resources while transferring the risks to the outsourced party. However, outsourcing has caused significant implications on information visibility and sharing as the potential financial value of return products cannot be assessed until the physical arrival of the return products to the premises. Consequently, organizations depend on the approximate return quantities which are inaccurate. Hence, due to the lack of visibility; returned products cannot be utilized for other value recovery methods and the product handling, holding and lost opportunity costs have to be absorbed by the manufacturer (Zhao, 2001).

In order to mitigate the risks of outsourcing, organizations have implemented self-support systems to ensure efficient reverse logistics process. However, Smith (2005) argues self-support systems are feasible only for industries such as high end electrical and electronic manufacturing organizations due to the product visibility, which enables future product improvement opportunities. Furthermore, implementation of self-support systems is not a feasible solution for every organization due to the capital cost involved. He and Ji (2006) suggest a collaborative approach which incorporate multiple organizations is both effective and efficient solution as the capital investment required is being shared in between all the organizations involved which in turn allows to achieve economies of scale.

**E-waste: an overview**

Electrical and electronic industry is one of the rapidly expanding industries which includes a diverse range of products that has revolutionized the methods of communication, information retrieval and accessibility to the global market. Disparity in consumption rate and consumer preference on functionality has reduced the life span of the products as consumers are
continuously purchasing the latest available products which upholds new functions and design attributes within the market. Thus, the evolution of technology and the reduction of product life span has increased the generation of e-waste within the electrical and electronic equipment industry.

Definition of e-waste varies according to the institutional context and the technological evolution of electrical and electronics industries (Widmer et al, 2005). Thus, it could be stipulated that there is no uniformly agreed definition regarding e-waste. However, the most widely agreed definition has been published by the European Union through Waste Electrical and Electronic Equipment Directive (WEEE). As per the WEEE, e-waste is the electrical and electronic equipment, components and subassemblies which are a part of the discarding product (European Union Directive 2002/96/EC). Similarly, StEP (2005) defines e-waste as the electrical and electronic equipment and its components which have been discarded by the consumer without the intention of reuse. Giving a much broader definition, Leung, Cai and Wong (2006) states e-waste includes electrical and electronic equipment which has outlived its functionality and are due for proper disposal or recycling.

Puckett et al (2002) asserts substantial percentage of e-waste is generated through three main sectors: individual and small business; large business, institution and governments; and original equipment manufacturers. While the electrical and electronic market penetration in the developing countries are low in comparison to the developed countries, rapid growth in consumption rates and usage could be expected in near future.

However, Kahhat et al (2008) argues that in contrast to the percentage of e-waste generation, significant growth in reverse logistics processes such as value recovery and disposal methods has not transpired. Therefore, with the ever increasing end of life span products, the requirement for proper e-waste management processes have become a necessity. The typical composition of electrical and electronic items may include precious material as well as hazardous materials which should be properly disposed or recovered. While recycling of e-waste is a hazardous and complex process, it will enable organizations to reduce the costs, requirement for raw materials and dependence on foreign suppliers while reducing the environmental impact.

Published research identifies that the developed countries export 80 percent of the e-waste to the developing countries such as China, India, Ghana, Thailand, Cambodia for recycling where the valuable materials within the e-waste is extracted. Schwarzer et al (2005) claims that majority of the companies within the developed nations illegally exports the e-waste in order to reduce the costs. Due to the lack of proper legislation and infrastructure, majority of the e-waste is being discarded through regular waste streams and if preventive measures are not implemented for the efficient and effective management of e-waste; exponential increase in domestic e-waste within developing countries and the increasing end of life span products within developed countries will pose adverse effects on human and ecological environments globally.

**RESEARCH METHODOLOGY**

Due to the exploratory nature of the research, mixed method approach was selected as it gives an extensive interpretation regarding the theoretical and practical aspects of the reverse logistics process and its impact on the e-waste within the consumer electronics industry. Through qualitative research method, strategies which could be implemented to effectively manage the e-waste through reverse logistics were evaluated while quantitative data with statistical calculations have been used in analysing the questionnaire. Primary data was collected through questionnaire survey, which was distributed among Apple retailers and major wireless communication service providers in Australia. As web surveys and postal questionnaires has a lower response rate, the questionnaires were distributed in person to ensure higher response rate. The purpose of the questionnaire was to evaluate the Initial data related to reverse logistics in the consumer electronics industry. Questionnaire formulation was archived through comprehensive research on
the published literature and consisted of both structured and open ended questions to identify the opinions and issues encountered by the retailers and wireless communication service providers. Furthermore, company perspective regarding the e-waste issue and return management were evaluated. The sample size for the questionnaire was selected as 50 which included retailers and major wireless communication service providers within Australia and by the end of data collection, total responses received were 34 out of 50 recording a response rate of 68%.

Telephone interviews were conducted to identify the perspective of the customer, product usage and disposal habits. Current reverse logistics practices of Apple Australia were identified by interviewing employees of the Apple Inc. in order to gain an in-depth understanding. Furthermore, multiple interviews were conducted through telephone with consumers to gain an understanding regarding the consumer requirements for returning products and usage patterns. Furthermore, consumer perception regarding the end of life products and increasing e-waste issue were assessed. Through the published literature is was identified for interviews conducted in qualitative research studies, sample size of 10-20 participants was preferred (Crouch and McKenzie, 2006). Therefore, the research conducted regarding e-waste and reverse logistics management, sample size of 20 participants were selected. Average interview duration was approximately 15-20 minutes and the conducted interviews were coded to compare the perception of the participants. Table 1 represents a sample of questions used within the questionnaire and interviews.

| TABLE 1 HERE |

**FINDINGS**

As a developed country where information and communication technology has become a fundamental element of the economy, Australia is one of the top ten global consumers of electrical and electronic products due to the exponential increase in demand and the increasing number of consumers with higher income. As the consumers are upgrading and replacing the products continually, the life span of the products have become shorter resulting electronic waste generation. Within Australia, e-waste generation has become a continuous and perilous process which requires efficient management practices as the growth of e-waste is three times higher in contrast to other waste streams.

While the current global movement focuses on achieving zero waste strategy, capacity of the landfill sites has expanded due to the increasing electronic waste. Landfilling is the most common method of waste management within Australia. However, due to the increasing emphasis on the environmental impact and the regulatory measures taken to ensure ethical waste management; availability of locations for landfilling has decreased. Development of landfill sites in Australia are usually commenced on old quarries as it minimizes the visual impact of waste. The difficulties in obtaining regulatory approvals for landfill sites have increased over the years as higher percentage of waste is composed of hazardous substances. Figure 1 depicts the Australian landfill capacities and volume of waste received per annum.

**FIGURE 1 HERE**

Majority of the prevailing landfill sites are owned and operated by private companies and regulatory measures are taken to ensure operations performed within the landfill sites reduces the environmental impact and are continuously monitored. Companies which operate the landfill sites are liable for the management of fire hazards, odour, leachate and traffic and it is their responsibility to engage with auditors and regulatory authorities to transfer the taxes which have been collected through landfill to the state. Furthermore, landfill sites should be capable of providing opportunities for optimal resource recovery as organizations are continuously offering waste management services with the priority given for resource recovery and landfill as the last available option.

Through the questionnaire, the respondents were requested to identify the barriers or obstacles in
the company return management process. 91.2% of the respondents identified financial issues and lack of understanding regarding the reverse logistics to be key challenges within the return management. Furthermore, 85.3% recognized lack of information visibly and limited knowledge related to environmental regulations (76.5%) as secondary challenges. Other issues within the return management were identified as lack of information management systems (47.1%), lack of communication between departments (29.4%) and poor forecasting and planning (17.6%). Figure 2 illustrates the barriers and obstacles identified by the respondents.

**FIGURE 2 HERE**

### Challenges within the Australian Apple Reverse Supply Chain and E-Waste Management System

Through the distributed questionnaire, interviews conducted with customers as well as with Apple Australia and governmental publications, following challenges within the current Apple return management process and the Australian e-waste management system were identified (Table 2).

<table>
<thead>
<tr>
<th>Challenge</th>
<th>Description</th>
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<tbody>
<tr>
<td>1 Lack of awareness</td>
<td>Customers are unaware regarding the availability of recycling packaging sent to Infoactiv through Australia post outlets and limited Australia post outlets have the packaging instore. Therefore, due to the lack of awareness regarding the pre-paid option for recycling; customers often keep the obsolete products within the household or dump them illegally.</td>
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<td>2 Development of long-term-strategies</td>
<td>Strategies such as pre-paid recycling through Australia post, directly delivering the end of life span products to Infoactiv and recycling through retail chains does not allow customers to recover the remaining monetary value of the products. Hence, often customers prefer to sell the products at a cheaper price or as replacement parts.</td>
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<td>3 Refurbished products</td>
<td>Refurbished products which are sold in the secondary market by Apple are expensive in comparison to brand new products. Therefore, due to the lack of financial advantage customers prefer to purchase brand new products over refurbished products.</td>
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<tr>
<td>4 Cost and proximity to collection centres</td>
<td>Collection of the products by Infoactiv depends upon the cost of vehicle emissions against the value of recycling products. Hence, in certain occasions the products are not collected within the given timeframe as the costs exceed the total value of products. Furthermore, when the demand for recycling in a geographical area is low customers are required to deliver the products to a collection point appointed by Infoactiv. Therefore, with the busy schedules and cost of transportation customers are reluctant to deliver the products to the collection point for recycling. Furthermore, products accepted by Infoactiv for recycling are limited to a range of products which does not include any damaged...</td>
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<td></td>
<td>Components.</td>
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<td>5</td>
<td>Lack of alternative value recovery methods</td>
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<td></td>
<td>Although product collection and delivering to Infoactiv follows multiple</td>
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<td></td>
<td>strategies, all products are recycled according to a standard process</td>
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<td></td>
<td>thus alternative value recovery operations to obtain maximum value and</td>
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<td>possibilities for CSR activities are limited.</td>
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<td>6</td>
<td>Non-standard repair times</td>
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<td></td>
<td>Repairing times may vary from 5 to 12 days depending upon the parts</td>
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<td></td>
<td>availability and during the repair period only Apple stores and wireless</td>
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<td></td>
<td>communication service providers provides a replacement or loaner device.</td>
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<td>7</td>
<td>Inadequate financial funds</td>
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<td></td>
<td>With the increasing e-waste generation in Australia the requirement for</td>
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<td>proper e-waste recycling practices have increased. However, in contrast to</td>
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<td>the recycling targets which have been assigned; the financial funds</td>
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<td></td>
<td>available are inadequate. Therefore, the collection of products for</td>
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<td></td>
<td>recycling have been restricted resulting excess e-waste. Due to the</td>
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<td></td>
<td>unavailability of the financial funds, the cost related to the collection</td>
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<td></td>
<td>and sortation of e-waste have become expensive resulting reduction in</td>
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<td></td>
<td>recycling services throughout Australia and the remaining services are</td>
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<td></td>
<td>facing financial crisis with the increasing cost of operations.</td>
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<td>9</td>
<td>Lack of knowledge</td>
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<td></td>
<td>Lack of knowledge regarding the consumer law and return policies are the</td>
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<td>main reasons where customers generate negative impressions regarding the</td>
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<td>organizations return process. Furthermore, knowledge regarding the</td>
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<td></td>
<td>impact of e-waste on the environment is limited.</td>
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<tr>
<td>10</td>
<td>Ineffective regulatory framework</td>
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<td></td>
<td>Unconvincing regulatory measures related to e-waste management in Australia</td>
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<td>is a fundamental reason for the increase of e-waste and for the</td>
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<td>mismanagement of the returns process. Although Australia has regulated</td>
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</table>
the Product Stewardship Act 2011, to ensure the disposal and recycling of waste to reduce the adverse effect on the ecological environment; both customers and organizations are not aware regarding the policy. As majority of the landfill sites are located in old quarries the standards required are not maintained properly. Furthermore, due to the availability of landfill sites organizations and customers alike prefer to dispose of the remaining waste through landfill in order to minimize the costs associated.

Table 2 Challenges within the Australian Apple reverse supply chain and e-waste management system

<table>
<thead>
<tr>
<th>11</th>
<th>Negative perception regarding reverse logistics</th>
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<td></td>
<td>Majority of the organizations considers reverse logistics as a cost centre rather than an opportunity to increase revenue. From the company perspective reverse logistics is not recognized as a dimension of competitive advantage hence only focus on the forward supply chain. Therefore, the costs related to the recycling are transferred to other parties involved.</td>
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</table>

Conceptual Reverse Supply Chain Model for Apple Australia

E-waste management models proposed by Blaser and Schluep (2011) and PWC (2008) together with the published data on reverse logistics and e-waste management were analysed and evaluated in designing and proposing the below reverse logistics supply chain strategy to Apple Australia to ensure maximum efficiency and practicality (Figure 3).

FIGURE 3 HERE

The obsolete product collection could involve Apple stores, retailers and wireless communication service providers and once the customer return products either to be disposed of or due to a technical fault, inspection process could determine its status. Upon inspection, if it is repairable the customer could be given a standard time frame adopted by Apple Australia irrespective of the collection point and a replacement device could be offered to avoid customer dissatisfaction and inconvenience. The non-repairable devices could be valued according to the remaining monetary value and given an Apple instore gift card which will ensure future purchases and also as a method of compensation for the customer.

Furthermore, Apple could implement a central online system where customers could place and enquiry regarding the requirement for disposal product collection and depending on the geographical location third party logistic service providers could be allocated for collection. The products which are collected through Apple stores, retailers, wireless communication service providers and 3PL could be sent to a central warehouses located within each state.

Sortation could take place within the central warehouse and products which have the highest financial value could be refurbished and sold in the secondary market for a standard price. However, price differentiation should be made to motivate customers to purchase refurbished products. Moreover, obsolete products which does not have any remaining value could be recycled through multiple low cost recycling services through disassembly and extraction of valuable materials. For disassembly, Apple could monitor the recycling services and use its new robotic innovation “Liam” for a faster and efficient
disassembly rate. Products with least value could be repaired and donated to the local community within Australia or could export to third world countries. Through donation, Apple is able to sustain itself within the market as a socially responsible and ethical company and reduce the waste ends up in Australian landfill. EoL products which has only few useful components could be disassembled and sold to manufacture products such as toy drones and other electronic products.

In contrast to the current reverse supply chain, the proposed design does not rely solely on Infoactiv for the collection and disposal of obsolete products. By outsourcing to more than one party, Apple is able to achieve major cost savings in terms of flexibility and return percentage. Furthermore, it will enable larger geographic coverage as 3PL services will be utilized according to the geographic demand for recycling. Moreover, Apple is able to monitor the central online system to gather market data regarding product returns, quantities and range which could be used to make strategic decisions on future product designs and to avoid unethical disposal methods. Additionally, the collected data could be used to maximize the software capabilities of the manufactured devices which will extend the product life cycle of a typical Apple product. Consumer electronics is such an industry where due to rapid technological advancements product life cycles have become shorter as emerging technologies replaces the prevailing technologies. Higher consumption rates and products with obsolete technologies has exponentially increased the electronic waste.

Through the proposed reverse supply chain model, Apple will be able to extend its producer responsibility and acquire both financial and market advantage while being equally beneficial for the customer and wider society through reduction of e-waste and creating job opportunities. Furthermore, competitiveness in e-waste reduction will motivate other key manufacturers within the Australian market to implement proper reverse logistics strategies to manage e-waste.

**RECOMMENDATIONS**

The issues identified were evaluated against other advanced global economies where reverse logistics has been implemented for efficient e-waste management and the recommendations have been made according to the local context of Australia to implement both organizational and country wide to promote the significance of reverse logistics and its impact on the reduction of e-waste (Table 3).

<table>
<thead>
<tr>
<th>Issues</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lack of awareness regarding the pre-paid option for recycling of obsolete Apple products.</td>
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<tr>
<td></td>
<td>Remaining value of the obsolete products are not being compensated to the customer.</td>
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<td></td>
<td>Lack of variance in price in-between refurbished and brand-new products.</td>
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</tbody>
</table>
## A Conceptual Framework for E-waste Management through Reverse Logistics

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<p>| 5 | Standard recycling process for all the obsolete products. | Rather than having a standard recycling process for each and every product, Apple should discover alternative value recovery options. Currently the value recovery methods of Apple products include refurbishment, repair and recycling only. However, Apple could adopt upgrading and donating the products which need minimum repairing. For customers who are disposing the obsolete products due to outdated specifications, Apple could offer upgrading option which will extend the life cycle of the product and also reduce the e-waste generation. Donating the products is also an alternative solution which will increase the competitiveness within the Market. Furthermore, | Hazardous waste which are recovered through recycling could be used for remanufacturing in other industries. |
| 6 | Time taken for repairs differ due to parts availability and may cause inconvenience to customers. | As per the Apple warranty, products which have been returned due to technical faults are entitled to repairs within a period of one year. However, currently a standard time for repairs are not available and time taken for repairs may differ upon parts availability. Therefore, Apple could have a standard product repair period and offer replacement devices if required to avoid any inconvenience caused to the customers during the repair period. |
| 7 | Inadequate financial funds for e-waste management in Australia and its impact on recycling services. | Majority of the recyclers are challenged in terms of reduction of funds allocated for recycling and as a consequence planning and management of operations have become increasingly complex. Moreover, state governments as well as e-waste collection sites have been affected by the reduction in funds. In order to address this issue by ensuring continuous e-waste management and to reduce the obsolete electronic products ends up in landfill; the allocated funds must be increased through integrating the funds required to the budgeting process. Furthermore, co-regulatory partnership arrangements |</p>
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<th>Page</th>
<th>Issue</th>
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<td>Lack of information visibility and adaptation of technology in organizations. Information visibility and adaptation of technology has indeed been vital aspects towards achieving the organizational strategy and objectives successfully. Through investing upon new technologies such as RFID, WMS, ERP systems; organizations are able to reduce the operational cost as it will subsequently minimize human errors and requirement for labour intensive work. Moreover, it is essential to share information within the intermediary parties within the reverse supply chain, as it will enable organizations to recognize the challenges to overcome and the potential opportunities which will allow better forecast accuracy. Through the accurate forecasting organizations can allocate the required resources for disposal and recycling without incurring additional costs.</td>
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<td>Lack of knowledge regarding the consumer law and limited knowledge on the impact of e-waste on environment. Although Australia is one of the top ten consumers of electronic devices, majority of the population are unaware regarding the aftermath of obsolete electronic products. Moreover, during the product purchasing process, consumers are not aware regarding the Australian consumer law. In order to raise public awareness regarding the impact of e-waste and proper disposal methods available throughout Australia, the state and local governments could encourage schools and universities to incorporate the issues to the curriculum and raise awareness campaigns. As per the Australian consumer law, customers are eligible for repairs for a limited period even though the official warranty period has exceeded. However, majority of the customers are not aware regarding the basic consumer rights related to product purchasing. Hence, retailers benefit by selling extended warranties for an additional price. Therefore, Australian Competition and Consumer Commission could ensure that the consumer rights are protected through proper legislative measures.</td>
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<td>Unconvincing regulatory measures and lack of awareness. In contrast to the European legislative framework regarding the management of e-waste, Australian waste management framework is not well established and understood within Australia. Australian National Waste Policy, Product Stewardship Act 2011 and National Television and Computer Recycling Scheme are some of the regulatory measures Australia have imposed to ensure proper collection,</td>
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storage, transportation and recycling of obsolete products by sharing the responsibility among government, manufacturers and consumers. However, although the policies direct and instruct on ethical and alternative value recovery methods; the awareness related to the policies are low. Therefore, it is imperative to develop a widely accepted set of waste management policies with a broader scope by adopting best practices from countries such as U.S.A, Japan, U.K which has implemented efficient e-waste management and promote alternative methods of disposal to reduce the waste ends up in landfill. Furthermore, remaining landfill sites should be closely monitored to ensure the prerequisites are met and maintained to reduce the environmental impact.

**CONCLUSION**

Complexities in consumer demand patterns, globalization and increasing awareness regarding ethical business practices have become fundamental issues where companies seeks to achieve advantage over its competition. Although management of return products indeed create competitive advantage required in today’s globalized world, due to the challenges and lack of knowledge related to managing an efficient reverse logistics process; organizations consider reverse logistics to be a cost factor rather than a method of increasing revenue in the long term. In order to achieve the objectives of this research, the findings were compared and examined with the published literature to gain a broader understanding regarding alternative value recovery operations and the existing challenges within the reverse logistics process which prevent the implementation of reverse logistics and the factors which drives the successful reverse logistic processes.

Due to improper reverse logistic practices, globally e-waste generation has exponentially increased and organizations have not realized the full potential of e-waste management in terms of value recovery and financial savings. Although Australiana being one of the countries with the highest electronic equipment consumption rate, its regulatory directives regarding the management of

| 11 | Considering reverse logistics only as a cost centre and ignoring the potential benefits. | Reverse logistics is often regards as a costly process due to the incompatibility with the forward supply chain and additional resource requirement for efficient flow. However, potential benefits are hidden within the reverse logistics process which could be key factors in achieving competitive advantage against other organizations within the industry. Improved reverse logistics allows customers to return or dispose the products and through improved customer perception, organizations can secure the market position. Moreover, ethical environmental practices create positive impact on society and organizations are able to obtain tax and financial incentives. Therefore, in order to remain competitive and increase revenue in the long term; organizations must invest on proper reverse logistics practices. |
end of life products in the electronic industry has not conveyed to both organizations and to the wider society. Therefore, majority of the e-waste within Australia is disposed as landfill, combing with solid waste or through unethical discarding which are exported to other countries due to the ecological affects.

Apple Australia is one of the companies which have implemented extended producer responsibility in its return management process in order to efficiently manage the return process and the increase of obsolete products. However, it could be argued that the current strategies implemented in this regard are not focused upon achieving the maximum efficiency thus potential benefits are often ignored. Therefore, alternative solutions which could maximize the Apple reverse supply chain has been proposed and the Australian government can monitor the Apple reverse logistic process and enforce laws on the competitive manufacturers and liable parties requiring compliancy regarding proper reverse logistics practices to reduce the impact of e-waste. Furthermore, intermediary functions within the forward supply chain could be assessed and transformed into a closed loop supply chain where both reverse and forward supply chains are integrated. While the requirement for proper regulatory framework to ensure organizational and public compliance are at utmost importance state governments and manufacturers could organize community events for obsolete electronic products collection. Awareness of top management, clear return policies and consumer laws, advanced forecasting, international and environmental regulatory compliancy, insight into the total cost of logistics and performance with governmental tax reductions will indeed increase the performance of reverse logistics which will in turn reduce the increase of obsolete products. Organizations will be able to achieve major profits in terms of revenue growth through customer satisfaction, cost reduction in the total supply chain and sustainability through corporate social responsibly towards the wider society.

The consensus view seems to be that to efficiently manage the e-waste issue in Australia through reverse logistics; it is essential to asses and evaluate best practices from advanced economies where efficient e-waste management is being practiced and to develop the required legislative framework and processes according to the local context. Furthermore, in order to increase the success rate of reverse logistics it is imperative to share the obligations and responsibilities with all stakeholders and continuously monitor and develop the strategies implemented to ensure its practicality and efficiency in the long term.

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APPENDIX

Table 1: Sample questions within the questionnaire and interviews

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<th>Sample Questions from the Questionnaire</th>
<th>Sample Questions from the Interviews</th>
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<td>How does your organization consider reverse logistics?</td>
<td>Do you have any electronic devices which are not used or dysfunctional? Why do you keep them?</td>
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<td>How do you respond to products returned within the warranty period?</td>
<td>Would you be willing to purchase refurbished products or not? Why?</td>
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<td>Do you educate the customer regarding the return policies during purchasing?</td>
<td>What is your opinion regarding Australian consumer law? / e-waste?</td>
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<td>What are the issues your organization encounter in return management?</td>
<td>Are you willing to pay extra to recycle your end of life span products or would you prefer to recycle free of charge?</td>
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<td>In which methods does your organization offer compensation for the return products if the customer expectations are not fulfilled?</td>
<td>How would you dispose of the remaining electronic waste at your household if required?</td>
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Figure 1: Australian Landfill Capacity

![Australian Landfill Capacity](image_url)
Figure 2: Issues in Return Management

- Financial issues: 91.2%
- Poor performance management systems: 2.9%
- Poor outsourced return management (3PL): 2.9%
- Unwarranted returns: 0%
- Re-work: 0%
- Returns handling and storing: 5.9%
- Inefficient speed of recovery: 2.9%
- Lack of information visibility for all parties involved: 86.3%
- Poor forecasting and planning: 17.6%
- Lack of Information Management Systems: 47.1%
- Lack of communication in-between the departments: 25.4%
- Lack of knowledge related to environmental legislations: 76.5%
- Lack of understanding of reverse logistics and return policies: 91.2%
Figure 3: Proposed Reverse Supply Chain Model for Apple Inc. Australia