REVERSE LOGISTICS AND INFORMATION MANAGEMENT ISSUES IN MANUFACTURING AND E-BUSINESS INDUSTRIES

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DECLARATION

I certify that:

a) except where due acknowledgement has been made, the work is that of the candidate alone;
b) the work has not been submitted previously, in whole or in part, to qualify for any other academic award;
c) the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program;
d) any editorial work, paid or unpaid, carried out by a third party is acknowledged; and
e) ethics procedures and guidelines have been followed.

Signed:

…….
K. D. Dushantha Nimal Dissanayake

Date:

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LIST OF ABBREVIATIONS

ACCC	Australian Competition and Consumer Commission
ANZSIC	Australian and New Zealand Standard Industry Classification
AUD$	Australian Dollar
B2B	Business to business
B2C	Business to customer
df	Degree of Freedom
E-Business	Electronic business
InSig.	Insignificant
MSWord	Microsoft Word
OM & EM	Original Machinery and Equipment Manufacturing
Sig.	Significant
SPSS	Statistical Package for Social Sciences
UK	United Kingdom
USA	United States of America
US$	United States Dollar

ABSTRACT

This thesis investigates information and logistics management issues associated with the management of returned goods in the Australian Manufacturing and E-Business industries.

Literature review

An extensive literature review was conducted on reverse logistics management issues to understand reverse logistics as a business process. Issues such as reasons for returns, product return operations, value recovery operations, barriers and information management issues were addressed to establish the value of reverse logistics in the two industries in Australia. Reverse logistics is a comparatively new business process and studies on this topic to date are mainly from countries other than Australia.

Statistics identified from the literature on returned goods clearly indicate an increasing trend in reverse logistics in different industries, especially in E-Businesses and Manufacturing. Reverse logistics is different from forward logistics in objectives, operations, pricing, quality, quantity, packaging, product and information flow. Further, management of the returned products and their information is a major challenge since it is difficult to predict the time, place of origin, quantity and quality of the goods that will be returned. To establish the importance of reverse logistics as a business process and to understand related issues for information management, this research was undertaken with data from the Australian Manufacturing and E-Business organisations.

Research dimensions

The research examined six dimensions of reverse logistics in this project. These were:

(1) Factors that compel Manufacturing and E-Business organisations to manage reverse logistics;

(2) Operations in product return process;

(3) Methods of capturing value from returned goods;

(4) Barriers to reverse logistics management;

(5) Information management issues in reverse logistics; and

(6) Product return trends in the E-Business industry.

Research approach

This research was exploratory in nature and was accomplished via a quantitative research method. It adopted a positivist epistemology and followed a deductive approach to capture reverse logistics knowledge. Research data was elicited with postal questionnaire surveys using structured questions. Binomial test, Fisher's exact test, one sample t-test and one sample Wilcoxon test were undertaken to analyse the data and finalise the findings. Important elements of the research are described below.

The study

This study investigated 210 Australian manufacturing organisations via postal questionnaire survey. They were selected using the stratified random sampling technique. The data collected from the survey was analysed using frequency distributions to understand reverse logistics issues in the Australian Manufacturing industries. The survey outcomes highlighted the importance of returns in one particular type of manufacturing industry, the Australian Original Machinery and Equipment Manufacturing (OM & EM). As the literature review indicated a large number of returns from E-Business sales, the study was also extended to include a survey of the E-Business industry in Australia. Based on the literature and outcomes of the preliminary study, five hypotheses were formulated to test their validity while establishing reverse logistics issues in the Australian OM & EM and E-Business industries. The first four hypotheses are applicable to both industry sectors while the fifth hypothesis is specific to the E-Business industry.

Data collection and analysis

Data collection for the Australian OM & EM and E-Business industries was also accomplished via postal questionnaire surveys. Online service industries were removed from the sample because this study is about the management of returned products. Two similar survey instruments that consisted of structured questions were used to collect data. Fill in the gap answers were used to collect percentage of returned goods received and recovered in these industries. The instrument used for the E-Business industry included additional variables to understand the high rate of returns in this industry.

Since the data collected from the two main surveys was mainly nominal and ordinal, it was quantitatively analysed using non-parametric tests, Fisher's exact test and one sample Wilcoxon test. It also employed frequency distributions, binomial test and one sample t-test. An additional statistical test was carried out on each set of data to triangulate the finding. The tests were undertaken in Minitab spreadsheet computer packages.

Findings and conclusion

This research highlights the fact that reverse logistics management is an important business process in the Australian Manufacturing and E-Business industries. It is a strategic advantage, as well as an important customer service. Although substantial monetary value can be recovered from returned goods, at present two industries investigated have not tapped into this potential.

This research findings also indicate that a lack of efficient information management is a problem in reverse logistics. Information management in the two industries is based on land-line telephone, fax and computers.

This research identified that from E-Business sales error in ordering, customer change of mind on receipt of good and inefficient forward logistics operations (picking, packing and delivery) are important reasons for returns. It also established that e-businesses resell the returned goods and recapture value. The value recovery process in this

industry is different from the manufacturing industries where the prevalent value recovery processes are repair, resale and recycle.

Based on the data analysis, this research validated one hypothesis, partially validated three and rejected one.

Further research issues emanating from this project include evaluation methods for recapturing value from returned goods, effective information management strategies for return management and the impact of a law for returning certain types of used goods.

This research is an initial effort undertaken to establish returns management in the Australian industries. It establishes that reverse logistics should be recognised as a business process in these industries.

REVERSE LOGISTICS AND INFORMATION MANAGEMENT ISSUES IN MANUFACTURING AND E-BUSINESS INDUSTRIES

Chapter 1

INTRODUCTION

1.0 Overview

In today's world organisations are increasingly managing the return of goods from the consumer to the supplier. This is encouraged for value recovery, environmental protection and sustainable development. At the same time, higher competition among organisations and customer protection laws allow customers to return products free of charge if they are not satisfied (Brito & Dekker 2003; Krumwiede & Sheu 2002; Lee 2002). Consequently, as evident from literature, the rates of return in different traditional and online businesses are substantial (Dekker & Van der Laan 2002; Trebilcock 2002; Vigoroso 2001). In particular, the rates of returned goods in Manufacturing and E-Business industries are remarkably high (Mason 2002; Nairn 2003; Rogers & Tibben-Lembke 1998; Sharma, Wickramasinghe & Singh 2005; Tan, Yu & Arun 2003).

Reverse logistics refers to the return management of discarded used products, commercial returns and excess inventory of products and materials (Bayles 2001). Reverse logistics is an important component of supply chain management and for recovering value from the returned goods (Cater & Ellarm 1998). A number of

researchers, (Amini & Retzlaff-Roberts 2003; Brito, Flapper & Dekker 2003; Carella, Murino & Santillo 2002; De Koster, De Brito & Van de Vendel 2002; Kokkinaki et al. 1999; Roy 2003) are of the same opinion that reverse logistic activities include collection, disassembly and processing of used products, product parts, and/or materials in order to capture value from the returned product. Reverse logistics also helps recovery of electronic and electrical products such as computers (Europa 2000; Kokkinaki et al. 2001b) that may potentially have a damaging effect on the environment.

Reverse logistics have attracted substantial attention in recent years because of their direct and indirect benefits to organisations and their customers (Brito, Flapper & Dekker 2003; Kokkinaki et al. 2001b; Srivastava & Srivastava 2006). The benefits of reverse logistics are:

- Financial (Brito, Flapper & Dekker 2003; James, Thomas & Herbert 2002; Lund 1998; Roy 2003);

- Improved company image, goodwill and reputation (Boyer, Hallowell & Roth 2002; Jiang & Rosenbloom 2005; Rogers & Tibben-Lembke 1998; Sharma, Wickramasinghe & Singh 2005; Smith, Bailey & Brynjolfsson 2000);

- Fulfilment of legal obligations (ACCC 2001; Brito, Flapper & Dekker 2003; CCC 2005; http://web-japan.org 2005; Krikke et al. 2001; Mitsumori 1999; www.nyc.gov 2001; www.strategic.com 2005); and

- Higher customer satisfaction and retention (Boyer, Hallowell & Roth 2002; Jiang & Rosenbloom 2005; Krumwiede & Sheu 2002; Sharma, Wickramasinghe & Singh 2005; Smith, Bailey & Brynjolfsson 2000).

Advances in information and communication technologies offer opportunities to effectively handle the fundamental difficulties of traditional supply chain operations (Mason, Potter & Lalwani 2002; Spiegel 2000). For systematic handling of returns, businesses also need information and communication technologies to plan and control reverse logistics operations (Caldwell 1999; McNeill 1991; Nagel & Meyer 1999; Sarkis, Meade & Talluri 2004; Zhao 2001). Efficient management of reverse logistics

operations is a great challenge due to the high uncertainty of time and place of origin and quality of returns (Inderfurth 2005; Kokkinaki et al. 2001a; Thierry 1997). As suggested by Kokkinaki et al. (2001b), information and communication technologies can be applied to minimise uncertainty and effectively manage the volume of incoming returns.

From the above it is suggested that effective information and communication technology solutions to reverse logistics management will help, identify and gather important information supporting the process.

1.1 Background and rationale for the research

Products are returned because of manufacturing, commercial, product, warranty, service or environmental issues (Dekker & De Brito 2002; Lee 2002). Rates of product return in some business models are considerably high. The average return rate of products in general off-line businesses is 10 per cent (Dekker & Van der Laan 2002), main stores such as catalogues, telemarketing and television is up to 35 per cent (Trebilcock 2002) and from Internet sales is 30 to 50 per cent (Mason 2002; Nairn 2003; Sharma, Wickramasinghe & Singh 2005; Vigoroso 2001). Turban et al. (2006) are of the opinion that the volume of return in E-Business will increase as sales from E-Business increase. According to Tan, Yu and Arun's (2003) point of view volume of returned products can amount to 30 per cent of total products in the logistics channel of an organisation.

Reverse logistics management is important for achieving economic, environmental and strategic advantages for businesses (James, Thomas & Herbert 2002; Mitsumori 1999; Mukhopadhyay & Setaputra 2006; Roy 2003).

The literature clearly shows that returns are increased (Dekker & Van der Laan 2002), most significantly for catalogue, telemarketing and internet sales (Sharma, Wickramasinghe & Singh 2005; Trebilcock 2002). Electronics (Rogers & Tibben-Lembke 2002) and allied goods are returned due to commercial, warranty and environmental issues (Lee 2002). The management of returned goods gives organisations economic and strategic gains (Lund 1998; Roy 2003; Blumberg 1999). Therefore, it is important to understand whether all those reasons are

important or are there other reasons for reverse logistics and if they are same in different industries.

The literature cites eight operations of product return process such as information received about the return (Amini & Retzlaff-Roberts 2003), authorisation to return goods (Lonn & Stuart 2003), gate-keeping of returned goods (Bayles 2000), transportation of returned goods (Hutchinson 2000), inspection of returned goods (Roy 2003), selection of value recovery method (Trebilcock 2002), sorting of returned goods (Schwartz 2000), and refund to customers for returns (ACCC 2001). However, in the modern edge of technology which operations valid is not known. Thus, it is imperative to understand operations in product returning process for better management of returned goods.

Value recovery operations identified from the review of literature are repair (Amini & Retzlaff-Roberts 2003), resale (Bayles 2000), recycling (Rahman 2003), landfill (Bayles 2000), remanufacture (Meade & Sarkis 2002), upgrade (Roy 2003), refurbishment (Thierry et al. 1995), reuse (Brito & Dekker 2003), incineration (Le Blanc, Fleuren & Krikke 2002), hazardous waste management (Chopra, Reinhart & Abu-Al-Shaar 2001), donation (Roy 2003) and retrieval (Fleischmann, Nunen & Grave 2002). However, these operations are more relevant to manufacturing organisations as they recycle computers and electronic goods. However, which of these recovery operations are bound to entail recycling of all types of goods are unknown. Thus, it is important to explore recovery methods for receiving value from the returned goods.

The literature highlights some barriers to the management of reverse logistics. These include poor management of intermediaries (Zhao 2001), lack of attention to reverse logistics (Andel 1997), uncertainty in the return of goods (Kokkinaki et al. 2001) and lack of information systems for the management of reverse logistics (Caldwell 1999). Therefore, it is imperative to explore barriers and identify whether these barriers are exist in all countries.

This is the edge of information technology, it is increasingly applied to business operations in E-Business and Manufacturing industries. Importantly it is intensively and widely applied in forward logistics (Tan, Yu & Arun 2003). The management of data is

crucial to reverse logistics management (Smith 2005; Zhao 2001) and therefore it is important to have proper information management in reverse logistics. Thus, it is useful to identify information management issues in reverse logistics.

Current literature is mostly based on reverse logistics in manufacturing organisations (Dekker & De Brito 2002). However, an increasing amount of returns are being generated from E-Business sales (Sharma, Wickramasinghe & Singh 2005) and, therefore, it is important to explore reverse logistics issues in the E-Business industry.

As discussed on the above literature the following six issues are explored in this research.

- Reasons for managing reverse logistics;
- Operations in product return process;
- Methods of value recovery from the returned goods;
- Barriers to managing reverse logistics;
- Information management issues in reverse logistics; and
- Product return trends in the E-Business industry.

1.2 Research objectives

Reverse logistics management is a new business process (Morrell 2001) which has been given growing concern in the USA, UK, Japan and some European countries in the past few years. As specified earlier, figures identified from literature clearly indicate that the rate of returned goods in different industries, especially Manufacturing and E-Business industries is remarkably high (Rogers & Tibben-Lembke 1998; Sharma, Wickramasinghe & Singh 2005; Trebilcock 2002; Vigoroso 2001). It is also evident from literature that there are a number of issues such as reasons, product return operations, value recovery operations, barriers and information management associated with the management of reverse logistics. Previous studies by (Andel 1997; Lee 2002; Morrell 2001) concede that reverse logistics has not been given the same importance as

other business processes. Most of the literature on reverse logistics is generic and from other parts of the world. Thus it is important to establish the importance of reverse logistics in Australia. Based on return data identified from extant literature it is clear that returns in the Manufacturing and E-Business industries are on the rise. Therefore this research project investigated reverse logistics in the Australian Manufacturing and E-Business industries.

The objectives of this research are:

1. To investigate critical reverse logistics issues associated with management of returned products in the Australian Manufacturing and E-Business industries.

2. To investigate vital information and logistics management operations in reverse logistics management in the Australian Manufacturing and E-Business industries.

3. To investigate information management issues associated with reverse logistics in both the Australian Manufacturing and E-Business industries.

Research questions Q1 (for both OM&EM and E-Business industries) and Q6 (E-Business industry only) were developed to fulfil the first objective of this research (reasons for reverse logistics). Research questions Q2 and Q3 were formulated for the second objective (product returns and value recovery processes). Research questions Q4, Q5a and Q5b provided answers for the third objective, challenges and problems for reverse logistics.

1.3 Research questions

With the aim of achieving the above research objectives, the study formulated the following research questions to address and establish information and logistics management issues associated with reverse logistics in Manufacturing and E-Business industries. (Question six is applicable to the E-Business industry only.)

Q1. Why have Manufacturing and E-Business industries implemented reverse logistics?

Q2. What are the logistics and information management operations in facilitating handling of the returned goods in Manufacturing and E-Business industries?

Q3. What recovery operations are performed on returned goods to capture value in Manufacturing and E-Business industries?

Q4. What are the barriers to reverse logistics management in Manufacturing and E-Business industries?

Q5. *Q5a* - What information technologies are used to manage reverse logistics information?

Q5b - How can reverse logistics management be improved with electronic information management?

Q6. Why does the E-Business industry receive an increased amount of returns?

1.4 Scope of the research

This research is mostly depended on the literature on reverse logistics management mostly focused on the USA, UK, Japan, and some European countries. It is assumed that this literature provides comprehensive and sufficient knowledge to identify and investigate reverse logistics as a business process and issues for information management.

Since this study is to understand the logistics of returned goods it does not address services.

1.5 Research methodology

This research was exploratory in nature and was accomplished via a quantitative research method. It adopted a positivist epistemology and followed a deductive approach to capture reverse logistics knowledge.

Initially a preliminary survey was undertaken with a stratified random sample of Australian Manufacturing organisations. Data elicited from this survey was analysed using frequency distributions to understand reverse logistics issues in the Australian Manufacturing industries. Based on the literature and the outcome of the study five hypotheses were formulated. The survey outcome provided useful information for a

more detailed investigation of reverse logistics in the Australian Original Machine and Equipment (OM & EM) industries. As the literature review indicated a large number of returns from E-Business, the study was also extended to include a survey of the E-Business industry in Australia.

Data collection from the Australian OM & EM and E-Business industries was accomplished via postal questionnaire surveys using structured and fill in the gap type questions. Since the data elicited were mainly nominal and ordinal, it was quantitatively analysed using frequency distributions, binomial test and Fisher's exact test to triangulate the findings. One sample t-test and Wilcoxon test were undertaken to further confirm the findings. The variables were grouped into pertinent business applications to identify reverse logistics issues. The significance of the grouped variables was established using the above mentioned tests. Based on the findings from the analysis reverse logistics issues (reasons for reverse logistics, product return operations, value recovery operations, barriers to reverse logistics, technologies used in reverse logistics information management and reasons for E-Business returns) were established and five hypotheses were tested for validity in the selected two industries.

1.6 Outline of thesis

The presentation of this research study is divided into eight chapters.

Chapter 1 provides the general introduction of the topic, background and rationale for the research, research objectives and questions, scope and limitation of the research, summary of research methodology and an outline of what is in the thesis.

Chapter 2 is an extensive literature review on reverse logistics issues. Issues identified from literature were comprehensively put together (Figure 2.1) to shows the reverse logistics processes and flow of information requirements. Critical analyses of literature identified gaps that form the research questions are also included.

Chapter 3 outlines the research methodology, research approach, sample frame and unit of analysis, sample and sampling techniques, data collection and analysis. Data analysis methods and associated statistical tests are also explained.

Chapter 4 presents and describes the outcomes of the preliminary study highlighting that not all the Australian Manufacturing industries manage reverse logistics. But it indicates that reverse logistics is important for Original Machine and Equipment Manufacturing (OM & EM) industries.

Chapter 5 describes the formulation of five hypotheses tested for validity in this research.

Chapter 6 presents and describes the outcomes of the survey of OM & EM organisations. This chapter presents the important reasons for reverse logistics, operations in product return process and methods of value recovery from the returned goods. It explains the barriers and information technologies associated with managing returned products in this industry.

Chapter 7 presents and explains the outcomes of the survey of the E-Business industry. It describes the reasons why E-Business organisations manage reverse logistics. The important operations in product return and value recovery processes are also discussed. It explains the barriers to reverse logistics management and information technologies that support the management of reverse logistics information. It includes reasons why E-Business receive an increased amount of returns.

Chapter 8 presents answers to the research questions and the results of hypotheses. It also discusses the implications of the findings on reverse logistics and information management issues in OM & EM and E-Business industries. It also presents contribution of the research to overall knowledge on reverse logistics management and opportunities for future research. It concludes that reverse logistics is an important business process.

Chapter 2

LITERATURE REVIEW

2.0 Introduction

This chapter is a review of literature.

Reverse logistics is the management of returned products. Rogers and Tibben-Lembke, (1998) 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" pg 2.

Reverse logistics is an essential feature of Manufacturing organisations for strategic marketing and effective customer relationship management (Autry, Daugherty & Richey 2001; Krumwiede & Sheu 2002; Mukhopadhyay & Setaputra 2006) and environmental protection and sustainable development (Brito, Flapper & Dekker 2003; Fernández 2003; Krikke et al. 2001; Mitsumori 1999). Bayles (2001) describes that reverse logistics enables the reuse of discarded products from commercial returns and

management of excess inventory of products and materials. It entails processing merchandise returned due to damage, seasonal inventory, restock, salvage, recalls and excess inventory (Brito, Flapper & Dekker 2003). Reverse logistics management also encompasses recycling programs, hazardous material management programs, obsolete equipment disposition and asset recovery (Fernández 2003). The benefits of reverse logistic are regaining value (Roy 2003), achieving a competitive advantage (Autry, Daugherty & Richey 2001) and a positive impact on the environment (Brito, Flapper & Dekker 2003).

With the emergence of e-commerce, where customers purchase goods without trying or even seeing them, an efficient return policy is essential (Desai, Richards & Desai 2003; Jiang & Rosenbloom 2005; Smith 2005). Smith, Bailey and Brynjolfsson (2000) are of the opinion that efficient reverse logistics management is important to increase customers' trust in E-Businesses. Although actual data is not yet available, Jupiter Communication predicted that business to customer (B2C) Internet sales will grow to US $210 billion in the Asia Pacific region in 2006. Jupiter Communication also estimated a tremendous growth in business to business (B2B) on-line transactions. It forecasted that in 2005 the USA B2B E-Business market was worth US $6 trillion. The percentage of annual growth of total E-Business sale is 15 to 25 per cent (Turban et al. 2006).

According to Pan, Ratchford and Shankar (2001) online sale processes comprise four equally important major areas; pre-sales service, transactions, physical order fulfilments, and after-sales service. Lee (2002) is of the opinion that reverse logistics is important to deliver after sale service in E-Business. Additionally, the cost of reverse logistics is significant compared to the total logistics cost. According to Delaney (2001), reverse logistics costs has increased by 15 per cent in three years. Therefore, from the above information, it is clear that reverse logistics is gaining importance in both Manufacturing and E-Business industries.

Although reverse logistics is a new business process (Morrell 2001) and there is a lack of commitment by some organisations to manage this process compared to forward logistics (Andel 1997; Mukhopadhyay & Setaputra 2006), its relevance to business and the environment are important.

2.1 Definitions of reverse logistics

Reverse logistics is the process of planning, implementing and controlling the efficient, cost effective flow of raw materials, parts, components, and finished goods and associated information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal (Rogers & Tibben-Lembke 1998). Fleischmann (2000) associates reverse logistics with secondary goods those that are rejected, refused or returned after initial sale. Fernández (2003) states that reverse logistics is managing products into used products, unused products, components, parts and raw materials.

2.2 Inverse logistics

Pérez, Rodríguez and Sabrià (2003) and RAC/CP (2005) state that inverse logistics is a set of activities carried out by organisations aiming at extracting value from products and packagings that have come to the end of their useful life. They advocate that it is an important organisational capability in the new business era. Inverse logistics is recycling of returned products or their remains (Yoshinaga et al. 2002; Yoshinaga et al. 2004). This is a collective responsibility of organisations and municipalities. It also encompasses the return of excess inventories, customer returns, obsolete products and seasonal inventories returns, as well as product withdrawal, reclassification, reconditioning and reshipment to the original point of sale or to other secondary markets (Pérez, Rodríguez & Sabrià 2003).

The objectives of inverse logistics include asset recovery and recycling, achieving business advantage, obtaining improvement and benefits in production and market supply processes and the fulfilment of legal obligations (Pérez, Rodríguez & Sabrià 2003; RAC/CP 2005; Yoshinaga et al. 2002; Yoshinaga et al. 2004).

Although inverse logistics is an extra cost to organisations, it opens up new business opportunities and offers scope to secure competitive advantage and recover value (Pérez, Rodríguez & Sabrià 2003).

Pérez, Rodríguez and Sabrià also advocate barriers of inverse logistics to be a lack of investment, widespread lack of awareness and interest, lack of government subsidies and legal difficulties in implementing such processes.

Some researchers refer to inverse logistics as reverse logistics.

2.3 Closed-loop supply chains

In closed-loop systems, goods are returned and processed internally by the original producer (Inderfurth 2005). This practice is common in manufacturing industries that produce commercial aircrafts, computers, automobiles or chemicals (Dowlatshahsi 2000).

Closed-loop practices include:

1. A physical closed-loop, where the recovered product is sent to the original user (Fleischmann et al. 1997). An example would be where a customer returns a malfunctioning product to the retailer or distributor which, after repair, is returned to the customer.

2. A functional closed-loop, where the recovered product is reused for its original functionality (Brito & Dekker 2003). An example would be where a customer returns a malfunctioning product to the retailer or distributor and the product is repaired to restore its original functionality and then returned to the market place.

2.4 Supply chain management

According to Frazelle (2002) and Cousins, Lawson and Squire (2006), supply chain management was introduced more than two decades ago. It consists of a number of different functions purchase of raw materials, procurement and transformation of raw materials into finished good or parts, manufacture, delivery and distribution, and advertising, selling and marketing (Frazelle; Mohanty & Deshmukh 2005; Shapiro 2004; Varma, Wadhwa & Deshmukh 2006).

Lambert and Cooper (2000) define forward supply chain management as the integration of key business processes from end-user through original suppliers that provide products, services, and information that add value for customers and other stakeholders. The premise behind supply chain management is to integrate the internal business processes of the organisation with their suppliers and customers (Arend & Wisner 2005; Droge, Jayaram & Vickery 2004; Vickery et al. 2003). Levi, Kaminsky and Levi (2000) have defined supply chain management as a set of approaches that are utilised to effectively integrate business partners such as suppliers, manufacturers, distributors and storekeepers for the purpose of producing and distributing merchandise in the right quantities, to the right location, and at the right time with the lowest possible cost and while satisfying required service levels. Long term partnerships, mutual understanding and integration of supply chain partners are factors critical for success (Chang et al. 2005).

2.5 Forward logistics

In general, forward logistics is the process of supplying finished goods to customers (Lambert & Cooper 2000; Varma, Wadhwa & Deshmukh 2006). The Council of Logistics Management declares that logistics is that part of the supply chain process that plans, implements, and controls the efficient, effective flow and storage of goods, services, and related information from the point-of-origin to the point-of-consumption in order to meet customers' requirements (Rogers & Tibben-Lembke 2002).

- Forward logistics comprises inbound logistics, that is, the process of providing raw materials and supplies for finished goods and outbound logistics, which is the process of providing finished goods to the customers (Larson & Gammelgaard 2001). This process adds value to goods in four different ways (Coyle, Bradi & Jr 2002), form utility - adding value through manufacturing, place utility - adding value by moving goods from surplus to demand point, time utility - adding value by making available goods when the customer demands it, and possession utility - adding value by promoting products.

- Coyle, Bradi and Jr (2002) state that there are different micro-dimensions of forward logistics which can provide better results and add value to processes.

These dimensions include length of production runs, protective packaging, third party involvement, seasonal demand, marketing mix, matching scheduling, carrier pricing, channel competition, volume relationship, push and pull strategies, and wholesale and retail strategies.

2.6 Differences between reverse and forward logistics

The differences between forward and reverse logistics are presented in Table 2.1. From Table 2.1 it is clear that reverse logistics is perceived to be substantially different from forward logistics. The differences are apparent in seemingly related operations such as forecasting, packing, distribution, pricing, inventory management, communication and marketing. Similarly, other differences emerge in features such as origin and destination of products, quality of products, cost of operations and visibility of products. Therefore reverse logistics is not the same as forward logistics.

TABLE 2.1:Differences between forward and reverse logistics

Forward logistics	Reverse logistics
Forecasting relatively straight forward	Forecasting more difficult
One to many distribution points	Many to one distribution points
Product quality uniform	Product quality not uniform
Product packaging uniform	Product packaging often damaged
Destination / routing clear	Destination / routing unclear
Disposition options clear	Disposition not clear
Pricing relatively uniform	Pricing dependent on many factors
Importance of speed recognised	Speed often not considered a priority
Forward distribution costs easily visible	Reverse costs less directly visible
Inventory management consistent	Inventory management not consistent
Product life cycle manageable	Product lifecycle issues more complex
Negotiation between parties straightforward	Negotiation complicated by additional considerations
Marketing methods well known	Marketing complicated by several factors
Visibility of process more transparent	Visibility of process less transparent

Source: Croxton KL, García-Dastugue SJ, Lambert DM, Rogers DS, *The Supply Chain Management Processes, The International Journal of Logistics Management*, vol 12, No.2 (2001), p 30.

2.7 Current status of reverse logistics

Product return rates in some business models, notably E-Business, are considerably higher than the rate of returns in retail store businesses (Trebilcock 2002; Vigoroso 2001). Dekker and Van der Laan (2002) cite the average rate of returns in general off line business to be 10 per cent. Rogers and Tibben-Lembke, (1998) report that the rate of return for all types of products in the US market is around 6 per cent. However, the rate of sales via catalogues, the Internet, telemarketing and television is growing and returned goods in this market represent up to 35 per cent of total sales (Trebilcock 2002).

Successful sales strategies are able to convert potential customers into actual customers through attractive marketing programs. However, it is difficult to predict customer's reaction once the ordered product is received, particularly when it does not accord with the customer's perception gained from the screen, catalogue, or description. This is especially evident in Internet sales, with the estimated average return rate being 30 to 50 per cent (Mason 2002; Nairn 2003; Sharma, Wickramasinghe & Singh 2005; Vigoroso 2001). The volume of E-Business returns is predicted to further increase with the remarkable growth in E-Business sales in coming years (Turban et al. 2006).

In 1997 the cost of returns for US companies were estimated to be US $35 billion, representing 0.5 per cent of the US GDP (Rogers & Tibben-Lembke 1998). This grew by more than US $5 billion in the following three years and had increased to US $40 billion by 2001 (Delaney 2001). It is estimated that reverse logistics activities make up approximately 4 per cent of total logistics costs to a company and is increased by 15 per cent in three years (Delaney 2001; Minahan 1998).

With the projected growth in the rate of product returns discussed above returns management is no doubt an essential process.

2.8 Reasons for reverse logistics

Reverse logistics is an important part of supply chain management (Cater & Ellarm 1998). Reverse logistics management is necessary for a variety of reasons, some of

which can be avoided by improving process performance while others are due to the origin of the products (Srivastava & Srivastava 2006). According to Dekker and Van der Laan (2002) and Dekker and De Brito (2002) these reasons can be categorised into commercial returns, warranty returns, end-of-use returns and end-of-life returns. Additionally, E-Business, strategic marketing and retailing policies, legal requirements, environmental issues and sustainable development concerns become significant when putting into place an effective reverse logistics management system. Other researchers (Mukhopadhyay & Setaputra 2006; Richey, Genchev & Daugherty 2005; Rodriguez & Marcojohn 2004; Srivastava & Srivastava 2006) identify benefits of reverse logistics to be economic gain, strategic and competitive advantage, and increased customer retention to be reasons for reverse logistics as well. These reasons are discussed in detail in the following section.

2.8.1 Commercial returns and warranty returns

Commercial returns include products that are returned without fulfilling some or all of the claimed functionality and where a buyer or retailer returns a product to the manufacturer with a demand for a refund or replacement (Daugherty, Myers & Richey 2002; Lee 2002; Richey et al. 2004). According to Brito, Flapper and Dekker (2003) the volume and quality of commercial returns can be impacted by partners in the organisation's supply chain and financial risk transferability from the buyer to the seller.

Warranty returns include products that fail during use within a specified period (Barsky & Ellinger 1999; Desai, Richards & Desai 2003). It also includes goods damaged during delivery from the manufacturer to the buyer. Product mismatch, safety concerns and manufacturer recalls are other reasons for commercial and warranty returns (Smith 2005; Teng, Ho & Shumar 2005). Safety recalls are a strategic decision from manufacturers to avoid potential damage to brand value, market share and to reduce stock price (Batesa et al. 2007).

2.8.2 Strategic marketing and liberal return policies

According to Krumwiede and Sheu (2002) strategic marketing and liberal return policies have led to the growing need for efficient reverse logistics management. These

policies commonly exist in most sale strategies used by a range of sellers and include direct store, catalogue, telephone, television, and E-Business where customers are often allowed to return products if they are not happy (Autry, Daugherty & Richey 2001; Beullens et al. 2001; Smith 2005).

Customer protection legislation enacted in many countries allows customers to return products if they are not satisfied with goods (Brito & Dekker 2003; Desai, Richards & Desai 2003; Krumwiede & Sheu 2002). Lee (2002) states that some buyers return products to the original sender with a demand for a refund instead of a replacement or an exchange. Lee further states that customers rightfully, and sometimes incorrectly, take advantage of the opportunity to return products. Strategic marketing and competition between vendors also lead to more relaxed return polices which can result in unlimited returns (Rogers & Tibben-Lembke 1998). Competition to attract customers tends to create more flexible return policies (Gual et al. 2005) and a subsequent increase in the volume of returned goods (Oracle 2006).

2.8.3 E-business

E-business is the process of selling goods via electronic channels, replacing traditional methods of selling through retail outlets (Corritore, Kracher & Wiedenbeck 2003; Gefen, Karahanna & Straub 2003; Gefen & Straub 2003). It is also used to service customers and to collaborate with business partners (Turban et al. 2006). E-business organisations tend to provide more flexible return policies as customers are not able to examine, touch or feel the product before buying (Desai, Richards & Desai 2003; Jiang & Rosenbloom 2005; Smith 2005). Although product descriptions in E-Businesses have improved in the past (Barua et al. 2002; Cagle 2006), the rate of return of goods from E-Business is high (Nairn 2003; Sharma, Wickramasinghe & Singh 2005).

Smith, Bailey and Brynjolfsson (2000) and Boyer, Hallowell and Roth, (2002) suggest that providing flexible return policies alone is not sufficient to improve and maintain customer trust in E-Businesses. They argue that an efficient reverse logistics management system needs to be implemented because of the lack of face-to-face interaction with customers, invisibility and physical distance between customer and seller. Sarkis, Meade and Talluri (2004) and Mukhopadhyay and Setaputra (2006) also highlight that the growth of E-Business has precipitated an increased volume of returns.

Reasons for E-Business returns

Lee (2002) cites a number of reasons why goods are returned from supply chain partners in the E-Business model. They include errors in ordering, picking or shipping, damage due to transportation and handling, cancellation of orders, trade-ins, and overstocked items due to seasonal business cycle. Some E-Business returns are due to unfulfilled promises, unrealistic response times and customer dissatisfaction (Harris & Goodman 2001; Smith 2005).

2.8.4 End-of-use and end-of-life returns

End-of-use or end-of-life returns also warrant reverse logistics management. End-of-use occurs when a product's scheduled life is complete, for example, at the end of a lease, business contract or agreement. End-of-life of a product occurs when the product life is over and it can no longer be used for its intended functionality (Brito, Flapper & Dekker 2003). For end-of-use returns the challenge is in determining the match between demand for used products and supply. These can be impacted by time, quantity, and quality and can be managed by proactive management of returned goods information (Sarkis, Meade & Talluri 2004). Environmental protection, competitive advantage and the imperative to regain value from end-of-life products have triggered a growing interest in reverse logistics in recent years (Brito, Flapper & Dekker 2003).

2.8.5 Legal restrictions, environmental protection and sustainable development

The USA (www.nyc.gov 2001), UK and Europe (CCC 2005; www.strategic.com 2005) mandate to manufacturers and suppliers clear legal instructions about the disposal of white goods. Similarly, the Japanese government also mandates that manufacturers collect, transport and recycle household and office trash to the manufacturers' plants (http://web-japan.org 2005; Mitsumori 1999). The strong disposal laws in Japan compel manufacturers to produce up to 25 per cent of all new machines with over 50 per cent recovered modules, parts, components and materials (Mitsumori 1999).

Customer protection legislation allows customers to return products if they are not satisfied with it (Brito & Dekker 2003; Krumwiede & Sheu 2002). In Australia, the Australian Competition and Consumer Commission (ACCC) protect customers by

legally facilitating customers to return goods for a refund, or the offering of an exchange, credit note or repair if they are not satisfied with a product (ACCC 2001).

Countries such as Japan, the USA, Germany, the Netherlands and some European countries, have imposed disposal tariffs and bans for waste transportation, prevention and emission control which compel producers to manage returned goods (Krikke et al. 2001). A current environmental challenge is managing the disposal of electronic goods such as personal computers which contain toxic substances such as lead, mercury, cadmium, chromium and bromine (Europa 2000; Kokkinaki et al. 2001b). It has been predicted that 500 million personal computers will be returned by 2007 in the USA alone (Kokkinaki et al. 2001b), with many more around the world. Consumer and environmental protection legislation is equally applicable to online stores since all types of goods, commodities, white goods, electronic appliances and other retail items are now also sold online.

2.8.6 Economic gains

According to James, Thomas and Herbert (2002), some returned product can be resold at a higher price in a different market. They illustrated an example of cordless phones that were called back from one market, and then modified and sold at a higher price in a different market. Substantial economic gains can be achieved from the reuse of products, parts or recycling of parts from returned goods (Brito, Flapper & Dekker 2003; Inderfurth 2005; Krikke, Jacqueline & Wassenhove 2001). This is evident in the USA where there are over 70,000 jet and car engines, auto parts and photocopier re-manufacturing firms relying upon reverse logistics which supports a US $53 billion turnover (Lund 1998; Roy 2003).

2.8.7 Strategic and Competitive advantage

Efficient management of reverse logistics adds strategic value to organisations (Autry, Daugherty & Richey 2001; Blumberg 1999). This idea is supported by Gilmour (1999) who stated that delivering customer value and maintaining core competency in reverse logistics can bring about strategic gains for organisations. Organisations that experience higher volumes of returned product develop the expertise or experience necessary for better management of reverse logistics (Johnson 1998). Richey, Genchev and

Daugherty (2005) are of the opinion that larger firms which customise their reverse logistics program and build flexibility into their systems and procedures achieve superior performance. They further state that using innovative reverse logistics processes is a "strategic weapon" for organisations. Marien (1998) and Woods and Marien (2001), also advocate that the allocation of resources and the proactive use of reverse logistics solutions provide a competitive advantage for organisations in different industry segments. Rust, Moorman and Dickson (2002) state that an innovative reverse logistics program has the potential for cost savings, profit improvement, defect rate reduction, standardisation and forms the basis for activity-based accounting. Rodriguez and Marcojohn (2004) emphasise that organisations need to recognise that dedicated returns handling create a competitive market and strategic advantages.

Brito, Flapper and Dekker (2003), Srivastava and Srivastava (2006) and Mukhopadhyay and Setaputra (2006) are of the opinion that organisations can achieve a competitive advantage from a well-managed reverse logistics system. This is further supported by Roy (2003) and Winch and Joyce (2006) who suggest that manufacturers with better reverse logistics systems are able to provide timely and better customer service with a shorter lead-time and low operating margins than those who don't manage returned goods effectively. Further, according to Roy, minimising the time that returned products are held up in reverse channels and maintaining clear distribution channels give a competitive advantage to organisations.

This means that an efficient means of bringing back obsolete, outdated and clearance items is imperative in the improvement of business efficiency. For example, Xerox replaces or upgrades hundreds of office printing machines every month (Roy). By doing this, the organisation is able to act quickly to provide state of the art technology with minimum interruption to customers' day-to-day operations. This suggests that a competitive advantage for them and they retain satisfied customers (Autry, Daugherty & Richey 2001; Daugherty, Myers & Richey 2002; Smith 2005).

2.8.8 Customer retention

One of the goals of almost every business is to offer such a high quality of goods/services to their customers that they will not move to another supplier (Jiang & Rosenbloom 2005; Srivastava & Srivastava 2006). There are many ways to make it

difficult and unprofitable for customers to switch to another supplier. One is for a supplier to offer its customers the option of having unsold or defective merchandise taken back quickly and a timely credit offered to the customer (Rogers & Tibben-Lembke 1998). Reverse supply chain can be a customer service leading to customer satisfaction (Autry, Daugherty & Richey 2001; Daugherty, Myers & Richey 2002; Daugherty et al. 2003; Smith 2005). The process of managing reverse logistics is an essential component in improving customer service through customer relationship management (Anton & Petouhoff 2002).

Reverse logistics and customer related issues are further emphasised by Jiang and Rosenbloom (2005) and Sharma, Wickramasinghe and Singh (2005). They cited increased customer loyalty and increased customer retention rates as important considerations.

The benefits of reverse logistics listed above are equally relevant to both E-business and Manufacturing organisations. Customer trust and confidence and enhanced company image and goodwill can be achieved from returns management (Boyer, Hallowell & Roth 2002; Jiang & Rosenbloom 2005; Smith, Bailey & Brynjolfsson 2000).

2.8.9 Other reasons and benefits

Rogers and Tibben-Lembke (1998) state a number of other reasons why firms in the USA manage reverse logistics. These include increased product rotation on retailers' shelves by taking back old products, especially those near the end of their lives to maintain clean logistics channel and the protection of profit margins by upgrading old and obsolete products with upgraded parts/products from the recovery plant.

Based on the review of literature in this section, it is clear that there are number of advantages of reverse logistics management. A summary of the reasons for reverse logistics is presented in Table 5.1 in section 5.1.1, page 84.

The next section discusses the operations within the return process and methods of value recovery from returned goods.

2.9 Product return and value recovery processes

In order to understand and establish the information flow process in reverse logistics, it is essential to conceptualise the relationship between product return process and value recovery process. The following operations of product return process have been identified after an extensive literature search and presented in the next section. Each operation is labelled (a) to (h). These are inform (notify) about returned goods (a), return authorisation (b), gate-keeping of returning goods (c), collection and transportation of returns (d), inspection of returned goods (e), selection of a recovery method (f), sorting of returned goods (g) and refund or reimbursement (h).

The value recovery operations identified are redistribution (i), resale (j), reuse (k), donation (l), upgrade (m), repair (n), refurbishment (o), remanufacture (p), retrieval (q), recycling (r), hazardous waste management (s), incineration (t) and landfill (u). These value recovery operations are described in the next section as well.

Based on a description of product return and value recovery processes a reverse logistics process model was developed and is presented in Figure 2.1. Although Figure 2.1 is a reverse logistics process model, it was also used to guide the research questions and objectives.

Operations within product return and value recovery processes included in the model were identified from literature tabulated in Tables 2.2 to Table 2.22.

2.9.1 *INFORM* (a) - notification of goods to be returned

TABLE 2.2:Receive returns information

Reference	Description/definition
Carella, Murino and Santillo (2002) and Bayles (2000).	Once a decision to return a product is made by a customer or a retailer, they inform either a third party or the manufacturer about their decision.
Lonn and Stuart (2003)	Dealer initially informs either a third party or the manufacturer about the products to be returned.
Amini and Retzlaff-Roberts (2003).	Customers fill out the product return form or write a letter to the retailer indicating the reason(s) for returning the product(s) and request action to facilitate the return.
Bayles (2000) and Lau et al. (2004).	When a user or a customer wants to return a product, he/she initially informs the customer support centre or technical assistance centre by sending an email, fax or telephoning identifying the product fault and requesting a return.
Roy (2003).	To improve product-returning process companies educate their customers about initial points of contact for product return.
Amini and Retzlaff-Roberts (2003).	Advance information of products to be returned is very useful for customer support centres to provide others in the organisation detailed analysis of reasons for returns, warranty, place of return and condition of products.
Carella, Murino and Santillo (2002), Roy (2003) and Rogers and Tibben-Lembke (1998).	The most difficult operation in reverse logistics is obtaining advanced and accurate information of future returns. The customer or retailer informs either a call centre, a third party or the manufacturer about the product to be returned thus providing this information.

2.9.2 *RETURNS AUTHORISATION* (b) - how returns authorisation are issued

TABLE 2.3:Returns authorisation

Reference	Description/definition
Bayles (2000) and Lonn and Stuart (2003).	A return authorisation is a document provided by a merchant to protect against fraudulent returns. A leading heavy vehicle manufacturer, Caterpillar, processes approximately 500 return requests per day independently of return authorisation, on a first-come, first-served basis when products enter the distribution channel.
De Koster, de Brito, and Van de Vendel (2002).	Returns authorisation is a document that grants permission to return the product(s) as long as it is within the warranty period.
Lau et al. (2004).	In some cases goods can be authorised for return even if it is outside the warranty period provided customers pay the relevant fee for work.
James, Thomas and Herbert (2002) and Lau et al. (2004).	Issuing a return authorisation to identify and facilitate the returned products.

2.9.3 *GATE-KEEPING* (c) - how gate-keeping is accomplished.

TABLE 2.4:Gate-keeping of returned goods

Reference	Description/definition
Lonn and Stuart (2003).	Manufacturers gate-keep dealers' returned products to check according to predetermined value and/or quantity limits for the given period of time before accepting or rejecting returns.
James, Thomas and Herbert (2002).	Gate-keeping is the process of checking for product origin, identity and validity (warranty and guarantee entitlement such as returned products' expiry dates and ages). This is widely practised by Manufacturing organisations.
Lau et al. (2004), Lee (2002) and Bayles (2000).	Gate-keeping is the screening of defective and unwarranted returned products at the reverse logistics entry point. This helps the company to charge the customer a service fee for the returned product if applicable.
Meade and Sarkis (2002).	This is a process determining which products are to be allowed to enter the reverse logistics stream.
Bayles (2000).	Some merchants perform gate-keeping operations to check whether the returned products are in a specified form. For example, most software selling merchants perform gate-keeping of returns to check whether the packaging is unopened before accepting returns.
Roy (2003).	Gate-keeping is the first critical factor in making the entire process profitable and manageable and to stop all fraudulent returns at the entry point. To minimise unnecessary cost and work, returns are physically examined to verify and identify the product's defectiveness(s), warranty, the expiry date and the manufacturer.

2.9.4 *COLLECTION AND TRANSPORTATION* (d) - how returned goods are collected and transported.

TABLE 2.5:Collection and transportation of returned goods

Reference	Description/definition
Pohlen and Farris (1992) and Schwartz (2000).	Return collection is a process of accumulating returned products.
Bayles (2000).	Collection is the process of bringing returned products back from a retailer or a customer to the seller. This process is generally managed by intermediaries.
Amini and Retzlaff-Roberts (2003).	Customers use mail service to send back products. Most of the merchants recommend customers use a shipping company that can track packages, for example, FedEx, UPS and the U.S. Postal Service (USPS).
Tan, Yu and Arun (2003).	A third party service provider collects and transports returns.
De Koster, de Brito and Van de Vendel (2002) and Le Blanc, Fleuren and Krikke (2002).	Manufacturers provide retailers a returns collection and transport system by placing specially designed trailers at retailers' premises so they can load products to be returned. These trailers are transported and replaced by manufacturers at a predetermined time, such as twice a week.
Meade and Sarkis (2002).	The company or the customer bears the responsibility of the collection and transportation of unwanted products to the processing centre.

***COLLECTION AND TRANSPORTATION* (d) - how returned goods are collected and transported - continued**

Reference	Description/definition
James, Thomas and Herbert (2002), Hutchinson (2000) and Trebilcock (2002).	Consumers deliver products and packages at a large number of collection centres set up by manufacturers. For example, Sears has set up over 2,900 collecting locations and then transports returns to three central return handling centres. In addition, Return Store plans to establish approximately 2,000 collecting locations at over 4,000 locations in their "Return Valet" Program to aggregate their returns.
Krikke, Pappis, Tsoulfas, and Bloemhof-Ruwaard (2001).	Industrial Automation Control, a high value industrial goods producer initially despatch a service engineer to the defective product's location, examine the product and fix the problem. If the product or part is unrepairable it is then transported to the company.
Amini and Retzlaff-Roberts (2003).	Returns products collection and transportation processes is a convergent process compared to forward logistics in which products' flow is divergent. This is because transporters have to visit many destinations to collect returns and transport to a few return handling centres.
Ammons, Realff and Newton (1997). Le Blanc, Fleuren and Krikke (2002).	Costs incurred during the collection process represent from 25 per cent to 50 per cent of the total reverse logistics costs. Due to geographically dispersed collection centres an effective transportation solution is employed.

2.9.5 *INSPECTION* (e) - how returned goods are inspected

TABLE 2.6:Inspection of returned goods

Reference	Description/definition
Amini and Retzlaff-Roberts (2003) and Lonn and Stuart (2003).	Inspection is the process of examination and assessment of quality and condition of each return to identify defects and to determine the best method of product recovery and its destination with the aim of recovering maximum value.
Bayles (2000).	Inspection is done to identify whether customers have actually sent back a defective product.
Rogers and Tibben-Lembke (2001).	Individual customer's returns are inspected according to the customer's request while retailers' or distributors' returns are inspected in groups of returned products collectively for out of date, called back or other common defects.
Lau et al. (2004).	The technical assistance centre inspects the returned product for its problems and condition. Based on the results of inspection, the company decides whether to provide a replacement product to the customer for interim use or to return the recovered product back to the customer within an acceptable time period.
Krikke, Jacqueline and Wassenhove (2001) and Roy (2003).	Some products returned have only a few valuable parts, while other products have many valuable parts. It is hard to determine beforehand which parts are recoverable until the products are inspected, therefore products are inspected to determine whether there are reusable and/or the best recovery option applicable.
De Koster, De Brito and Van de Vendel (2002).	Inspections are conducted in a separate area so that returned products can be stored according to their condition, quality and age.

***INSPECTION* (e) - how returned goods are inspected - continued**

Reference	Description/definition
Krikke, Jacqueline and Wassenhove (2001).	A decentralised system for the inspection and separation of returned products is employed. This means that transportation of "junk" is minimised. Packages are inspected to verify if they have been opened and to ascertain if they have their original packaging.
Roy (2003).	Inspection of returned products is essential as the returns come from different places, in different conditions and for different purposes.
Krikke, Pappis, Tsoulfas, and Bloemhof-Ruwaard (2001).	Returns are inspected for selecting optimal recovery considering various aspects such as pollution generation, energy use, residual waste, production technology, secondary materials, by-products, ability to recycle, product complexity and its functionality.

2.9.6 *SELECTION* (f) - how returned goods are selected for recovery

TABLE 2.7:Selection of a recovery method

Reference	Description/definition
Fleischmann, Nunen and Grave (2002).	Selection is a process of deciding which parts are to be disassembled and the best recovery operation. This determines through which channel the recovery is sent and its method of dismantling. Time of dismantling is dependant upon current stock level and future demand level for the parts and the products.
James, Thomas and Herbert (2002).	New goods are given priority so they can be immediately sent back to the market to maximise value.
Kokkinaki et al. (1999), Amini and Retzlaff-Roberts (2003) and Roy (2003).	Selection is a process of categorising returned goods based on their quality. During this process a decision is made as to whether a given product or its part(s) could be reused, remanufactured, recycled or disposed.
Krikke, Pappis, Tsoulfas, and Bloemhof-Ruwaard (2001).	Selection is a complex operation based on the quality of the product, its usable parts and the recovery operation to be used. A decentralised selection system is suggested as a more effective way to avoid unnecessary transportation of “junk”.

***SELECTION* (f) - how returned goods are selected for recovery - continued**

Reference	Description / Definition
Trebilcock (2002).	Selection is a process where someone at the returns facility checks the products to identify the quality and condition of returns to select a method of recovery.
De Koster, de Brito, van de Vendel (2002).	Products are stored in separate areas according their condition, quality and age.
Le Blanc, Fleuren and Krikke (2002).	The key factors when considering the recovery process and the party to perform that process are the quality of the product and the level of its environmental impact.

2.9.7 *SORTING* (g) - how returned goods are sorted

TABLE 2.8:Sorting of returned goods

Reference	Description/definition
Meade and Sarkis (2002), Schwartz (2000) and Pohlen and Farris (1992).	Sorting is a process of organising returns based on what needs to be done with each return.
Amini and Retzlaff-Roberts (2003) and Roy (2003).	Sorting is a process of arranging the returns based on their product groups after opening, assessing, and checking the contents of each package against its attached papers or by additional physical inspection if papers are missing. Returns are then sent to the appropriate recovery area.
De Koster, De Brito and Van de Vendel (2002).	Sorting is performed in a separate area and is based on the type of product and its condition. Returns deemed to be "good as new" are sent back to the inventory of new products be sent to a different market.
Lonn and Stuart (2003).	Returned goods are sorted into high demand returns for fast resale and low-demand returns for discount sales.
James, Thomas and Herbert (2002).	New goods are given priority in sorting so they can be immediately sent back to the market so recovered value is maximised.

2.9.8 *REFUNDS AND REIMBURSEMENT* (h) - how refunds and reimbursement are performed

TABLE 2.9:Refunds for returned goods

Reference	Description / Definition
Davis, Hagerty, and Gerstner (1998).	The organisation's return policies allow consumers to return products and obtain a refund. Sometimes the organisation offers only a store credit for returns and not a cash refund.
Moorthy and Srinivasan (1995).	Organisations are bound to compensate customers for the returned product when the product fails to meet quality guarantees.
Australian Competition and Consumer Commission (2001).	The Australian Competition and Consumer Commission (ACCC) has legislated that if goods are damaged or not up to expected quality then a refund, exchange, credit note or repair of goods must be offered.

2.9.9 *REDISTRIBUTION* (i) - how returned goods are redistributed

TABLE 2.10:Redistribution of returned goods

Reference	Description/definition
Amini and Retzlaff-Roberts (2003).	Redistribution could be considered as a return recovery operation that involves very minimal work and changes to pass the product(s) back to the market. It is a process of distributing a high quality returned product to distribution centres for the purpose of redirection to another point of sale in the original market. On some occasions products have to be repackaged depending upon the condition of its original packaging. Normally these products have not been sold earlier.
Brito, Flapper and Dekker (2003).	Some returned products, in as new condition, are redistributed. This is done based on forecasted demand for each location with redistribution done on the basis of distributing between locations with excess products and those experiencing shortages.
Kokkinaki et al. (2001b).	Redistribution refers to the selling of returned products through new distribution centres and channels. Redistribution is an activity that is performed to introduce returns back to the marketplace or transfer to a customer. The majority of redistributed returns are used for their original purpose.

2.9.10 *RESELLING* (j) - how returned goods are resold

TABLE 2.11:Resale of returned goods

Reference	Description/definition
Bayles (2000).	The process of reselling returns as new and for its original purpose. Resale also refers to the sale of returned goods to new buyers in the same or different market.
Amini and Retzlaff-Roberts (2003).	A product is returned after it is sold and is resold as new in the original or a different market. A moderate amount of repackaging could be undertaken.
Kokkinaki et al. (2001b) and Kokkinaki et al. (2001a).	A process of repetitive changes of ownership of a product where the product performs its original functionality. It can sometimes be the first use of the product.
Brito, Fapper and Dekker (2003).	Law in USA prohibits resale of a previously sold product as new.

2.9.11 *REUSE* (k) - how returned goods are reused.

TABLE 2.12:Reuse of returned goods

Reference	Description/definition
Amini and Retzlaff-Roberts (2003) and Bayles (2000).	Reuse is a process of redirecting returned product(s) or packaging to another consumer for use. A moderate amount of changes and/or repackaging of returns may be done before it is sent for reuse.
Kokkinaki et al. (2001a).	Returns are reused, according to their original functionality, without modification if the products are in a good operating condition.
Brito, Fapper and Dekker (2003).	Customers return products to the retailer or distributor at the end of a lease or contract and the product is reused for the original or similar purpose without change.
Kokkinaki et al. (2001b).	Reuse is the process of changing ownership of a product where the new customer uses it for the same purpose.
Kokkinaki et al. (1999) and Meade and Sarkis (2002).	Reuse is an operation by which good quality used products are directed to use again almost immediately in the same or an alternative market with a little or no changes to the product except for repackaging.
Rahman (2003).	Reuse is an important reverse logistics process enabling recapture of significant financial value.
Ritche et al. (2000).	Automotive parts returned from dealers are reused for similar purposes.

2.9.12 *DONATION* (l) - how returned goods are donated

TABLE 2.13:Donation of returned goods

Reference	Description/definition
Rogers and Tibben-Lembke (2002).	Donation is a process of the free offering of obsolete, used or unused returns which are still usable to obtain tax advantages for the company.
Rogers and Tibben-Lembke (1998) and Roy (2003).	Nike donates used shoes which are shipped back by customers to make basketball courts and running tracks. They also donate funds to help build and maintain those courts. By doing this, the value of its brand is enhanced and people are encouraged to purchase their products.
Amini and Retzlaff-Roberts (2003) and Tibben-Lembke (2002).	Lower quality return products are donated to charity. The warranty is generally voided.

2.9.13 *UPGRADE* (m) - how returned goods are upgraded

TABLE 2.14:Upgrade of returned goods

Reference	Description/definition
Autry, Daugherty and Richey (2001) and Rogers and Tibben-Lembke (2001).	Upgrade is the process of changing a product's configuration or technical specification to a higher level. Generally this happens when a product does not have the capability to perform additional tasks of a new version. This is usually done at the customer's request.
Bayles (2000) and Roy (2003).	The upgrade involves cleaning and reconfiguration of returns into "like new" state to perform more advanced tasks when compared to its previous operation.
Fleischmann, Nunen and Grave (2002).	The upgrading is performed to recapture maximum value of the returns. It is considered to be the major value-adding activity in the dismantling channel.
Bayles (2000) and Fleischmann, Nunen and Grave (2002).	The upgrade requires the least amount of effort when compared to the remanufacture of returns.

2.9.14 *REPAIR* (n) - how returned goods are repaired

TABLE 2.15:Repair of returned goods

Reference	Description/definition
Lau et al. (2004).	Repair is a process that reinstates a defective return into its original or similar operating condition. This could extend the duration of product life cycle and improve product failure rates.
Bayles (2000).	Repair is a process which converts the defective return into a like new state. During this process returns are checked and made fit for proper operating. Repairs involve comparatively higher work than an upgrade but need a lesser amount of effort when compared to remanufacture.
De Koster, De Brito and Van de Vendel (2002).	Repairing defective returns is a process that includes checking returns for defects, fixing, repacking and labelling.
Fleischmann, Nunen and Grave (2002).	Repairing of defects is a very important and common operation in reverse logistics management in the closed loop supply chain.
Amini and Retzlaff-Roberts (2003).	Repair is a process of restoring the used product's utility and returning it to its original functionality by the replacement of worn parts.
Autry, Daugherty and Richey (2001) and Brito, Fapper and Dekker (2003).	Repairing is a process that restores malfunctioning products to their original functionality by installing new parts or components depending on their condition.
Fleischmann, Nunen and Grave (2002) and Kokkinaki et al. (1999).	Products have a predetermined repair schedule set at the time of sale. After repair the product is used again for the same purpose by the same customer.

2.9.15 *REFURBISHMENT* (o) – how modules of goods are refurbished

TABLE 2.16:Refurbishment of returned goods (module recovery)

Reference	Description/definition
Roy (2003) and Thierry et al. (1995).	Refurbishment is the process of extracting valuable modules from returns, which could be used again after some modifications or improvements. All valuable modules of returns are extracted and used to produce new products or to upgrade or repair another product. Generally these returned products are not suitable for upgrade or repair due to their condition. For this reason they are not selected for any of the above product recovery operations.
Bayles (2000).	Refurbishment is the process of dismantling used equipment to extract valuable modules which have a much longer economic and technical lifecycle than the product as a whole. Extracting modules is a relatively quick and low cost operation.
Fleischmann, Nunen and Grave (2002).	Refurbishment is the large-scale process of recapturing valuable modules from returns.

2.9.16 *REMANUFACTURE* (p) - how components of goods are remanufactured

TABLE 2.17:Remanufacture of returned goods (component recovery)

Reference	Description/definition
Thierry et al. (1995).	Remanufacturing is the process of removing valuable components from returned goods, which are then used to remanufacture products.
Kokkinaki et al. (2001b).	Remanufactured components are used to manufacture the same or different products.
Fleischmann, Nunen and Grave (2002).	There are two kinds of remanufacturing techniques involving “pull” and ”push” dismantling. The “pull” technique allows the building up of dismantled parts stock from which components are taken and tested, remanufactured and used at the required time. In the “push” technique components are dismantled, tested and remanufactured as soon as possible and then added directly to serviceable stock.
Rahman (2003).	A value adding, rather than material recovery, process of disassembling returns into their constituent components.
Bayles (2000).	The series of steps necessary to convert the components of returns into a usable product.
Lau et al. (2004) and Meade and Sarkis (2002).	Remanufacturing to extend the components’ and product’s life cycles while diminishing the risk of product failure rate.
Krikke, Pappis and Tsoulfas et al. (2001).	This form of remanufacturing involves more extensive work when compared to refurbishment and greater effort when compared to repair, which involves the least.

2.9.17 *RETRIEVAL* (q) - how parts of goods are retrieved

TABLE 2.18:Retrieval of returned goods (part recovery)

Reference	Description/definition
Brito, Fapper and Dekker (2003) and Thierry et al. (1995).	Retrieval is a process of recovering selected parts from returns.
Bayles (2000).	During this process a restricted set of reusable parts are recovered from used products. When a returned product does not fit into any of the above recovery operations its remaining useful parts are recovered.
Kokkinaki et al. (2001b) and Sarkis, Meade and Talluri (2004).	The remanufactured parts are used to repair or upgrade other products or to manufacture a new product.
Fleischmann, Nunen and Grave (2002).	Well functioning parts of returned products are retrieved, even if the performance of these products is unacceptable.

2.9.18 *RECYCLING* (r) - how materials of goods are recycled

TABLE 2.19:Recycling of returned goods (material recovery)

Reference	Description/definition
Amini and Retzlaff-Roberts (2003), Bayles (2000) and James, Thomas and Herbert (2002).	Recycling is a process of converting a return into its basic materials for reuse. The return is dismantled into its parts and components and then grouped into basic material types to be used to in the manufacture of other products.
Meade and Sarkis (2002).	This is a process where returned products are recycled into basic materials and entered into the material lifecycle chain to become inputs as raw material to produce new products.
Fleischmann, Nunen and Grave (2002) and Thierry et al. (1995).	Returned products are dismantled and sorted into basic material types and, according to quality standards, become inputs as raw material to produce new products.
Krikke, Jacqueline and Wassenhove (2001).	Recycling is a process that converts waste into its basic raw material.
Kokkinaki et al. (2001b).	Recycling of waste computers recovers gold, copper, fibreglass, silver, steel and plastic.
Roy (2003) and Rahman (2003).	Recycling is considered the most common recovery in reverse logistics.

2.9.19 *HAZARDOUS WASTE MANAGEMENT* (s) - how hazards materials of goods are managed

TABLE 2.20:Hazardous waste management (environment recovery)

Reference	Description/definition
Chopra, Reinhart and Abu-Al-Shaar (2001).	A process that prevents and removes dangerous solid waste materials from returned goods. A classification system for waste materials is used in order to determine the degree of the hazard and the required handling and treatment processes.
Kokkinaki et al. (2001b) and Europa (2000).	Personal computers are ranked by the Environmental Protection Agency as the fastest-growing category of solid waste as they contain materials hazardous to the environment. These include lead, cadmium, mercury and other heavy metals. They pose a direct environmental threat if the computer is disposed in a landfill rather than an appropriate hazard waste management program.

2.9.20 *INCINERATION* (t) - how goods are incinerated

TABLE 2.21:Incineration of returned goods (energy recovery)

Reference	Description/definition
Brito, Fapper and Dekker (2003) and Le Blanc, Fleuren and Krikke (2002).	Anything remaining from recovery and other processing operations are incinerated some times to generate energy or for environmental protection.

2.9.21 *LANDFILL* (u) - how goods are land filled

TABLE 2.22:Landfill of returned goods (environment recovery)

Reference	Description/definition
Fleischmann, Nunen and Grave (2002) and Thierry et al. (1995).	Anything remaining from recovery and other processing operations are used for land fill.
Amini and Retzlaff-Roberts (2003).	Most organisations realise that landfill is expensive due to high waste transportation cost and landfill fees.
Bayles (2000).	Government bodies could use solid waste for landfill to control the environment.

2.10 A model of reverse logistics process – (Process Model)

It is important to understand the nature and purpose of the individual processes of reverse logistics to establish logistics and information management requirements. The reverse logistics processes were logically and systematically put together in Figure 2.1 to establish reverse logistics operations. However, the processes included in this model are identified from literature relevant to the manufacturing industry. Continuous line arrows in Figure 2.1 indicate the reverse logistics processes from managing returned goods, the flow of the returned goods to relevant recovery processes and then to processes for recovering value from the returned goods. Broken line arrow shows the possibility of sold goods being returned which would follow the product return process.

FIGURE 2.1 A model of the reverse logistics process

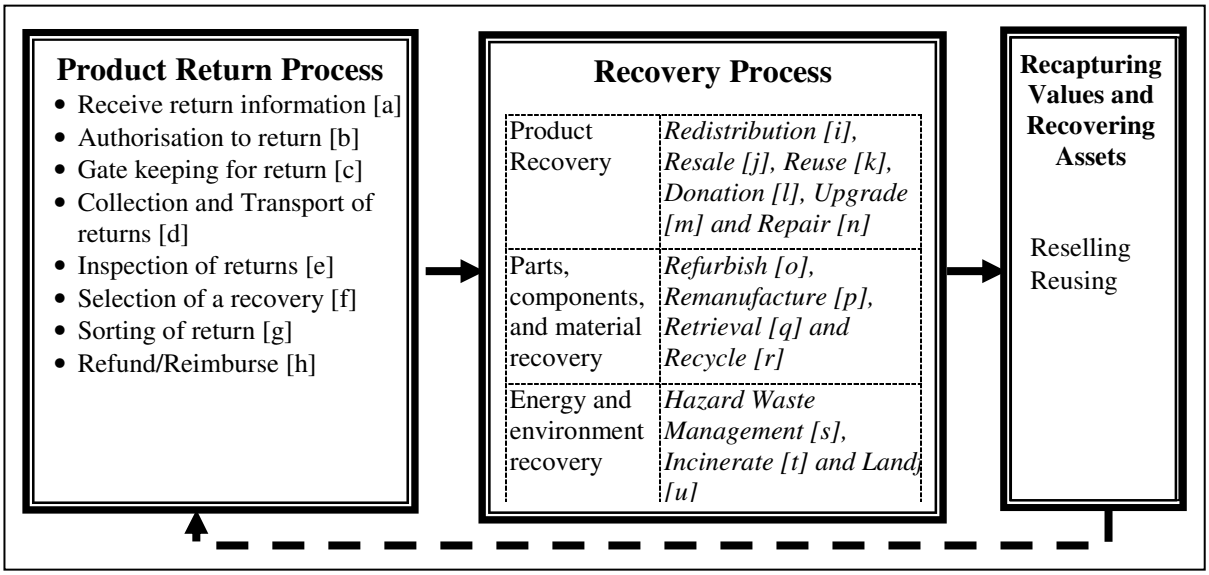


Figure 2.1 shows the flow of returned goods that commences at point [a] and flows to [h]. From [h] the returned goods flow to one or more points of [i], [j], [k], [l], [m], [n], [o], [p], [q], [r], [s], [t] and [u], according to recovery decisions made in the first eight operations [a, b, c, d, e, f, g and h]. The recovered products, parts, components, and materials at the end of each recovery process are then resold or reused to recapture assets and value.

Figure 2.1 is useful to understand the flow of products and pertinent recovery processes in reverse logistics.

Reverse logistics like any other business application faces problems and challenges which are discussed in the following section.

2.11 Problems and challenges

Some problems identified from literature are:.

2.11.1 Poor management of outsourced services

Many companies depend on third parties for reverse logistics operations (Cottrill 2000; Mukhopadhyay & Setaputra 2006; Zhao 2001). Anecdotal evidence shows that, in the Australian E-Business, returns are handled by Australia Post and other delivering companies. Krumwiede and Sheu (2002) emphasise that a lack of guidelines and collaborative information sharing between organisations and intermediaries affect reverse logistics solution. As a result, returns become invisible and are not recorded in the organisation's information system which means they are not considered for potential reuse until the product physically arrives at the premises (Zhao 2001). This negatively affects business as it makes it difficult for operations managers to schedule re-work on returned goods (Daugherty, Myers & Richey 2002; Richey et al. 2004; Zhao 2001). On the other hand, it is not always easy for an organisation to predict the exact amount of returned goods at any one time (Carella, Murino & Santillo 2002). For example, historical data from Caterpillar, a heavy machine manufacturer, shows that returned goods from dealers account for up to 3 per cent of the its total inventory. There is a long return management interval (2 - 3 months on average from the time a dealer decides to return the parts until the parts are on the shelf again in the manufacturer's inventory) and during this time the returned parts are not registered on their information system. With no record of the returned goods they cannot be fully utilised for resale, reuse, or repair. At the same time, the returned product handling cost in this period, such as holding and lost opportunity, is borne by the manufacturer (Zhao 2001). Therefore poor coordination between partners and intermediaries is a problem in the management of returned goods.

2.11.2 Lack of importance

Reverse logistics has not been given the same importance as other business processes due to a lack of understanding by organisations about the benefits of managing returns (Morrell 2001; Rogers & Tibben-Lembke 1998). This lack of understanding often results in companies not providing the necessary resources to operate a proper functioning reverse logistics system (Rogers et al. 2003). Some company managers are also reluctant to use their information management systems for returns (Tan, Yu & Arun 2003). Rogers and Tibben-Lembke (1998) are of the opinion that many Manufacturing organisations have under estimated the benefits of reverse logistics management. This view is supported by Spiegel (2000) who suggests that Manufacturing organisations missed significant opportunities due to the lack of technologically advanced and integrated logistics operations for both reverse and forward logistics. Andel (1997) and Mukhopadhyay and Setaputra (2006) also support the view that companies that ignore reverse logistics miss tremendous profit making opportunities.

2.11.3 Scheduling recovery and Uncertainty

Decision making in reverse logistics management operates in a highly uncertain environment (Guide 2000; Inderfurth 2005; Thierry 1997). Therefore, scheduling reverse logistics operations and the recovery of returned goods are more difficult when it is hard to predict the exact amount of material in a certain collection centre (Carella, Murino & Santillo 2002). This is further supported by other researchers (Inderfurth 2005; Kokkinaki et al. 2001b; Srivastava & Srivastava 2006), who state that there is a challenge to be faced when processing returns that stem from unpredictability in time, quality, volume, configuration and place of origin of returns.

2.11.4 Short life spans and speed of recovery

Fleischmann, Nunen and Grave (2002) report that delays in receiving returned goods can limit the reusability of products, particularly those with short life cycles. Smith (2005) stated that the product life cycle is one of the oldest concepts in the management of reverse logistics. Returned products with short lifecycles, such as electronic products, machines and equipment should be processed quickly in order to retrieve value from

them before depreciated (Fleischmann, Nunen & Grave 2002; Rogers et al. 2003). As goods with a limited life span have high depreciation rates timely management of returns is important (Dekker & De Brito 2002). With expanding market volumes and short product lifecycles it is even more important to minimise the time returned products are in the reverse logistics chain to identify those that need disposal (Fleischmann, Nunen & Grave).

2.11.5 Lack of technology support for information management

An efficient reverse logistics management system which provides information online could enhance reverse logistics management (Sarkis, Meade & Talluri 2004; Smith & Offodile 2002; Smith 2005). Smith (2005) suggests that appropriate technology must be installed to support reverse logistics processes in an environment where reverse logistics management is recognised as a valued-added operation. However, earlier research (Rogers & Tibben-Lembke 1998) highlights that, although organisations use different types of technologies to capture reverse logistics information, there is no dedicated software or system supporting reverse logistics management. Several authors (Caldwell 1999; Grommesh 1991; McNeill 1991; Nagel & Meyer 1999) repeat the contention that commercial software specifically designed for supporting reverse logistics is not available. Nagel and Meyer (1999) and Zhao (2001) state that a lack of information management is a problem which makes the management of recycling systems difficult, leading to substantial loss in profits by companies. Spiegel (2000) identifies that most businesses lose 70 per cent of their time due to a lack of technological competence and the inability to automatically integrate all aspects of logistics operations, including reverse logistics. Lee (2002) reports that without an effective information system it is difficult to identify the accuracy of returned materials at the point of entry into the reverse logistics channel.

2.12 Importance of Information Management for reverse logistics

For modern day businesses, logistics information management is crucial because of the large amount of goods they deal with and the need to deliver customers' goods accurately and efficiently (Azevedo, Ferreira & Leitao 2007; Bourlakis & Bourlakis 2006; Lai, Ngai & Cheng 2005; Piplani, Pokharel & Tan 2004).

Efficiency in managing the reverse logistics process can be achieved in two ways, one is by reducing the actual time required to process returns (Carella et al 2002) and by eliminating the queuing and wasting time these goods spend in the process. The first can be achieved through improved reverse logistics operational efficiencies and the second, by eliminating idle time, which can be accomplished with timely availability of information (Lee 2002; Nagel & Meyer 1999; Sarkis, Meade & Talluri 2004; Sohal, Power & Terziovski 2002; Spiegel 2000; Zhao 2001).

Information management requirements for reverse logistics are:

2.12.1 Forecasting returns

A lack of effective information management impedes company's ability to forecast, conduct product improvement or process modification and gain value from returns (Bayles 2001). Smith (2005) is also of the opinion that appropriate reverse logistics information system can aid companies minimise volume of returned goods and forecast future returns.

2.12.2 Tracking and tracing returned products

The use of information technology which enables tracking and tracing of returns, have enabled partners and intermediaries to accurately locate their consignment anywhere in the world using a global positioning satellite network (Mason, Potter & Lalwani 2002; Murr 2002). In virtual reverse logistics networks, information flows actually precede the flow of returned goods and they can be used to diminish uncertainty about the configuration, condition and place of origin of returns thus enabling better planning and control for the remaining operations in the reverse logistics system (Smith 2003a, 2003b; Smith & Offodile 2002).

2.12.3 Loss minimisation

When a company receives goods back from customers or partners they need to minimise the magnitude of loss. For example, a product recall needs to be carefully managed in order to protect company image, goodwill and customer trust and to minimise time, cost, and resource damage (Dekker & De Brito 2002). Quick retrieval of information through the use of an information management system can help identify

productivity improvement opportunities (Smith 2005). It is suggested that a good reverse logistics system improves the corporate bottom line (Rogers et al. 2003), customer trust and confidence (Daugherty, Autry & Ellinger 2001) and contribute to a sustainable and competitive business environment (Beamon 1999; Smith 2005). Application of information technologies to reverse logistics management benefit organisations (Smith 2005).

2.13 Research gaps

It is evident from the literature review, that reverse logistics as a business process has a large number of issues to address. The available literature is relatively generic and related to the Manufacturing industry. However, it is known that both Manufacturing and E-Business organisations encounter a large amount of returned goods for a variety of reasons.

From the literature data suggests that the Manufacturing industries returns are due to damage, seasonal inventory, restock, salvage, recalls, warranty, service and excess inventory (Brito, Flapper & Dekker 2003; Dekker & De Brito 2002) however, there is a lack of literature on why E-Business industry receive an increased volume of returns.

Although Daugherty and Richey (2001) and Morrell (2001) emphasised a lack of research on reverse logistics, from the extant literature it is apparent that there are no Australian studies addressing reverse logistics. Also investigation of products return policies of organisations in the Australian Manufacturing and E-Business industries clearly shows that customers are allowed to return the goods. It shows that managing returned goods is a requirement for organisations in the Australian Manufacturing and E-Business industries to remain sustainable and win orders in the international context.

The available literature highlights the importance of reverse logistics and identifies several issues (reasons, benefits, challenges and barriers to manage returns) and operations associated with product return and value recovery processes. It also emphasises is placed on the need for information management in reverse logistics.

However, as mentioned earlier the review of literature discussed above is from countries other than Australia. Thus it is important:

1. To investigate critical reverse logistics issues associated with management of returned products in the Australian Manufacturing and E-Business industries.

2. To investigate vital information and logistics management operations in reverse logistics management in the Australian Manufacturing and E-Business industries.

3. To investigate information management issues associated with reverse logistics in both the Australian Manufacturing and E-Business industries.

To accomplish the above research objectives the following six research questions (Q1, Q2, Q3, Q4, Q5 and Q6) are posed. The sixth question is applicable to the E-Business industry only:

Q1. Why have Manufacturing and E-Business industries implemented reverse logistics?

Q2. What are the logistics and information management operations in facilitating handling of the returned goods in Manufacturing and E-Business industries?

Q3. What recovery operations are performed on returned goods to capture value in Manufacturing and E-Business industries?

Q4. What are the barriers to reverse logistics management in Manufacturing and E-Business industries?

Q5. *Q5a* - What information technologies are used to manage reverse logistics information?

Q5b - How can reverse logistics management be improved with electronic information management?

Q6. Why does the E-Business industry receive an increased amount of returns?

As there are no previous studies on reverse logistics management in the Australian industries, a preliminary study was undertaken to identify some pertinent reverse logistics issues. The findings of the preliminary study is discussed in Chapter Four.

2.14 Conclusion

This chapter summarises a review of literature undertaken on the management of reverse logistics. It established reasons for reverse logistics management, product return operations, value recovery operations, barriers and information management requirements.

A comprehensive process model (Figure 2.1) representing the reverse logistics process was developed to show the relationship between processes within reverse logistics and information flow.

Based on the gaps in the reviewed literature five research questions are posed to investigate reverse logistics management issues in the Australian Manufacturing and E-Business industries. The first five questions (Q1, Q2, Q3, Q4 and Q5) are common for both the industries while the sixth question (Q6) is specific to the E-Business industry.

The research methodology used to accomplish answers to the above questions is explained in the next chapter.

Chapter 3

RESEARCH APPROACH AND METHODOLOGY

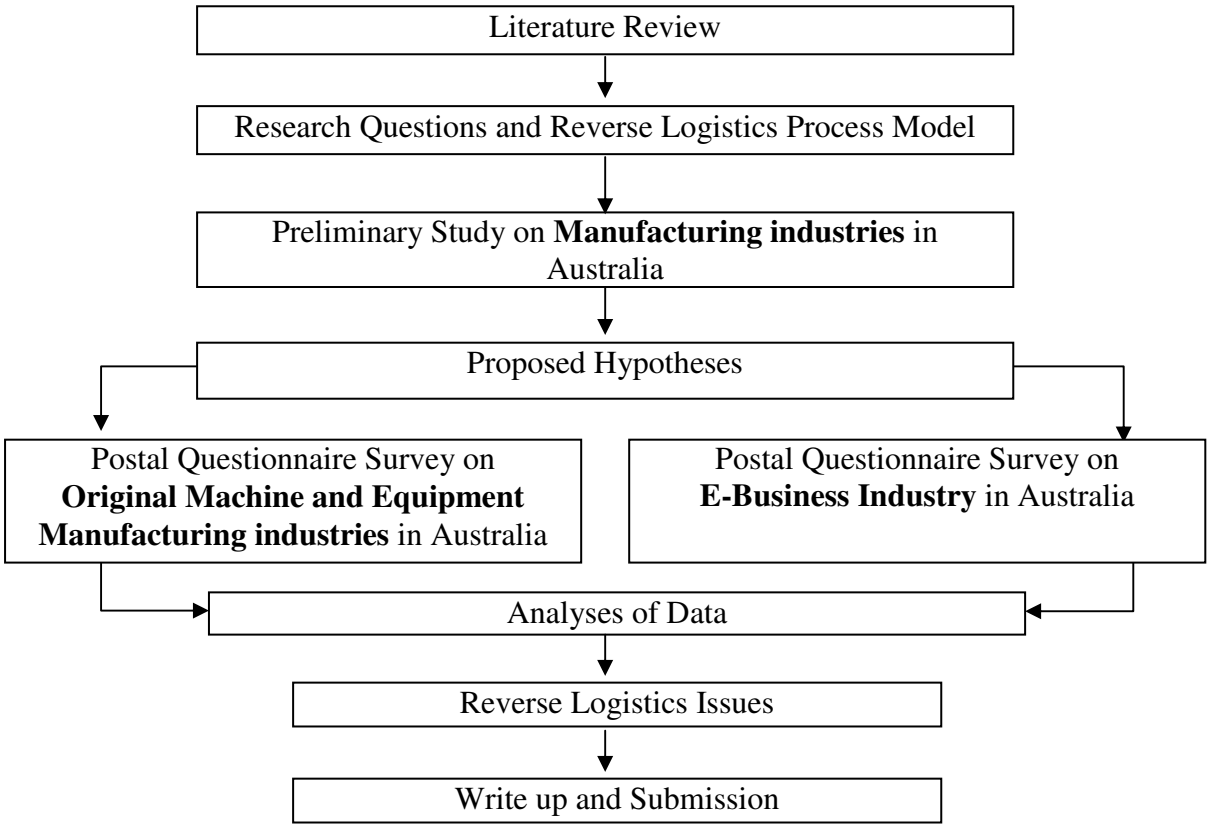
3.0 Introduction

This chapter describes the research method, approach and philosophy used to undertake this research. It describes how the hypotheses were developed, the data collection, collation and analysis techniques used.

This study consisted of a number of research processes starting with a review of literature. At the end of the literature review, research objectives, questions and a conceptual process model for reverse logistics management were developed. Initially a preliminary study was undertaken with the Australian Manufacturing industries to establish the status of reverse logistics in Australia. Based on the review of literature and the outcomes of this preliminary study five hypotheses were proposed to test their validity in Manufacturing and E-Business industries. Two postal questionnaire surveys were conducted with the Original Machinery and Equipment Manufacturing (OM & EM) industries and the E-Business industry.

Data from the surveys on OM & EM and E-Business organisations was then analysed to identify reverse logistics issues and test the validity of the hypotheses. Based on the findings generic and industry specific reverse logistics issues in Manufacturing and E-Business industries were determined. The research process used to accomplish this study is illustrated in Figure 3.1.

FIGURE 3.1 Research process



3.1 Research design

This is an empirical study that entails exploratory research. Exploratory research was undertaken to establish information and logistics management issues associated with the management of returned products in the Australian Manufacturing and E-Business industries. This approach was based on Saunders, Lewis and Thornhill (2003) and Cavana et al.'s (2001) opinions that exploratory methods are useful for exploring issues that are not investigated.

Since reverse logistics in Australia was not investigated before, a preliminary study was undertaken to establish the status of reverse logistics issues in Australia. Based on the review of literature and the findings of the preliminary study five hypotheses were formulated. A more detailed research was then undertaken to establish information and

logistics management issues in the Australian Original Machine and Equipment Manufacturing (OM & EM) and E-Business industries.

This research was underpinned by the positivist philosophy and a deductive approach to establish reverse logistics issues. This is based on Collis and Hussey's (2003) point of view that positivist philosophy enables deductive inferences about a population from which a statistical sample is drawn to collect quantifiable data which is tested for a number of hypotheses. Blaikie (2003) is also of the opinion that the deductive approach is suitable for hypothesis testing.

Based on Collis and Hussey's (2003) suggestion that postal questionnaire surveys are useful in collecting data from a large number of organisations scattered over a larger geographical area, postal questionnaire survey method was employed to collect data from organisations around Australia. Saunders, Lewis and Thornhill (2003) confirm that postal questionnaire surveys are a commonly used research strategy to collect large quantities of data quickly, economically and conveniently from a sizable sample in a large geographical area. Zikmund (2003) suggests that self-administrated questionnaires eliminate interviewer bias.

In order to minimise disadvantages of postal questionnaires such as quality of responses and sampling errors (Zikmund), guidelines based on the work of Alreck and Settle (1995), Blaikie (2003), Cavana et al. (2001) and Sekaran (2003) were followed. These are:

(1) An appropriate sample size and technique were selected for the surveys to represent the population that the research was intended to study.

(2) The survey instruments were revised and improved many times with the principal supervisor to ensure the appropriate wording, scales, format, content and sequence of the questions. Three pilot studies were carried out to assess understandability and content validity of the three survey instruments and subsequent improvements made prior to survey distribution.

(3) The surveys were administrated with a two contact strategy. First, a covering letter introducing the researcher, the objectives of the research and the importance of the study was sent with the questionnaire and a prepaid envelope. A reminder letter was sent two weeks after the first contact. A second copy of the survey was sent to those respondents who requested one.

(4) Survey documents were printed on light green colour paper so they would be easily distinguished from other documents at the respondents' end.

(5) The participants were assured of their anonymity and the privacy of data to improve their trust in the process and to expedite their response. Participants were also advised that the aggregated findings from this research would be made available to them if they required it.

(6) As reverse logistics management is not a well known concept (Morrell 2001), the survey was sent to Manufacturing managers in Manufacturing organisations and operations managers in E-Business organisations. However, it was understood that if the manufacturing or operations manager were not involved in the reverse logistics the incumbent would pass it on the person responsible.

This research collected data from the population samples at a single point in time. This study collected categorical data about reverse logistics issues such as reasons, product return operations, value recovery operations, barriers and information technologies, from Manufacturing and E-Business organisations in the form of 'yes' and 'no'. The data was converted into a numerical form for quantitative analysis using statistical tests to understand the issues.

Population, sample size, strategy and sources of industry information

Table 3.1 presents details of population, sample size, sampling method and sources of industry information from which samples were drawn.

TABLE 3.1:Population, sample size, sampling method and industry information

Study on	Population	Sample size	Sampling method	Sources of industry information
Manufacturing industries	Australian Manufacturing organisations	210 (out of 4000)	Stratified random sampling	Industry Search, http://www.industrysearch.com.au, November 2004.
Original Machinery and Equipment Manufacturing industries	Australian Original Machinery and Equipment Manufacturing (OM & EM) organisations	310 (out of 1800)	Random sampling	The Business Who's Who of Australia, http://bww.dnb.com.au and IBIS World of Australia, http://www.ibisworld.com.au, June 2005.
E-Business industry	Australian E-Business organisations	310 (out of 1000)	Random sampling	The Business Who's Who of Australia,http://bww.dnb.com.au, IBIS World of Australia, http://www.ibisworld.com.au and Australian online shopping directory, http://www.shopsafe.com.au, October 2005.

An initial sample, based on a stratified random sampling technique, of 210 Manufacturing organisations were selected from Australian Industry Search: a business directory that provides a list of organisations in all industries. A stratified random sampling technique was used to select organisations because the sample needed to be a consistent, proportional representation of all Manufacturing industries (Blaikie 2003). Australian Manufacturing organisations were selected because of the importance of reverse logistics management in Manufacturing industries (Fleischmann, Nunen & Grave 2002; Rogers & Tibben-Lembke 1998; Roy 2003; Trebilcock 2002). This was a preliminary study to establish relevant reverse logistics issues in Australia. The Australian and New Zealand Standard Industrial Classification (ANZSIC) http://www.abs.gov.au/ausstats was also used to identify Manufacturing organisations for this survey.

The second study was with the OM & EM industries. A sample of 310 OM & EM organisations, using a random sampling technique, were selected from two Australian national business directories Business Who's Who of Australia and IBIS World of

Australia. Australian OM & EM organisations were selected for analysis based on the findings (Sections 4.4.1 to 4.4.4, Pages 75 to 78) from the preliminary survey of Australian Manufacturing industries. As this study was designed to establish reverse logistics issues, organisations with more than AUD $1 million of annual income were selected based on the assumption that for large organisation over AUS$ 1 million is the threshold as these were more likely to have implemented reverse logistics.

The third study was with a sample of 310 E-Business organisations, using a random sampling technique; randomly drawing numbers that uniquely assigned to represent each organisations. These were selected from three national business directories: Business Who's Who of Australia, IBIS World of Australia and Australian online shopping. Australian E-Business organisations were selected based on literature discussed in Chapter Two that from e-business sales there is an increased amount of returns. The selected organisations were checked to ensure that they dealt with products, not services, and that their websites incorporated a transaction facility.

None of the organisations were selected for more than one survey.

Sample size

The sample sizes were selected based on suggestions by Alreck and Settle (1995) and Cavana et al. (2001) who provide a list of sample sizes suitable for different ranges of populations and levels of expected confidence. The population size was identified from the Australian national business directories listed in Table 3.1 (Industry Search of Australia, The Business Who's Who of Australia, IBIS World of Australia, and Australian online shopping directory).

Accordingly, a sample of 210 organisations was selected for the preliminary study on the Australian Manufacturing industries and 310 organisations for the surveys on the Australian OM & EM and E-Business industries. These sample sizes represent a 95 per cent confidence as suggested by Alreck and Settle (1995). The sample sizes were considered appropriate based on Sekeran's (2003) view that sample sizes larger than 30 and less than 500 are appropriate to satisfy most quantitative research requirements for accuracy, validity and repeatability of the ranges in the wider cluster.

3.2 Survey instruments

This section provides the details of the three survey instruments used in this research.

Survey of the Manufacturing industries

Initially a postal questionnaire survey utilising structured questions as well as open-ended questions was used as the data collection tool. The survey instrument was developed using Microsoft Word. The survey questionnaire (Appendix A) consisted of six pages. The questionnaire comprised four sections. The four sections, with their title and purpose, are shown in Table 3.2.

TABLE 3.2:Structure of the survey instrument for the Manufacturing industries

Part	Title	Purpose
A	Organisation profile and introduction	To understand the organisation background and the role of the respondents
B	Reverse logistics in the organisation	To establish reverse logistics issues and types of products returned
C	Operations and implementation	To establish product returning processes and methods of value recovery from the returned goods
D	Use of technologies	To understand information technologies used for information management and to establish the impact of information on benefits of reverse logistics and barriers

The purpose of section A was to understand the organisation's background and the role the respondent played in managing reverse logistics. Questions in this section were simple and intended to make the respondent feel confident in filling out the survey. Section A comprised of seven questions presented in categorical scales to understand background of the organisation.

In section B, participants were requested to identify whether they managed reverse logistics. If they did not they were requested to send back the questionnaire. If they did they were requested to complete the questionnaire and send it back. It was intended to establish reverse logistics issues and the types of products managed in the process. Section B comprised of five questions. Three questions were presented in categorical scales to identify experience in reverse logistics management. Other two questions investigating types of goods returned provided with blank spaces for free text answers to capture information of returned goods.

Section C established product returning and value recovery processes for the returned good. Seven product returning and twelve value recovery operations identified from literature were included in the survey instrument. Section C comprised of two questions and they were presented in categorical scales to explore information as applicable to respondents' product returning and value recovery processes.

Section D collected data to identify information technologies used to support reverse logistics data management and the impact of this data on reverse logistics processes. A list of fourteen information technologies was included in the questionnaire. Separate questions were included to establish the reasons and barriers for reverse logistics management. Section D comprised of six questions. Three of these questions addressed information management issues and were presented in categorical scales. Other three questions addressing reasons and benefits of reverse logistics were blank spaces for answers to understand reasons and benefits of reverse logistics.

The respondents were requested to select one or more answers from categorical scales such as "yes" or "no". Some questions also provided a blank space for free text answers. A numerical scale with a rating list ranging from one (for extremely low use) to seven (for extremely high use) was used in section D to collect data on information technologies and their impact on reverse logistics. At the end of section D, open-ended questions were included to obtain reasons and benefits of reverse logistics management. Finally, participants were requested to provide consent and contact details if they agreed to participate in any further research or if they wished to receive a report.

Survey of OM & EM and E-Business industries

The survey instruments used for data collection from OM & EM (Appendix D) and E-Business (Appendix H) industries also comprised of four sections and are presented in Table 3.3.

TABLE 3.3:Structure of survey instruments for OM & EM and E-Business industries.

Part	Title	Purpose
1	Organisation profile and introduction	To understand the organisation background and the role of the respondents
2	Reverse logistics in the organisation	To establish reverse logistics management, types of products returned, sales strategies, and reasons for E-Business returns.
3	Operations and implementation	To establish reasons and barriers for reverse logistics management, reverse logistics and value recovery processes, parties performing the processes.
4	Use of technologies	To understand information technologies used for information management and the impact of information technology on reverse logistics operations.

Based on the experience of the previous survey the following changes were incorporated into the survey instruments used on OM & EM and E-Business industries to improve responses.

Since the response to the opened-ended questions in the preliminary survey was low, structured questions were used to establish reasons (question 3.1), barriers (question 3.2), and benefits (question 4.4) of reverse logistics. A set of four questions was added (questions 4.2.1 to 4.2.4) to understand the limitations of reverse logistics information systems and the barriers to reverse logistics data management.

Questions on reverse logistics operations (question 3.3) and value recovery operations (question 3.4) were modified based on the outcome of the preliminary study.

Question 2.7 was added to establish the reasons why E-Business customers return goods and the volume of returns.

3.3 Pilot study and ethics approval

The preliminary survey questionnaire on the Manufacturing industries was pilot tested with 38 research students at RMIT University. The participants were requested to assess understandability and content validity of the items and comment on intelligibility and

meanings of the instructions, questions and its scales. Based on the 19 responses received the questionnaire was revised and modified to eliminate identified ambiguities and improve clarity.

Due to changes in the instrument for OM & EM industries, the questionnaire was pilot tested with 12 postgraduate students at RMIT University. Based on the nine responses received the questionnaire was modified to eliminate the few ambiguities identified from this pilot study.

Similarly, the questionnaire for E-Business industry was pilot tested with another nine postgraduate students at RMIT University. Based on the three responses received the questionnaire was modified to improve quality of response.

Separate pilot studies were carried out on each survey instrument in order to collect informal responses by asking respondents to write their comments on the questionnaire. These responses were incorporated in the main questionnaires.

Ethics approval was obtained from the RMIT Business Research Ethics Committee prior to conducting the surveys.

3.4 Data collection

This section explains the process of data collection from Manufacturing, OM & EM and E-Business industries.

A telephone survey was considered as an option to encourage participants to respond to the survey. Although this may have produced a better response rate it was not pursued because it is a highly time consuming task and it is very difficult to get Manufacturing managers to the telephone.

3.5 Responses

Table 3.4 presents the survey, number sent, responses received and percentage of usable responses.

TABLE 3.4:Survey responses

Survey	Sent	Undelivered	Responded	Usable	% Usable
Survey on Australian Manufacturing industries	210	28	38	34	18.68%
Survey on Australian OM & EM industries	310	17	61	52	17.75%
Survey on Australian E-Business industry	310	19	48	39	13.40%

Column 6 of Table 3.4 presents the overall response rates to the surveys as a percentage, excluding the surveys that were returned undelivered due to wrong address. Response rates for the surveys were low, however, 13.40 per cent or above are considered to be reasonable. Collis and Hussey (2003) suggest that a 10 per cent or less response from postal questionnaire surveys is not uncommon.

Details of responses from the three Australian surveys are described in the next sections.

Responses to the Australian Manufacturing industries survey

The preliminary survey was sent on 2nd November 2004. Within four days 24 surveys were returned undelivered. At the end of two weeks 23 completed surveys were received. Of these only 19 responses were usable while the other four declined to participate due to their company policies. Two weeks after (on 15th November 2004) a reminder letter (Appendix C) was sent which generated another 15 usable questionnaires and a further four were returned undelivered. In total, 34 usable responses were received from Australian Manufacturing organisations (out of 182 surveys posted and delivered) which yielded an effective response rate of 18.68 per cent.

Responses to the Australian OM & EM industries survey

The survey was sent on 6th June 2005. Within four days 12 surveys were returned undelivered. At the end of two weeks 37 completed surveys were received. Of these only 28 questionnaires were usable. Two weeks after (on 20th June 2005) a reminder letter (Appendix F) was sent which generated another 24 usable questionnaires. In total, 52 usable responses were received from Australian OM & EM organisations (out of 293

surveys posted and delivered) which yielded an effective response rate of 17.75 per cent.

Responses to the Australian E-Business industry survey

The survey was sent on 7th November 2005. Within four days 16 surveys were returned undelivered. At the end of two weeks 31 completed surveys were received. Of these only 22 questionnaires were usable. Two weeks after (on 21st November 2005) a reminder letter (Appendix J) was sent which generated another 17 usable questionnaires. In total, 39 usable responses were received from Australian OM & EM organisations (out of 291 surveys posted and delivered) which yielded an effective response rate of 13.40 per cent.

3.6 Data analysis

This section describes the analysis of data from the three surveys.

Analysis of Australian Manufacturing survey

The data was acquired mainly from the use of categorical scales, except questions (4.1 and 4.3) which were acquired through the use of numerical scales. Cavana et al. (2001) describes that data elicited through categorical scales are nominal while data collected through numerical scales are ordinal. Sekaran (2003) states that some forms of categorical or numerical scales are more frequently used in business research to draw useful interpretive conclusions. Siegel and Castellan (1988) suggest that non-parametric statistical tests are used when the data are nominal or ordinal. Therefore data was analysed using to non-parametric tests. The data was summarised and analysed using Excel spreadsheet and SPSS in the Windows environment.

Since only 14 out of the 34 responding organisations managed reverse logistics, there were limited opportunities for detailed data analysis. However, the findings informed the design of the study for the OM & EM industries.

Detailed information on data analysis and results of the preliminary study are presented in Chapter Four. Based on the literature review and the study outcomes, five hypotheses

were formulated to establish reverse logistics issues in the Australian Manufacturing and E-Business industries.

Data analysis: Surveys of Australian OM & EM and E-Business industries

This section describes how the data collected from surveys on OM & EM and E-Business organisations were analysed. The same methods of data analysis was used to analyse the data collected from both surveys investigating reverse logistics issues in these industries.

The tests performed to determine non-response bias, types of data, data collation, statistical tests used, purpose and methods of data analysis.

Non-response bias

As explained in section 3.1, a number of steps were undertaken to maximise response rates and to minimise non-response bias. Lewis-Beck and Micheal (2004) and Merkle and Edelman (2002) suggest that, based on the response rates, the non-response bias in data cannot be determined. Therefore based on Lewis-Beck and Micheal's suggestion non-response bias was determined from both early and late responses using the Chi Square test on percentages on variables to check for discrepancies or deviations. Zikmund (2003) suggests that the Chi Square test is suitable for examining differences between two nominal variables.

The results are shown in Appendix G and K and are discussed in Chapters Five and Six.

Data collation and statistical tests

Data elicited from the surveys on OM & EM and E-Business industries were mainly nominal since they were obtained from categorical scales such as "yes" and "no" as described by Cavana et al. (2001). The answers to questions 4.1 and 4.3 on reverse logistics information management were ordinal since they were obtained from numerical scales. Cavana et al. (2001) and Gray, Streatfield and McMurray (1998) describe that data collected from numerical scales is ordinal. Siegel and Castellan (1988) suggest that non-parametric statistical tests are used when the data are nominal or ordinal. Thus nominal and ordinal data was analysed using non-parametric tests,

Fishers exact test and one sample Wilcoxon test. It also employed frequency distributions and binomial test. NIST/SEMATECH (2003) identifies that the Fisher's exact test is a non-parametric test useful to analyse binary ("yes" or "no") variables. Gibbons (1976) advocates that one sample Wilcoxon signed rank test is a non-parametric test useful to analyse ordinal data. NIST/SEMATECH describes binomial test to be a suitable analysis for discrete data. The one sample t-test was used to analyse the data collected via fill in the gap answers indicating the percentage of goods received and processed as described in NIST/SEMATECH (2003).

Initially the data were coded and recoded into Electronic spreadsheet to convert them into numerical form and checked for errors.

This next section explains how the data from the surveys on OM & EM and E-Business organisations were analysed.

Data analysis

This section includes purpose of data analysis, statistical tests used, methods of data triangulation and the order in which tests were carried out.

The purpose of the data analysis was to establish the reverse logistics issues and test the validity of the five hypotheses with OM & EM and E-Business industries. It identifies reasons for reverse logistics, product return operations, value recovery operations, barriers to reverse logistics, information technologies used in reverse logistics information management and reasons for E-Business returns in this industry.

Data triangulation was accomplished to confirm the findings. The data was initially analysed using frequency distributions to get an insight into each of the above issues. To further understand the preliminary findings from frequency distributions and to determine their significance, binomial test was used. To triangulate the findings from frequency distributions and binomial test, Fisher's exact test was undertaken on each of the issues. Value recovery data which was collected in percentages was analysed using one sample t-test to determine which value recovery operations were widely adopted in these industries. Information technology issues data which was analysed using one

sample Wilcoxon test. The variables were categorised into groups based on their relationship with pertinent business applications.

Data elicited through categorical scale (yes/no) was initially analysed using frequency distributions to understand preliminary reverse logistics issues. To determine the significance of the findings, an exact 95 per cent binomial confidence interval for population proportion was constructed. This is based on NIST/SEMATECH (2003) which suggests that binomial distribution is a suitable analysis for discrete data and more accurate than normal approximation test for small sample sizes. Several researchers (Keren 2007; Krag et al. 1998) have used this method of data analysis on the binary variable data. Fisher's exact test was then undertaken to verify the above findings. It is an appropriate nonparametric technique for analysing (nominal or ordinal) discrete variables and it is more accurate than the Chi Square test for all sample sizes (http://www.minitab.com/ 2006; NIST/SEMATECH 2003). It compares the proportions of success of two groups to determine the significance of the difference between proportions (NIST/SEMATECH 2003, http://www.itl.nist.gov/div898/handbook/, accessed 25th March 2007). In this research, Fisher's exact test was used to compare the proportions of organisations that manage reverse logistics according to the issues (reasons, barriers, product return and value recovery operations and reasons for E-Business returns) investigated. This method of proportion comparison has been widely used in earlier similar analysis (Kanji 1993; Krag et al. 1998; Stekel, Git & Falciani 2000). The variables were grouped into pertinent business applications based on their relationship. The significance of the grouped variables were determined using the above tests.

The one sample t-test was used to analyse the data collected via fill in the gap indicating the percentage of returned goods received due to each reason and processed through value recovery operations. The test constructs a 95 per cent confidence interval within which we can be 95 per cent sure that the population mean is contained (Groebner et al. 2005). This method of mean comparison is also used in earlier research (Mehilli et al. 2007) for similar analysis.

Based on the analysis reverse logistics issues such as reasons for reverse logistics, product return operations, value recovery operations, barriers to reverse logistics and reasons for E-Business returns were established

Data with information management issues was elicited via a numerical scale (0 for no, 1 to 7 for very low to very high). The ordinal data was initially converted into binary variables; no (responses 0) and yes (responses 1-7). This was done to analyse data using frequency distributions, binomial test and Fisher's exact test to identify reverse logistics data management issues (information technologies used and impact of reverse logistics data on operations). The data (responses 0 to 7) was further analysed using one sample Wilcoxon test to confirm the above findings. Groebner et al. (2005) suggest that one sample Wilcoxon test is useful to analyse ordinal data and determine the population median value. This method of data analysis is supported by Krag et al. (1998). The median is the central item in a group of observations when they are presented in either a ascending or descending order (Groebner et al. 2005). The Wilcoxon test constructs a 95 per cent confidence interval within which we can be 95 per cent sure that the population median is contained (Gibbons 1976; Hollander & Wolfe 1973). This analysis established types of information technologies used in reverse logistics and impact of reverse logistics data on operations.

Based on the results of the Fisher's exact test and the confidence intervals (exact binomial test, one sample t-test and one sample Wilcoxon test) the variables were summarised into groups with similar importance. This grouping based on Duncan's grouping method (Duncan 1975) as used by Mallela, Titus-Glover & Yu (2006).

The frequency distributions, binominal test, Fisher's exact test, one sample t test and one sample Wilcoxon tests were carried out using Minitab spread sheet software. Data collated in SPSS were imported in Minitab for the above analysis.

Details of the test are explained in Chapters Six and Seven.

3.7 Limitations

The response rate from the surveys are very low. Since reverse logistics is not a recognised business process in most organisations it was not easy to elicit more responses.

This research is only from the business point of view. Getting other supply chain management stakeholders' perspective which was beyond the scope of this research may have added new insights.

3.8 Conclusion

This chapter described the research methodology. This included the research design, survey instruments, data collection and responses. It further describes the analysis techniques used for the analysis of data from the three surveys. Preliminary survey data is analysed in Chapter Four. Research hypotheses are formulated in the Chapter Five. Analysis of data from the surveys of the Australian OM & EM and E-Business industries are presented in Chapters Six and Seven respectively. Chapter Eight presents a discussion of implications of the findings in these industries.

Chapter 4
PRELIMINARY STUDY OF REVERSE LOGISTICS IN THE AUSTRALIAN MANUFACTURING INDUSTRIES

4.0 Introduction

This chapter describes the analyses of the data collected from the preliminary survey of Manufacturing organisations in Australia.

4.1 Survey method

The postal questionnaire survey was the most appropriate method to reach the randomly selected Australian Manufacturing organisations. The aim of the survey was to establish reverse logistics issues in the Australian Manufacturing industries. It examined product return operations and value recovery operations used by these organisations. Further areas examined were the use of information technologies and barriers to management of reverse logistics management. The survey was sent to a stratified random sample of 210 Australian Manufacturing organisations.

4.2 Responses

Nineteen complete and four incomplete responses were received. Twenty four undelivered questionnaires were also received from the survey. A reminder letter

(Appendix C) was sent after two weeks to all except those that were returned undelivered. Fifteen more completed responses and four returned undelivered questionnaires were received in the next two weeks. A total of 34 usable responses were received. Details of this break-up are depicted in Table 4.1.

The overall response rate from this survey was 18.68 per cent which is considered to be a reasonable result based on Collis and Hussey (2003) and Remenyi et al's (2003) opinion is that a 10 per cent or less response from postal questionnaire surveys is not uncommon.

TABLE 4.1:Responses to the survey

Survey on Australian Manufacturing industries (n=210)	Number sent	Number returned undelivered	Number returned unusable	Number returned usable for analysis	Percentage of response
Before reminder letter	210	24	4	19	18.68%
After reminder letter	-	4	-	15	

4.3 Data analysis

Initially the data were coded and recoded into SPSS to convert them into numerical form and then checked for errors. Fourteen of the 34 responding Manufacturing organisations managed reverse logistics and were included for further data analysis. Due to the low response rate and to establish some preliminary reverse logistics issues in Australia, only frequency tables were used for the analysis of this data.

The data analysis described in the subsequent sections are grouped into preliminary findings and reverse logistics issues.

4.4 Preliminary findings

The following section discusses the data obtained from parts one and two of the survey.

4.4.1 Industry categories and management of reverse logistics

Table 4.2 shows information about the responding Manufacturing organisations and their management of reverse logistics. These industry categories (column one of Table

4.2) was guided by the Australian and New Zealand Standard Industrial Classification (ANZSIC), http://www.abs.gov.au/ausstats.

From data in column one of Table 4.2, it is apparent that the largest numbers of respondents were from machinery and equipment manufacturing organisations. Of these, approximately two thirds of them managed reverse logistics.

Half of the responding metal and allied product manufacturers perform reverse logistics. Only a few of the rubber, plastic and leather products (3) and coal, petroleum and chemical products (2) manufacturers manage reverse logistics.

The respondents in the last four categories of products food, drink and tobacco, stone, clay, glass and concrete products, timber and furniture, and paper, printing and publishing do not manage reverse logistics.

TABLE 4.2:Reverse logistics in Manufacturing industries

Industry Categories	**Response (Percentage)**	**Managing reverse logistics**	
		Yes (Percentage)	**No (Percentage)**
Machine and equipments	8 (23.53%)	5 (14.71%)	3 (8.82%)
Metal and allied products	6 (17.65%)	3 (8.82%)	3 (8.82%)
Rubber, plastic and leather products	3 (8.82%)	3 (8.82%)	0 (0.00%)
Coal, petroleum and chemical products	2 (5.88%)	2 (5.88%)	0 (0.00%)
Food, drink and tobacco	5 (14.71%)	1 (2.94%)	4 (11.76%)
Stone, clay, glass and concrete products	4 (11.76%)	0 (0.00%)	4 (11.76%)
Timber and furniture	3 (8.82%)	0 (0.00%)	3 (8.82%)
Paper, printing and publishing	3 (8.82%)	0 (0.00%)	3 (8.82%)
Total	**34 (100.0%)**	**14 (42%)**	**20 (58%)**

Table 4.2 shows that 58 per cent of surveyed organisations (20) do not recognise reverse logistics management as a business process.

Based on this finding, it can be inferred that not all Manufacturing industries recognise reverse logistics management as a business process. The data also suggests that machinery and equipment manufacturing industry are more likely than others to practice reverse logistics management as part of their business processes.

The following sections describe and analyse the data from the 14 responding organisations that managed reverse logistics. These fourteen organisations cover the following Manufacturing industries machinery and equipment manufacture, metal and allied products, rubber, plastic and leather products, coal, petroleum and chemical products and food, drink and tobacco.

4.4.2 Volume of product recovered and experience

Table 4.3 shows the percentage of returned goods recovered and the number of years of experience that the organisation has in managing reverse logistics. It is apparent from Table 4.3 that only 10 per cent or less of goods that are returned are recovered for resale and reuse. The data also shows that machinery and equipment manufacturing organisations recover a comparatively higher percentage of returns than other Manufacturing industries. Similarly, it is clear from Table 4.3 that in machinery and equipment manufacturing industries a majority of organisations (more than two) recover value from returned goods.

TABLE 4.3:Volume of products recovered and experience

Industry	Percentage of returned goods recovered		Reverse logistics management experience in years		
	10% or less	Over 10%	Less than 1	1 to 5	More than 5
Machinery and equipment	3	2	1	2	2
Metal and allied products	3	0	2	1	0
Rubber, plastic and leather products	3	0	2	0	1
Coal, petroleum and chemical products	2	0	0	0	2
Food, drink and tobacco	1	0	0	1	0
Total	**12**	**2**	**5**	**4**	**5**

Also, the machine and equipment manufacturing industries have been dealing with reverse logistics for more than five years. Therefore from this data it is clear that amongst manufacturing organisations, machine and equipment industries require more reverse logistics than others.

This finding supports Dekker & Van der Laan (2002) and Rogers and Tibben-Lembke's (1998) opinion that the characteristics of electronic goods and equipment such as

dynamic spot markets for supply and demand and higher depreciation of products demand an efficient logistics management system.

It is therefore be inferred that reverse logistics is important in the machine and equipment industry for the management of returns.

4.4.3 Annual income and reverse logistics costs

Annual income and reverse logistics costs, as reported by the 14 responding organisations, are presented in Table 4.4. From this table it is clear that the majority (10) of these organisations have an annual income level of up to AUD $50 million. The data also show that the expenditure on reverse logistics in the Manufacturing industries is a relatively minor proportion of annual income. The greatest expenditure on reverse logistics is by the machine and equipment manufacturing industry further confirming the importance of reverse logistics in this industry.

TABLE 4.4:Annual income and cost of reverse logistics

Industry	Annual income AUD$ millions		Annual reverse logistics cost AUD$ millions	
	50 or less	Over 50	1 or less	Over 1
Machinery and equipment	5	0	3	2
Metal and allied products	2	1	3	0
Rubber, plastic and leather products	2	1	3	0
Coal, petroleum and chemical products	0	2	2	0
Food, drink and tobacco	1	0	1	0
Total	**10**	**4**	**12**	**2**

4.4.4 Numbers of workers and market

Table 4.5 shows the number of employees in the responding Manufacturing organisations and the market in which they sell the goods. Most of the respondents have fifty or fewer employees, indicating they are small or medium enterprises. The majority of the organisations from all industries sell their goods in the national market.

TABLE 4.5:Numbers of workers and market

Industry	Numbers of workers			Market		
	50 or less	51-100	Over 100	Regional	National	Global
Machinery and equipment	4	1	0	1	4	0
Metal and allied products	2	1	0	0	3	0
Rubber, plastic and leather products	2	1	0	0	2	1
Coal, petroleum and chemical products	0	0	2	0	2	0
Food, drink and tobacco	1	0	0	1	0	0
Total	**9**	**3**	**2**	**2**	**11**	**1**

It is clear from Tables 4.4 and 4.5 that, although the coal, petroleum and chemical products industries are larger than the machine and equipment manufacturing industry, their expenditure on reverse logistics is far less than the machine and equipment manufacturing industry indicating return of products is not an issue in this industry.

4.4.5 Title of the respondents

Table 4.6 shows the designations of the respondents.

TABLE 4.6:Job titles of respondents

Titles	Responses
Operations manager	4
Manager	3
Production manager	2
Manufacturing manager	1
Administration officer	1
General manager	1
Office manager	1
Logistics strategy manager	1
Director	0
Total	**14**

It is interesting to note from Table 4.6 that comparatively higher numbers of respondents were managers, operation managers and production managers. The obvious inference is that reverse logistics is managed by operations managers in most organisations.

The 14 respondents did not indicate their roles in the process of managing returned goods. Information about the products that are mostly returned was also not indicated in their responses.

4.5 Reverse logistics issues

The next sections describe results of the data analyses from those organisations that managed reverse logistics. It identifies reverse logistics issues, product return operations, value recovery operations, information technologies used to support reverse logistics and barriers to the management of returned goods.

4.5.1 Product return process

Table 4.7 presents the product return operations carried out by the 14 Australian Manufacturing organisations. Returns authorisations, receiving information about goods to be returned and selection of a recovery operation are more important than others. These operations aid the selection of an appropriate recovery operation.

Collection of goods and gate-keeping are not carried out by most of the respondents, despite these being important operations identified for management of reverse logistics (Amini & Retzlaff-Roberts 2003; Lau et al. 2004; Roy 2003; Tan, Yu & Arun 2003).

TABLE 4.7:Product return operations

Product return operations	Number of respondents manage the operation	Percentage respondents manage the operation
Returns authorisation	14	100.00
Information about goods to be returned	13	92.86
Selection of a recovery operation	12	85.71
Inspection of returned goods	10	71.43
Sorting of returned goods	10	71.43
Collection and transportation of returned goods	8	57.14
Gate-keeping of returned goods	7	50.00

From column two of Table 4.7, it is clear that information related processes such as returns authorisations and information about product returns impact value recovery process.

Although several researchers (Ammons, Realff & Newton 1997; Le Blanc, Fleuren & Krikke 2002) suggest that the collection and transportation of returned goods are the most important operations in the management of reverse logistics, the data depicted in Table 4.7 indicates that this is not the case in Australia.

4.5.2 Value recovery operations

Table 4.8 indicates the types of value recovery operations used to process returned products by the responding organisations that manage reverse logistics. Respondents were allowed to select one or more recovery operations from a categorical scale.

From Table 4.8 it is clear that recycling, resale, remanufacture and repair recovery operations are used by manufacturing organisations to process goods that are returned. Other value recovery operations are not commonly used. It is clear from this table that retrieval and hazardous waste management are used by one organisation and incineration recovery operations is not used at all.

Therefore, it is inferred that Manufacturing organisations in Australia use only a few recovery operations indicating that reverse logistics is very underdeveloped. Product recovery (Page 48, Figure 2.1) (47, resale – 12, repair – 11, redistribution – 9, reuse – 9 and upgrade - 6) and module, parts, components, and materials recovery (Page 48, Figure 2.1) (34, recycle – 13, remanufacture – 12, refurbishment – 8 and retrieval - 1) are commonly used by the responded organisations.

TABLE 4.8:Value recovery operations

Value recovery operations	Number of respondents mange the recovery	Percentage of respondents mange the recovery
Recycle	13	92.86
Resale	12	85.71
Remanufacture	12	85.71
Repair	11	78.57
Redistribution	9	64.29
Reuse	9	64.29
Refurbishment	8	57.14
Upgrade	6	42.86
Landfill	6	42.86
Retrieval	1	7.14
Hazardous waste management	1	7.14
Incineration	0	0.00

4.5.3 Information technologies for reverse logistics management

A list of information technologies associated with reverse logistics information management and the numbers of respondents who used them to record, retrieve and manage returned products information are shown in Table 4.9.

From Table 4.9 it is clear that traditional technologies, such as land-line telephones, faxes and computers are the technologies used for managing reverse logistics data.

TABLE 4.9:Information technologies for reverse logistics management

Information technologies	Organisations responded	Percentage responded
Land-line/fax	14	100.0
Computers - personal/desktop	9	64.3
Mobile phone/palm device	4	28.6
Electronic Data Interchange	4	28.6
Barcode and scanning technology	4	28.6
Extranet	4	28.6
Data mining and data logging	3	21.4
Track and tracing technology	3	21.4
Intranet	3	21.4
Entrepreneurship resource planning	2	14.3
Internet	2	14.3
Radio frequency identification	1	7.1
Decision support system	0	0.0
Global positioning system/ geographical information system	0	0.0

From the outcome of Table 4.9 it can be concluded that since reverse logistics is so underdeveloped (based on the finding Table 4.2 column 4) in Australia data is managed only with land-line telephone and fax. This finding supports the Rogers & Tibben-Lembke (1998) and Zhao's (2001) opinion that many organisations may still need to clarify the role and value of information technologies for managing returned goods information.

4.5.4 Barriers to the use of reverse logistics

The surveyed organisations identified a number of barriers to the effective use of reverse logistics. These are presented in Table 4.10.

As shown in Table 4.10, the five barriers to reverse logistics identified in Manufacturing organisations are a lack of information about future returns, lack of online and other information systems for the management of reverse logistics information, unknown

status of returned products and added work/rework associated with returned goods handling. This finding is commensurate with Table 4.9 which indicates that these organisations use land-line telephone and fax to manage reverse logistics data.

It is concluded from data in Table 4.10 that data collected from basic technologies such as land-line telephone and fax is a problem. The respondents clearly highlight the need for better information management.

TABLE 4.10:Barriers to the use of reverse logistics

Barriers to the use of reverse logistics	Organisations responded	Percentage responded
Lack of information about future returns	6	42.9
Lack of online information system	6	42.9
Lack of information system for reverse logistics	5	35.7
Unknown state of returned products	5	35.7
Added work/rework	5	35.7
Lack of information sharing between partners	4	28.6
Long lead time for recovery	4	28.6
Return wait long time between operations	3	21.4
Unwanted/unauthorised returned goods	3	21.4
Lack of communication	2	14.3
Returned product handling	2	14.3
Storage of returned products	2	14.3
Resources wasted/idle	1	7.1

4.6 Summary of findings from the survey

The survey results show that Original Machinery and Equipment Manufacturing (OM & EM) organisations use reverse logistics more than other manufacturing industries. Table 4.2 shows that reverse logistics is gaining recognition in Australia. These findings support and confirm the view of Dekker & Van der Laan (2002) and Rogers and Tibben-Lembke (1998) that since the electronic goods and equipments have dynamic spot markets for supply and demand, sell in high volumes, and high variability demand an efficient logistics management system.

The findings also show that a lack of appropriate information systems for reverse logistics is a barrier for the management of returned goods. Traditional technologies such as land-line telephone and fax are the most commonly used tools for the management of returned goods information at the current time in the Australian manufacturing industries. A few (4) recovery operations at this stage are used.

4.7 Conclusion

In this chapter, the data from the Australian Manufacturing industries was analysed with the aim of identifying issues associated with reverse logistics management. Due to a low response rate cause and effect are not justified.

Conclusions from this analysis show that reverse logistics is important in the Original Machinery and Equipment Manufacturing (OM & EM) industries.

Based on the review of literature and some findings of this survey, research hypotheses are formulated and presented in the Chapter Five, the next stage of research was undertaken to investigate reverse logistics issues in the OM & EM industries.

Chapter 5

DEVELOPMENT OF HYPOTHESES

5.0 Introduction

This chapter presents the five hypotheses for this research based on literature findings from Chapter Two and some findings from the study presented in Chapter Four.

5.1 Research hypotheses

Four hypotheses (H1, H2, H3 and H4) are proposed for Australian OM & EM and E-Business industries for the first five research questions (Q1, Q2, Q3, Q4 and Q5).

The fifth hypothesis (H5) is specific to the Australian E-Business industry. It is developed to address to the sixth research question (Q6), reasons for an increased volume of returns in the E-Business industry.

5.1.1 Reasons to manage reverse logistics

Reverse logistics is becoming an important business process (Cater & Ellarm 1998; Srivastava & Srivastava 2006) and the volume of returned products amount to thirty per cent of the total products in the logistics channel (Tan, Yu & Arun 2003; Trebilcock 2002). Andel (1997) emphasises that companies that ignore reverse logistics miss tremendous profits. However, a number of researchers advocate that organisations tend

to accept returned goods and manage reverse logistics to capitalise on its opportunities, as shown in Table 5.1 below.

TABLE 5.1:Reasons for managing reverse logistics

Reasons for reverse logistics	References
Strategic and competitive advantages	(Autry, Daugherty & Richey 2001; Blumberg 1999; Brito, Flapper & Dekker 2003; Daugherty, Myers & Richey 2002; Johnson 1998; Mukhopadhyay & Setaputra 2006; Richey, Genchev & Daugherty 2005; Roy 2003; Smith 2005; Srivastava & Srivastava 2006)
Improved customer loyalty and increased customer retention rate	(Autry, Daugherty & Richey 2001; Boyer, Hallowell & Roth 2002; Daugherty, Myers & Richey 2002; Jiang & Rosenbloom 2005; Roy 2003; Sharma, Wickramasinghe & Singh 2005; Smith 2005; Srivastava & Srivastava 2006)
Economic gain and value recovery	(Brito, Flapper & Dekker 2003; Inderfurth 2005; James, Thomas & Herbert 2002; Krikke, Jacqueline & Wassenhove 2001; Lund 1998; Roy 2003; Shih 2001; Srivastava & Srivastava 2006)
Legal requirements (customer and environmental protection and disposal laws)	(ACCC 2001; Brito & Dekker 2003; CCC 2005; Fernández 2003; Giorgiadis & Vlachos 2004; http://web-japan.org 2005; Inderfurth 2005; Krikke, Jacqueline & Wassenhove 2001; Krumwiede & Sheu 2002; Mitsumori 1999; Srivastava & Srivastava 2006; www.nyc.gov 2001; www.strategic.com 2005)

Thus, due to the reasons discussed in Table 5.1, organisations tend to include liberal return policies as a marketing strategy (Brito & Dekker 2003; Desai, Richards & Desai 2003; Krumwiede & Sheu 2002), and accept returns due to commercial and warranty reasons (Daugherty, Myers & Richey 2002; Desai, Richards & Desai 2003; Lee 2002; Richey et al. 2004). From the above literature discussion it is inferred that organisations manage reverse logistics to achieve a strategic advantage, to attain financial benefits and to fulfil legal obligations.

Thus, hypotheses one is:

H1: OM & EM and E-Business organisations implement returned goods management to achieve strategic advantages, attain financial benefits and to fulfil legal obligations.

5.1.2 Product return operations

An extensive review of the literature on reverse logistics process identified that there are eight operations for handling returned goods. A summary of these operations is presented in Table 5.2 below.

The eight product return operations are categorised into two groups: information centred operations (receive returns information, returns authorisation, gate keeping and refund) and logistics centred operations (transportation, inspection, selection and sorting). This was to identify the importance of, and types of operations associated with reverse logistics.

TABLE 5.2:Product return operations

Product return operations	References
Inform - Initially customers have to inform organisation or its agent about goods to be returned.	(Amini & Retzlaff-Roberts 2003; Bayles 2000; Carella, Murino & Santillo 2002; Lau et al. 2004; Lonn & Stuart 2003; Rogers & Tibben-Lembke 1998; Roy 2003)
Return authorisation - Organisations then issue note of return authorisation.	(De Koster, De Brito & Van de Vendel 2002; James, Thomas & Herbert 2002; Lonn & Stuart 2003)
Gate-keeping - Gate-keeping of returned goods is carried out by organisations to check the products' validity and originality.	(Bayles 2000; James, Thomas & Herbert 2002; Krikke, Jacqueline & Wassenhove 2001; Lau et al. 2004; Lee 2002; Lonn & Stuart 2003; Meade & Sarkis 2002; Roy 2003)
Transportation - Then goods are collected and transported to inspection centre.	(Amini & Retzlaff-Roberts 2003; Ammons, Realff & Newton 1997; Bayles 2000; De Koster, De Brito & Van de Vendel 2002; Hutchinson 2000; James, Thomas & Herbert 2002; Krikke et al. 2001; Le Blanc, Fleuren & Krikke 2002; Meade & Sarkis 2002; Pohlen & Farris 1992; Schwartz 2000; Tan, Yu & Arun 2003; Trebilcock 2002)
Inspection - Inspection of returned goods is undertaken to identify its condition or nature of defect or damage.	(Amini & Retzlaff-Roberts 2003; Bayles 2000; De Koster, De Brito & Van de Vendel 2002; Krikke, Jacqueline & Wassenhove 2001; Lau et al. 2004; Lonn & Stuart 2003; Roy 2003)
Selection - Accordingly the goods are selected for a value recovery.	(Amini & Retzlaff-Roberts 2003; De Koster, De Brito & Van de Vendel 2002; Fleischmann, Nunen & Grave 2002; James, Thomas & Herbert 2002; Kokkinaki et al. 1999; Krikke et al. 2001; Le Blanc, Fleuren & Krikke 2002; Roy 2003; Trebilcock 2002)
Sorting - The returned good are then sorted for recovering value.	(Amini & Retzlaff-Roberts 2003; De Koster, De Brito & Van de Vendel 2002; James, Thomas & Herbert 2002; Lonn & Stuart 2003; Meade & Sarkis 2002; Pohlen & Farris 1992; Roy 2003; Schwartz 2000)
Refund - Accordingly organisations refund or issues credit note customers if the products not replaced or resend.	(ACCC 2001; Davis, Hagerty & Gerstner 1998; Moorthy & Srinivasan 1995).

Some researchers, (Carella, Murino & Santillo 2002; Daugherty, Myers & Richey 2002; Richey et al. 2004; Smith 2005) are of the view that better management of the information associated with the operations enhances overall reverse logistics management. On the other hand, several other authors (Bayles 2001; Dekker & De Brito 2002; Fleischmann, Nunen & Grave 2002; Kokkinaki et al. 2001a) are of the opinion

that proactive management of logistics operations is essential to reduce cost and increase the customer satisfaction with the return of goods.

From the literature presented in Chapter Two, summarised in Table 5.2 hypothesis two is:

H2: Logistics and information management are equally important for reverse logistics in OM & EM and E-Business organisations.

5.1.3 Value recovery operations

Thirteen value recovery operations were identified from the review of literature in Chapter Two. A summary of these recovery operations is presented in Table 5.3. These value recovery operations are categorised into three groups based on the nature of the outcome of value recovery, to identify the importance and commonly associated value recovery operations in OM & EM and E-Business industries:

- Product recovery (redistribution, resale, reuse, donation, upgrade and repair);
- Modules, parts, components and materials recovery (refurbishment, remanufacture, retrieval and recycling); and
- Energy and environmental recovery (hazardous waste management, incineration and landfill).

According to the condition and quality of returned products, organisations use these value recovery operations to add value to returned goods enabling them to be resold or reused. The recovery operations are also used to recapture some value from returned goods by recovering assets and components, protect the environment or to improve organisational goodwill and image (Fleischmann, Nunen & Grave 2002; Rogers & Tibben-Lembke 1998; Roy 2003).

According to Amini and Retzlaff-Roberts (2003), Brito, Flapper and Dekker (2003), Fleischmann, Nunen and Grave (2002) and Thierry (1997) redistribution, resale, repair, reuse, remanufacture and recycling recovery operations are more applicable to process returns.

As the value recovery operations discussed in Table 5.3 is basically generic and not directly related to the E-Business industry it is not known which value recovery operations are used to process returns in this industry. However how the Australian Manufacturing and E-Business industries recover returned goods are unknown.

TABLE 5.3:Recovery operations

Recovery operations	References
Redistribution	(Amini & Retzlaff-Roberts 2003; Brito, Flapper & Dekker 2003; Kokkinaki et al. 2001b)
Resale	(Amini & Retzlaff-Roberts 2003; Bayles 2000; Brito, Flapper & Dekker 2003; Kokkinaki et al. 2001a)
Reuse	(Amini & Retzlaff-Roberts 2003; Bayles 2000; Brito, Flapper & Dekker 2003; Kokkinaki et al. 2001a; Kokkinaki et al. 2001b; Kokkinaki et al. 1999; Meade & Sarkis 2002; Rahman 2003; Ritche et al. 2000)
Donation	(Amini & Retzlaff-Roberts 2003; Fleischmann, Nunen & Grave 2002; Rogers & Tibben-Lembke 2002, 1998; Roy 2003; Tibben-Lembke 2002)
Upgrade	(Autry, Daugherty & Richey 2001; Bayles 2000; Fleischmann, Nunen & Grave 2002; Rogers & Tibben-Lembke 2001; Roy 2003)
Repair	(Amini & Retzlaff-Roberts 2003; Autry, Daugherty & Richey 2001; Bayles 2000; Brito, Flapper & Dekker 2003; De Koster, De Brito & Van de Vendel 2002; Fleischmann, Nunen & Grave 2002; Kokkinaki et al. 1999; Lau et al. 2004)
Refurbishment	(Bayles 2000; Fleischmann, Nunen & Grave 2002; Roy 2003; Thierry et al. 1995)
Remanufacture	(Bayles 2000; Fleischmann, Nunen & Grave 2002; Kokkinaki et al. 2001b; Krikke et al. 2001; Lau et al. 2004; Meade & Sarkis 2002; Rahman 2003; Thierry et al. 1995)
Retrieval	(Bayles 2000; Brito, Flapper & Dekker 2003; Fleischmann, Nunen & Grave 2002; Kokkinaki et al. 2001b; Sarkis, Meade & Talluri 2004; Thierry et al. 1995)
Recycling	(Amini & Retzlaff-Roberts 2003; Bayles 2000; Fleischmann, Nunen & Grave 2002; James, Thomas & Herbert 2002; Kokkinaki et al. 2001b; Krikke, Jacqueline & Wassenhove 2001; Meade & Sarkis 2002; Rahman 2003; Roy 2003; Thierry et al. 1995)
Hazardous Waste Management	(Chopra, Reinhart & Abu-Al-Shaar 2001; Kokkinaki et al. 2001b)
Incineration	(Brito, Flapper & Dekker 2003; Le Blanc, Fleuren & Krikke 2002)
Landfill	(Amini & Retzlaff-Roberts 2003; Bayles 2000; Fleischmann, Nunen & Grave 2002; Thierry et al. 1995)

Based on literature presented in Chapter Two and summarised in Table 5.3 hypothesis three is:

H3: All returned goods in OM & EM and E-Business industries warrant one or more recovery operations in order to recapture value.

5.1.4 Barriers to reverse logistics

Several authors (Cottrill 2000; Knemeyer, Corsi & Murphy 2003; Zhao 2001), have identified that intermediaries play a vital role in returned goods management. However, other authors (Krumwiede & Sheu 2002; Richey et al. 2004; Zhao 2001) describe a lack of guidelines and collaborative information sharing between organisations and their intermediaries as affecting reverse logistics management.

Previous studies by (Andel 1997; Morrell 2001) concede that reverse logistics has not been given the same importance as other business processes due to a lack of understanding of the importance and benefits of returns management by organisations.

Carella, Murino and Santillo (2002) and Inderfurth (2005) are of the view that when managing returns of machinery and high value irreplaceable goods it is difficult to meet customer deadlines and financial penalties can accrue. Several other researchers (Dekker & De Brito 2002; Fleischmann, Nunen & Grave 2002) support this idea, emphasising that expanding volumes of products with shorter life-spans makes it more challenging for organisations to manage and recover returned goods.

According to some authors (Carella, Murino & Santillo 2002; Guide 2000; Kokkinaki et al. 2001b) scheduling reverse logistics operations and allocating resources to recover returned goods are more difficult as it is hard to predict the volume of returns, time and origin of returns and the quality of returned goods.

Previous studies by (Caldwell 1999; Grommesh 1991; McNeill 1991; Nagel & Meyer 1999) point that although some organisations use different types of technologies to capture reverse logistics information, there is no dedicated software or system supporting reverse logistics management. However, many researchers (Richey et al. 2004; Sarkis, Meade & Talluri 2004; Smith 2005) are of the view that efficient information system which provides information online could enhance reverse logistics management. Rogers and Tibben-Lembke (1998) are of the opinion that some of the common obstacles managing reverse logistics are company policies, management in-attention, relax return policies due to competition, rate of returns arrival faster than

processing, unauthorised returns, and a lack of financial resources and personnel resources, are some of the common obstacles for this process.

Based on the literature discussed above the barriers were categorised into three groups:

- Administrative barriers which obstruct the smooth administration of the reverse logistics process;
- Operational barriers which impede the handling of returned goods in the reverse logistics process; and
- Technological barriers which influence better management of reverse logistics data, identify the nature and significance of reasons for returns.

Therefore, hypothesis four is:

H4: Effective reverse logistics information management enables better rescheduling of work on returned goods and streamlines administrative processes in OM & EM and E-Business industries.

5.1.5 Reasons for E-Business returns

A number of recent studies have revealed that the rate of returns in the E-Business industry is 30 to 50 per cent (Mason 2002; Nairn 2003; Sharma, Wickramasinghe & Singh 2005; Trebilcock 2002; Vigoroso 2001). Thus, managing the volume of returns in E-Business is becoming a significant challenge especially when considering that the industry records trillions of dollars in business transactions and has a 15 to 25 per cent annual growth (Turban et al. 2006).

Although, Barua et al. (2002) and Cagle (2006) assert that product descriptions in E-Business have improved other authors (Desai, Richards & Desai 2003; Jiang & Rosenbloom 2005; Smith 2005) stated that the most likely reasons online customers return goods is because they are not able to examine, touch or feel the product before buying. According to Lee (2002) B2B and B2C E-Business returns are generated from after sales service and business agreements which allow goods to be returned if there are errors in ordering, picking or shipping, damage due to transportation and handling, cancellation of orders, trade-ins and overstocked items due to seasonal business cycle.

Harris and Goodman (2001) and Smith (2005) are of the opinion that unfulfilled promises and unrealistic response times by some E-Businesses contribute to the increased volume of returns seen in this industry.

It is therefore logical to conjecture that online customers tend to return products due to three categories of reasons.

- The products ordered online does not meet the customer's expectations.
- Provision of after sales services and warranty provisions.
- Lease or business agreements allowing the return of products that are excess to the customer's requirements, seasonal returns or end-of-use (lease) returns.

Hence, hypothesis five is:

H5: Online customers return goods because they find the goods they receive are different from how they conceptualised them on a computer screen, due to after sales service and business agreements.

The five hypotheses developed in this chapter are based on literature discussed in Chapter Two with some input from the preliminary study presented in Chapter Four. The five hypotheses are also to provide answers to the six research questions.

Research Question Q1: "Why have Manufacturing and E-Business industries implemented reverse logistics?"

Hypothesis ***H1: OM & EM and E-Business organisations implement returned goods management to achieve strategic advantages, attain financial benefits and to fulfil legal obligations.***

Research Question Q2: "What are the logistics and information management operations in facilitating handling of the returned goods in Manufacturing and E-Business industries?"

Hypothesis ***H2: Logistics and information management are equally important for reverse logistics in OM & EM and E-Business organisations.***

Research Question Q3: "What recovery operations are performed on returned goods to capture value in Manufacturing and E-Business industries?"

Hypothesis ***H3: All returned goods in OM & EM and E-Business industries warrant one or more recovery operations in order to recapture value.***

Research Question Q4: "What are the barriers to reverse logistics management in Manufacturing and E-Business industries?"

Research Questions Q5:

Q5a: "What information technologies are used to manage reverse logistics information?"

Q5b: "How can reverse logistics management be improved with electronic information management?"

Hypothesis ***H4: Effective reverse logistics information management enables better rescheduling of work on returned goods and streamlines administrative processes in OM & EM and E-Business industries.***

Research Question Q6: "Why does the E-Business industry receive an increased amount of returns?"

Hypothesis ***H5: Online customers return goods because they find the goods they receive are different from how they conceptualised them on a computer screen, due to after sales service and business agreements.***

5.2 Conclusion

First four hypotheses are relevant to both the Australian OM & EM and E-Business industries tested in Chapters Six and Seven. The fifth hypothesis is specific to the Australian E-Business industry tested in Chapter Seven only.

Chapter 6

SURVEY OF REVERSE LOGISTICS IN THE AUSTRALIAN ORIGINAL MACHINERY AND EQUIPMENT MANUFACTURING (OM & EM) INDUSTRIES

6.0 Introduction

From the survey of Australian Manufacturing organisations (Chapter Four), one important finding that emerged was that OM & EM industries are faced with more returned goods than any other manufacturing industries. Accordingly, reverse logistics was investigated in the OM & EM organisations.

This chapter describes the analysis of data collected from the survey of OM & EM industries in Australia. It identifies reverse logistics issues including reasons for reverse logistics, product return operations, value recovery operations, barriers to reverse logistics and information technologies used in reverse logistics information management in these industries. The data was initially analysed using frequency distributions to get an insight into each of the above issue. To further understand the preliminary findings from frequency distributions and to determine their significance binomial test was used.

To triangulate the above findings from frequency distributions and binomial test, Fisher's exact test was undertaken on each of the above issues. Value recovery data which was collected in percentages was analysed using one sample t-test to determine which value recovery operations were more prevalent in these industries. Information technology issues data which were ordinal were analysed using one Wilcoxon test. The findings are presented in Tables (6.8, 6.9, 6.11, 6.12, 6.13 and 6.14) and discussed in this chapter. Based on these findings, four hypotheses were tested for validity.

6.1 Survey method

The postal questionnaire survey was considered to be an appropriate method to reach the randomly selected 310 Australian OM & EM organisations. The purpose of this survey was to understand reverse logistics in the OM & EM industries. It elicited data on the reasons for reverse logistics, product return operations and value recovery operations. It also collected data on barriers to the management of reverse logistics and the information technologies used to manage returned goods data.

The next section describes the responses to the survey.

6.2 Responses

This section describes the survey responses and how they were checked for non-response bias. Details of the responses are presented in Table 6.1.

TABLE 6.1:Responses from the survey

Survey on Australian OM & EM industries (n=310)	Number sent	Number returned undelivered	Number returned unusable	Number returned usable for analysis	Percentage of response
Before reminder letter	310	12	9	28	17.75%
After reminder letter	-	5	-	24	

The overall response rate from the survey of Australian OM & EM organisations was 17.75 per cent, excluding returned surveys. A response rate of 17.75 per cent is considered to be a reasonable result based on Collis and Hussey (2003) and Remenyi et

al's (2003) opinion that a 10 per cent or less response from postal questionnaire surveys is not uncommon.

Non-bias analysis for early and late responses

A number of pre-survey steps (Chapter 3.1) were undertaken to minimise non-response bias and, because the reminder letters initiated more responses, percentages on the variables associated with early and late responses were evaluated using the Chi Square test to ascertain non-response bias. Zikmund (2003) asserts that the Chi Square test is suitable for examining the homogeneity of two samples of nominal variables. However, there were a few cells with zero or low counts and these were ignored. The result of this test is shown in Appendix G. The outcome confirms that the survey data is free from non-response bias.

6.3 Data analysis

Initially the data were coded and recoded into an electronic spreadsheet to convert them into numerical form and then checked for errors. Data collected from the survey was mainly nominal and ordinal since they were acquired from categorical and numerical scales (Cavana et al. 2001). Data on the volume of goods processed through each recovery operations was collected in percentages. Siegel and Castellan (1988) suggest that non-parametric statistical tests are useful for analysing nominal or ordinal data thus they were analysed using Fisher's exact test. The analysis also employed frequency distributions, binomial test, one sample t test and one sample Wilcoxon test to construct 95 per cent confidence intervals and to identify the important issues in reverse logistics.

Data elicited through categorical scale (yes/no) was initially analysed using frequency distributions to understand preliminary reverse logistics issues. To determine the significance of the findings, an exact 95 per cent binomial confidence interval for population proportion was constructed. This is based on NIST/SEMATECH's (2003) suggestion that binomial distribution is a suitable analysis for discrete data and more accurate than normal approximation test for small sample sizes. Several researchers (Keren 2007; Krag et al. 1998) have used this method of data analysis on binary variable data. Fisher's exact test was undertaken to confirm the above findings. The

Fisher exact test is an appropriate nonparametric technique for analysing (nominal or ordinal) discrete variables and it is more accurate than the Chi Square test for all sample sizes (http://www.minitab.com/ 2006; NIST/SEMATECH 2003). It compares the proportions of success of two groups to determine the significance of the difference between proportions (NIST/SEMATECH 2003, http://www.itl.nist.gov/div898/handbook/, accessed 25th March 2007). In this research, Fisher's exact test was used to compare the proportions of organisations that manage reverse logistics according to the issues (reasons, barriers, product return operations and value recovery operations) investigated. This method of proportion comparison is used in earlier research (Kanji 1993; Krag et al. 1998; Stekel, Git & Falciani 2000). Based on the findings of the above methods, reverse logistics issues relevant to OM & EM industries in Australia were established. The variables were grouped into pertinent business applications based on their relationship. The data analysis was base on frequency distributions, an exact binomial test and the Fisher's exact test.

The one sample t test was used to analyse the data collected via fill in the gap indicating the percentage of returned goods processed through value recovery operations. The test constructs a 95 per cent confidence interval within which we can be 95 per cent sure that the population mean is contained (Groebner et al. 2005). This method of mean comparison is also used in earlier similar research (Mehilli et al. 2007).

Based on the data analysis reasons for reverse logistics, product return operations, value recovery operations and barriers to reverse logistics were established.

Data with information management issues was elicited via a numerical scale (0 for no, 1 to 7 for very low to very high). The ordinal data was initially converted into binary variables; no (responses 0) and yes (responses 1-7). This was done to analyse data using frequency distributions, binomial test and Fisher's exact test to identify types of information technologies used and impact of the reverse logistics data collected on reverse logistics operations. The data (responses 0 to 7) was further analysed using one sample Wilcoxon test to confirm the findings from binomial test and Fisher's exact test. Groebner et al. (2005) suggest that one sample Wilcoxon test is useful to analyse ordinal data and determine the population median value. This method of data analysis is also supported by Krag et al. (1998). The median is the central item in a group of

observations when they are presented in either an ascending or descending order (Groebner et al. 2005). Wilcoxon test constructs a 95 per cent confidence interval with a 95 per cent assurance that the population median is contained (Gibbons 1976; Hollander & Wolfe 1973). This analysis established the types of information technologies used in reverse logistics and the impact of this collected data on reverse logistics operations.

Based on the results of the Fisher's exact test and the confidence intervals (exact binomial test, one sample t-test and one sample Wilcoxon test) the variables were summarised into groups with similar importance. This grouping is based on Duncan's grouping method (Duncan 1975) and presented in Tables (6.8, 6.9, 6.11, 6.12, 6.13 and 6.14) in descending order of importance as used by Mallela, Titus-Glover & Yu (2006). This analysis was undertaken to test the validity of hypotheses, H1, H2, H3 and H4.

The data analysis elicited from 39 out of the 52 responding OM & EM organisations which managed reverse logistics are discussed by first presenting frequency distributions and then analysis using binomial, Fisher's exact, one sample t and one sample Wilcoxon tests.

6.4 Preliminary findings

This section discusses some background information on the types of organisations that responded to the survey.

6.4.1 Product categories, reverse logistics management and market

To understand the products that warranted reverse logistics responses were summarised into five categories based on the type of products shown in column one of Table 6.2. The products are categorised according to the Australian and New Zealand Standard Industrial Classification (ANZSIC) presented in column one of Table 6.2.

Table 6.2 highlights that majority of the respondents were from electronic and electrical equipments and parts manufacturing industry (42 per cent) and automotive and parts manufacturing industry (25 per cent). This indicates that reverse logistics is important for the management of returns in the electronic and electrical equipments and automotives and parts manufacturing industries.

TABLE 6.2:Product categories, use of reverse logistics and market

Product category	Responses (column %)	Manage reverse logistics (row%)		Market (row%)		
		Yes	No	Regional	National	Global
Electronic and electrical equipment and parts	22 (42%)	17 (77%)	5 (23%)	5 (29%)	5 (29%)	7 (41%)
Automotive and parts	13 (25%)	10 (77%)	3 (23%)	1 (10%)	2 (20%)	7 (70%)
Mining and irrigation equipment	6 (12%)	5 (83%)	1 (17%)	0 (0%)	2 (40%)	3 (60%)
Construction equipment	6 (12%)	3 (50%)	3 (50%)	0 (0%)	1 (33%)	2 (67%)
Medical and scientific equipment	5 (10%)	4 (80%)	1 (20%)	0 (0%)	1(25%)	3 (75%)
Overall		**39 (75%)**	**13 (25%)**	**6 (15%)**	**11 (28%)**	**22 (56%)**
Total	**52 (100%)**	**52 (100%)**		**39 (100%)**		

From the data in column three of Table 6.2, it is apparent that reverse logistics is important as indicated by 75 per cent of the responding OM & EM organisations. Table 6.2 also indicates that reverse logistics is required for the management of returned goods from regional, national and global markets.

6.4.2 Product life span and return processing time

Table 6.3 presents product categories with short (three years or fewer) and long (over three years) life spans and the time taken to process returned products.

TABLE 6.3:Product life span and return processing time

Product categories	Product's lifetime (row%)		Returns processing time (Weeks) (row%)			
	3 years or less	Over 3 years	Less than 1	1 to 4	4 to 8	Over 8
Electronic and electrical equipment and parts	3 (18%)	14 (82%)	4 (24%)	9 (53%)	2 (12%)	2 (12%)
Automotive and parts	4 (40%)	6 (60%)	6 (60%)	4 (40%)	0 (0%)	0 (0%)
Mining and irrigation Equipment	0 (0%)	5 (100%)	1 (20%)	2 (40%)	0 (0%)	2 (40%)
Construction equipment	0 (0%)	3 (100%)	2 (67%)	0 (0%)	0 (0%)	1 (33%)
Medical and scientific Equipment	0 (0%)	4 (100%)	1 (25%)	1 (25%)	1 (25%)	1 (25%)
Overall	**7 (18%)**	**32 (82%)**	**14 (36%)**	**16 (41%)**	**3 (8%)**	**6 (15%)**
Total	**39 (100%)**		**39 (100%)**			

It is clear from Table 6.3 that products with longer life spans tend to be returned more frequently than those that have a short life span. However, products with shorter life

spans are also returned and thus require a more efficient reverse logistics solution to gain some value from returned goods.

Similarly, Table 6.3 shows that the processing time for the majority of returned goods is more than a week. If the average returns processing time of a returned product is over three weeks the returned product spends an average of 2 per cent of its life in the reverse logistics process. This means that while the goods are in the recovery process neither manufacturers nor customers receive any benefit or utility from these items, rather, the product continues to depreciate. Thus to achieve value from returned goods it is essential to minimise processing time. According to literature, this can be achieved in two ways, one, reducing the time used in returns processing (Carella, Murino & Santillo 2002) and reducing the time spent in managing reverse logistics information (Sarkis, Meade & Talluri 2004; Zhao 2001). This indicates the importance of an efficient reverse logistics system.

6.4.3 Annual income and reverse logistics costs

Table 6.4 outlines the cost of reverse logistics in comparison to the organisations' annual income.

TABLE 6.4:Annual income and reverse logistics costs

Product categories	**Annual income AUD $million (row%)**			**Annual reverse logistics costs AUD $million (row%)**	
	100 or less	**101-250**	**Over 250**	**5 or less**	**Over 5**
Electronic and electrical equipment and parts	11 (65%)	3 (18%)	3 (18%)	15 (88%)	2 (12%)
Automotive and parts	6 (60%)	1 (10%)	3 (30%)	10 (100%)	0 (0%)
Mining and irrigation Equipment	3 (60%)	0 (0%)	2 (40%)	5 (100%)	0 (0%)
Construction equipment	3 (100%)	0 (0%)	0 (0%)	3 (100%)	0 (0%)
Medical and scientific Equipment	0 (0%)	2 (50%)	2 (50%)	4 (100%)	0 (0%)
Overall	**23 (59%)**	**6 (15%)**	**10 (26%)**	**37 (95%)**	**2 (5%)**
Total	**39 (100%)**			**32 (100%)**	

The data in Table 6.4 shows that, the cost of reverse logistics in the responding organisations is minimal. This findings is similar to that of the USA which according to Delaney (2001) is 4 per cent of the total logistics costs.

6.4.4 Numbers of workers

Table 6.5 shows the number of full time workers employed by responding organisations. This was done to establish the importance of reverse logistics as a business process.

TABLE 6.5:Numbers of workers

Product categories	**Numbers of fulltime workers (row%)**		
	100 or less	**101-250**	**Over 250**
Electronic and electrical equipment and parts	9 (53%)	7 (41%)	1 (6%)
Automotive and parts	2 (20%)	3 (30%)	5 (50%)
Mining and irrigation equipment	3 (60%)	0 (0%)	2 (40%)
Construction equipment	2 (67%)	1 (33%)	0 (0%)
Medical and scientific equipment	0 (0%)	1 (25%)	3 (75%)
Overall	**16 (41%)**	**12 (31%)**	**11 (28%)**
Total	**39 (100%)**		

Table 6.5 shows that 59 per cent of responding organisations are medium and large in terms of their number of employees. Therefore it is concluded that reverse logistics management is not related to the size of the organisation number of employees (Table 6.5) or annual income (Table 6.4).

6.4.5 Title of respondents

Table 6.6 shows the title of personnel responsible for reverse logistics management.

It is interesting to note that a large number of respondents were operations and manufacturing managers. From this it is inferred that reverse logistics is not very well recognised as a separate business process in these organisations.

TABLE 6.6:Titles of respondents who manage reverse logistics

Titles of respondent	Responses
Operations Manager	9 (23.1%)
Manufacturing Manager	6 (15.4%)
Marketing Manager	4 (10.3%)
Logistic Manager	4 (10.3%)
Production Manager	3 (7.7%)
Supply Chain Manager	2 (5.1%)
General Manager	1 (2.6%)
Business Manager	1 (2.6%)
CEO	1 (2.6%)
Director	1 (2.6%)
Distribution Manager	1 (2.6%)
Engineer	1 (2.6%)
IT Manager	1 (2.6%)
MRP Controller	1 (2.6%)
Plant Manager	1 (2.6%)
Product Manager	1 (2.6%)
Public Relations Manager	1 (2.6%)
Total	**39 (100.0%)**

6.4.6 Business models used for marketing

Table 6.7 shows the business models respondents used to sell their products. This data was elicited using a numerical scale (0 for not used, 1 to 7 for minimum to maximum usage). The participants were allowed to select more than one business model. The use of the different business models is summarised in column three of Table 6.7 and presents the mean values of the business models. This finding indicates that reverse logistics is required no matter which mode of sale is used.

TABLE 6.7:Business models used for marketing

Business Models	Percentage (column %)	Level of use - Mean
Wholesaling	34 (87%)	4.69
Retailing	26 (67%)	2.64
Telephone	24 (62%)	2.95
Catalogue	22 (56%)	2.59
B2B E-Business	16 (41%)	2.39
B2C E-Business	12 (31%)	1.88
Total	**39 (100%)**	

6.5 Data analysis for hypotheses testing

This section establishes reverse logistics issues reasons for managing reverse logistics, product return operations, value recovery operations, barriers to reverse logistics and information technologies used in the management of returned goods information and tests the validity of hypotheses H1, H2, H3 and H4.

6.5.1 Reasons for reverse logistics

In this section, individual and collective reasons for reverse logistics management in OM & EM organisations are investigated and the first hypothesis (H1) is tested for validity.

To establish why OM & EM organisations manage returns, participants were presented with a list of reasons. Participants could choose more than one reason by indicating a response with a ‘yes’ or ‘no’.

Column one in Table 6.8 lists the 13 reasons for managing reverse logistics that were identified from literature. Column two of Table 6.8 indicates that, in OM & EM industries, customer service (82 per cent) is the most important reason for reverse logistics. This is followed by strategic issues (74 per cent) and, less importantly, legal obligations (51 per cent). The other nominated reasons are clearly less important for the management of returns in OM & EM industries.

However, to confirm the importance of each reason an exact 95 per cent binomial confidence interval was constructed. A summary of the results, grouped A to F are presented in column three of Table 6.8. It is clear that group A reasons (customer service, strategic gain and legal obligations) are important reasons for reverse logistics in the Australian OM & EM industries.

TABLE 6.8:Reasons for reverse logistics management

(1) Reasons for reverse logistics management	(2) Percentage n=39	95% CI lower limit	95% CI upper limit	(3) Groups of reasons with same significance (based on binomial distribution)						(4) Groups of reasons with same significance (based on Fisher's exact test)						
1. Customer service	82%	66%	92%	A						A						
2. Strategic issues	74%	58%	87%	A	B					A	B					
3. Legal obligations	51%	35%	68%	A	B	C					B	C				
4. Competitive reason	44%	28%	60%		B	C	D					C	D			
5. Environmental protection laws	39%	23%	55%			C	D	E				C	D	E		
6. Resale of returns	31%	17%	48%			C	D	E	F			C	D	E	F	
7. Customer protection laws	23%	11%	39%			C	D	E	F				D	E	F	
8. Retail return policy	23%	11%	39%			C	D	E	F				D	E	F	
9. Legal disposal laws	21%	9%	36%			C	D	E	F					E	F	G
10. Recapture value	15%	6%	31%				D	E	F						F	G
11. Recover asset	15%	6%	31%				D	E	F						F	G
12. Clean logistics channel	13%	4%	27%					E	F						F	G
13. Protect margin	5%	1%	17%						F							G
G1. Strategic advantages (1, 2, 4 and 12)	**53%**	**45%**	**61%**	**A**						**A**						
G2. Customer and environmental protection laws (3, 5, 7, 8 and 9)	**31%**	**25%**	**38%**			**B**						**B**				
G3. Financial advantages (6, 10, 11 and 13)	**17%**	**11%**	**23%**					**C**						**C**		

Note: (categorical scale, 'yes' or 'no' response).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).

Fisher's exact test was undertaken to further confirm the above findings. A summary of the results, grouped A to G are presented in column four of Table 6.8. Details of Fisher's exact test results are presented in Table 1 in Appendix L. The findings further confirm that in the Australian OM & EM industries, reverse logistics is implemented for customer service and for strategic advantage. Fisher's exact test result did not indicate legal obligations to be significantly important. Other reasons such as achieving a competitive advantage, complying with environmental protection laws and regaining value through resale of returns (group C in column four) were less important.

Thus, this research findings indicates that reverse logistics management is a customer service support and a strategic advantage in the OM & EM industries. Since the binomial test indicated that legal obligations are significant it is inferred that if legal disposal and environment protection laws in Australia were as strong they are in other part of the world (Europa 2000; Krikke, Jacqueline & Wassenhove 2001; Mitsumori 1999) they would enforce reverse logistics management.

For further analysis of the data and to test the validity of hypothesis one (H1), the 13 reasons for managing reverse logistics were categorised into three groups: strategic advantage (G1); regulatory issues (G2); and financial advantage (G3). The average percentages of the three categories are presented in column two of Table 6.8. This clearly implies that reverse logistics management is a strategic advantage (53 per cent) in the OM & EM industries. Customer and environmental protection laws (31 per cent) are not important motivators for reverse logistics. This finding differs from literature which highlighted that customer and environmental protection laws are important for returns management (Brito & Dekker 2003; Mitsumori 1999). From the findings, financial advantage (17 per cent) also does not appear to be important in the Australian OM & EM industries, however, previous researchers, (Brito, Flapper & Dekker 2003; Lund 1998; Roy 2003; Shih 2001; Srivastava & Srivastava 2006) indicated that substantial financial benefits can be achieved from reverse logistics management. The findings of this research imply that in Australia reverse logistics is new and its financial benefits have not yet been realised.

An exact 95 per cent binomial confidence interval was constructed to determine the significance of reverse logistics being a strategic advantage. Fisher's exact test was also

undertaken to confirm the finding. A summary of the results, grouped A to C, are presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 6.8. Details of Fisher's exact test results are presented in Table 6 in Appendix L.

The results from both the analyses confirm that, in the Australian OM & EM industries, reverse logistics is a strategic advantage (group A in columns three and four). They also show that customer and environmental protection laws (group B in columns three and four) are moderately important.

Based on the above findings for OM & EM industries, hypothesis one (H1): ***OM & EM and E-Business organisations implement returned goods management to achieve strategic advantages, attain financial benefits and to fulfil legal obligations,*** is only partially supported.

6.5.2 Operations in product return process

In this section individual and groups of operations in the product return process in OM & EM industries are investigated and hypothesis two (H2) is tested for validity.

The management of returned goods entails a number of operations, beginning with the receipt of information about the goods to be returned finishing with value recovery operations. To establish operations in the product returns process, a list of operations was presented to respondents to elicit a response with a 'yes' or 'no'. The data collected on eight operations is presented in column two of Table 6.9. It implies that the majority (over 77 per cent) of Australian OM & EM organisations perform the eight operations in the management of returned goods. Selection of a recovery method (85 per cent) and gate-keeping for returns (77 per cent) are the least important operations.

TABLE 6.9:Product return operations

(1) Reasons for reverse logistics management	(2) Percentage n=39	(3) 95% CI lower limit	(3) 95% CI upper limit	(3) Groups of operations with same significance (based on binomial distribution)		(4) Groups of operations with same significance (based on Fisher's exact test)		
1. Information received about the return	100%	93%	100%	A		A		
2. Inspection of returned goods	100%	93%	100%	A		A		
3. Authorisation to return goods	97%	87%	100%	A	B	A	B	
4. Sorting of returned goods	95%	83%	99%	A	B	A	B	
5. Transport of returned goods	95%	83%	99%	A	B	A	B	
6. Refund/reimbursement	92%	79%	98%	A	B	A	B	C
7. Selection of recovery method	85%	69%	94%	A	B		B	C
8. Gate-keeping of returned goods	77%	61%	89%		B			C
G1. Information-centred operations (1, 3, 6 and 8)	**92%**	**86%**	**95%**	**A**		**A**		
G2. Logistics-centred operations (2, 4, 5 and 7)	**94%**	**89%**	**97%**	**A**		**A**		

Note: (categorical scale, 'yes' or 'no' response).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).

However, to confirm the importance of each operation, an exact 95 per cent confidence interval was again calculated, and confirmed with Fisher's exact test. A summary of the results, grouped A to C according to Duncan's grouping method (Duncan 1975), are presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 6.9. Details of Fisher's exact test results are presented in Table 2 in Appendix L.

The findings confirm that collecting information about goods to be returned, facilitating goods return by issuing returns authorisation, transportation of retuned goods, inspection of returned goods for problem identification, sorting of returned goods for recovery operations, refunding customers for returns and selection of a value recovery method (group A in column three) are the main return operations in OM & EM industries.

The results in column four further confirm that six operations notification, authorisation, transportation, inspection, sorting of returned goods and refund for customers (group A in column four) are useful operations for the management of returned goods in OM & EM industries. This analysis did not support selecting a value recovery method to be important. These findings differ from literature which indicates that selection of a recovery and gate-keeping for returns are important operations in the management of returned goods (Amini & Retzlaff-Roberts 2003; Davis, Hagerty & Gerstner 1998; Lau et al. 2004; Lonn & Stuart 2003; Roy 2003).

The eight operations in the product return process were categorised into two groups information-centred and logistics-centred operations based on the characteristics of the operations. Operations that are mainly associated with information and document creation and management are notification, authorisation, refund and gate-keeping of returns were grouped together as information-centred operations (G1). The logistics-centred operations (G2) involve physical handling and movement of goods and are listed as inspection, sorting, transportation and selection of a recovery operation. The categorisations enabled further analysis of data to investigate the importance of the types of operations in product return process and to test the validity of hypothesis two (H2). The average percentages of organisations indicating the importance of the groups of operations in the management of reverse logistics are presented in column two of

Table 6.9. It is clear that both the logistics-centred operations (94 per cent) and information-centred operations (92 per cent) are essential in reverse logistics.

An exact 95 per cent binomial confidence interval and Fisher's exact test were undertaken to further confirm the findings. A summary of the results, group A, is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 6.9 to explicate the importance of the categories of operations in reverse logistics. Details of Fisher's exact test results are presented in Table 7 in Appendix L. It is evident from Table 6.9 (columns three and four) that both logistics and information management are essential for reverse logistics in the OM & EM industries.

It can therefore be concluded that, in OM & EM industries, hypothesis two (H2): ***Logistics and information management are equally important for reverse logistics in OM & EM and E-Business organisations,*** is true and valid.

To establish how OM & EM organisations managed product return operations and associated information, participants were asked to select how they manage the operations in-house or by intermediaries and the information channel used, such as phone, email, post, online or other methods. The participants could choose more than one method by indicating a response with a 'yes' or 'no'.

TABLE 6.10:Method of managing operations and its information

Operations in product return process	**Percentage**						
	Managed by		**Method of collecting return information**				
	In-house	**Intermediaries**	**Phone/ fax**	**Email**	**Post**	**Online IS**	**Other**
Receive return information	97.4	2.6	72	64	28	10	0
Inspection of returned goods	86.5	15.4	21	21	21	10	13
Authorisation to return goods	92.3	5.1	62	56	21	15	0
Transport of returned goods	46.25	**48.7**	33	26	23	18	3
Sorting of returned goods	79.5	15.4	21	23	15	13	13
Refund/reimbursement	84.6	7.7	36	33	21	21	5
Selection of a value recovery	82.1	2.6	26	28	10	13	8
Gate-keeping of return goods	72	5.1	41	36	13	15	5

Column one of Table 6.10 presents the list of operations. Columns two and three of the table present the frequency distributions of the method of managing operations for

respondents. Columns four to eight present the frequency distributions of the mode of information management used by respondents.

It is clear from columns two and three of Table 6.10 that, while most of the product return operations are mainly managed in-house by OM & EM organisations, transportation of returned goods is mainly carried out by intermediaries. It also shows that land-line, fax and email are the preferred technologies supporting reverse logistics data management.

6.5.3 Value recovery operations

This section investigates the value recovery operations used and hypothesis three (H3) is tested for validity.

A number of recovery operations can be used to regain the value from returned goods (Table 5.3, page 87). Participants were presented with a list of value recovery operations and requested to identify the percentage of returned goods processed through each recovery.

The data was initially analysed based on the frequency distributions of operations presented in column two of Table 6.11. It shows that repair (69 per cent), resale (49 per cent) and recycling (41 per cent) are the main recovery operations used to reclaim value from goods that are returned to the Australian OM & EM industries. The other listed recovery operations appear to be of less important.

However, to confirm the importance of each recovery operation, an exact 95 per cent confidence interval and Fisher's exact test were again calculated. A summary of the results, grouped A to E based on Duncan's grouping method (Duncan 1975) are presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 6.11 to explicate the importance of recovery operations to reclaim value from returns. Details of Fisher's exact test results are presented in Table 3 in Appendix L.

TABLE 6.11:Returned product recovery operations

(1) Returned product recovery operations	(2) Percentage n=39	(3) 95% CI lower limit	(3) 95% CI upper limit	(3) Groups of operations with same significance (based on binomial distribution)	(4) Groups of operations with same significance (based on Fisher's exact test)	(5) Percentage of goods recovered: Average %	95% CI lower limit	95% CI upper limit	(5) Groups of operations with same significance (based on one sample t test)
1. Repair	69%	54%	83%	A	A	25.2%	17.2%	33.2%	A
2. Resale	49%	34%	67%	A B	A B	18.9%	9.3%	28.6%	A B
3. Recycling	41%	26%	58%	A B	B C	12.1%	5.5%	18.8%	A B C
4. Landfill	33%	19%	50%	B	B C	8.5%	3.7%	13.4%	B C D
5. Remanufacture	26%	13%	42%	B C	B C	7.7%	1.5%	14.0%	B C D E
6. Redistribution	23%	11%	39%	B C	C	9.0%	1.5%	16.5%	B C D E
7. Upgrade	23%	11%	39%	B C	C	7.3%	2.2%	12.4%	B C D E
8. Refurbishment	23%	9%	36%	B C	C	4.3%	0.0%	9.6%	B C D E F G
9. Reuse	21%	9%	36%	B C	C D	4.0%	0.7%	7.9%	C D E F
10. Incineration	5%	1%	17%	C D	D E	2.0%	0.0%	4.9%	D E F G
11. Hazardous waste management	5%	1%	17%	C D	D E	0.7%	0.0%	2.0%	E F G
12. Donation	3%	0%	13%	C D	E	0.2%	0.0%	0.7%	F G
13. Retrieval	0%	0%	7%	D	E	0.0%	-	-	G
G1. Product recovery (1, 2, 6, 7, 9 and 12)	**31%**	**26%**	**38%**	**A**	**A**	**64.6%**	**54.4%**	**74.8%**	**A**
G2. Module/part/ component /materials recovery (3, 5, 8 and 13)	**22%**	**16%**	**30%**	**A B**	**A B**	**24.2%**	**14.8%**	**33.6%**	**B**
G3. Energy and environmental recovery (4, 10 and 11)	**15%**	**9%**	**22%**	**B**	**B**	**11.2%**	**5.8%**	**16.7%**	**B**

Note: (categorical scale, 'yes' or 'no' response and write-in answer for percentage of goods recovered).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).
(5) = Average percentage of returned goods recovered, upper and lower limits of average value at 95 per cent confidence interval (one sample t test). Average percentages in (5) with the same letter in (5) are not significantly different.

The result in column three confirms that repair, resale and recycling (group A in column three) are the main recovery operations used to regain value from returned goods in OM & EM industries. Although landfill, remanufacture, redistribution, upgrade, refurbish and reuse (group B in column three) are also useful they are less important to recovering value from returned goods. This research finding is different from literature which shows that remanufacture, redistribution, upgrade, refurbish and reuse of returned goods generate financial value to an organisation (Amini & Retzlaff-Roberts 2003; Fleischmann 2000; Rogers et al. 2003; Roy 2003).

Column four of Table 6.11 further confirms that repair and resale (group A in column four) are significant recovery operations for reclaiming value from returned goods in the Australian OM & EM industries. This finding indicate recycling of returned goods has low priority, but it confirms that recycling, landfill and remanufacture (group B in column four) are useful in OM & EM industries. However, they are less important than repair and resale recovery operations. This finding differs from literature which suggests greater financial benefits can be achieved through recovery of material from returned goods as it is realised by manufacturing organisations in other countries such as the USA and Japan (Mitsumori 1999; Roy 2003).

To further confirm the above findings the value recovery operations were further analysed using one sample t-test on the volume of returned goods processed by the respondents. A summary of the results, grouped A to G according to Duncan's grouping method (Duncan 1975), is presented in column five in Table 6.11. This finding indicates that repair (*25.2 per cent*), resale (*18.9 per cent*) and recycling (*12.1 per cent*) are important recovery operations to reclaim monetary value from returned goods in OM & EM industries. The other value recovery operations are less important. It implies that the Australian OM & EM industries do not take full advantage of remanufacture, refurbish, reuse and retrieval recovery operations. Several researchers (Guide & Pentico 2003; Krikke, Jacqueline & Wassenhove; Roy 2003) are of the opinion that cost of recovering a part and component from returned goods is comparatively less than the new production costs of such units.

The 13 value recovery operations were categorised into three groups: product recovery (G1); module, part, component and material recovery (G2); and environmental and

energy recovery (G3). This sorting enabled further analysis of the data. The average percentage of organisations in the three categories indicating the importance of the groups of recovery operations are presented in column two of Table 6.11. This indicates that product recovery (31 per cent) is the main method of regaining value from returned goods in Australian OM & EM industries. While modules, parts, components and materials recovery (22 percent) is used up to some extent, energy and environment recovery operation (15 per cent) is perceived to be least important in OM & EM industries. This may be in part due to there being a consequence of the other activities.

An exact 95 per cent binomial confidence interval and Fisher's exact test were undertaken to confirm the findings. A summary of the results, grouped A and B, are presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 6.11 to establish the importance of the categories of recovery operations. Details of Fisher's exact test results are presented in Table 8 in Appendix L. It is apparent from Table 6.11 that Australian OM & EM organisations consider products recovery as well as modules, parts, component and material recovery operations (group A in columns three and four), to be useful in regaining value from returned goods.

To further confirm the above findings and determine the significance of the three categories of operations, the average percentage of returned goods recovered and a 95 per cent confidence interval were computed using one sample t test. The results are reported in column five of Table 6.11 indicating the importance of the three categories of operations. The results confirm that product recovery (*64.6 ± 10.2 per cent*) is the main method of reclaiming value from the returned goods. Although modules, parts, components and material (*24.2 ± 9.4 per cent*) are also recovered to a lesser extent, environment and energy recovery operations (*11.2 ± 5.4 per cent*) are clearly not practised. Several previous researchers (Brito, Flapper & Dekker 2003; Lund 1998; Roy 2003; Shih 2001) indicated that substantial financial benefits can be achieved by recovering parts, components and materials from returned goods which is obviously not a consideration in surveyed companies.

Thus for OM & EM industries, hypothesis three (H3): ***All returned goods in OM & EM and E-Business industries warrant one or more recovery operations in order to recapture value,*** is partially accepted.

6.5.4 Barriers to reverse logistics

In this section individual and collective barriers to the management of reverse logistics in OM & EM organisations are investigated and the fourth hypothesis (H4) is tested for validity.

As it is usual in the other business operations, organisations encounter barriers in the management of reverse logistics. To determine the barriers for managing reverse logistics in OM & EM organisations, participants were presented with a list of barriers identified from literature and requested to indicate its relevance to their organisation. Participants could choose more than one reason by indicating a response with a 'yes' or 'no'.

The percentages of organisation which encounter the listed barriers are presented in column two of Table 6.12. It is clear that the absence of online, real-time information systems (67 per cent), inability to forecast returns (67 per cent), collection of returns' statistics (67 per cent) and the inability to share information with partners (59 per cent) are the main barriers in the management of reverse logistics in OM & EM industries. They indicate that a lack of efficient management of reverse logistics information is an important barrier in return management.

However, to determine the impact of the other barriers, an exact 95 per cent confidence interval was again calculated, and Fisher's exact test was used to confirm the findings. A summary of the results, grouped A to D according to Duncan's grouping method (Duncan 1975), is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 6.12. Details of Fisher's exact test results are presented in Table 4 in Appendix L.

TABLE 6.12:Barriers to the management of reverse logistics

(1) Barriers to the management of reverse logistics	(2) Percentage n=39	(3) 95% CI lower limit	(3) 95% CI upper limit	(3) Groups of barriers with same significance(based on binomial distribution)			(4) Groups of barriers with same significance (based on Fisher's exact test)				(5) Process time long	(5) Process time short	(5) Process time Fisher's exact test *P-value*
1. Absence of online, real-time information system (IS)	67%	50%	81%	A			A				64%	71%	*0.733*
2. Inability to use IS to forecast	67%	50%	81%	A			A				68%	64%	*1.000*
3. Inability to use IS for statistics	67%	50%	81%	A			A				68%	64%	*1.000*
4. Inability to share information with partners	59%	42%	74%	A	B		A				64%	50%	*0.503*
5. Lack of importance	31%	17%	48%		B	C		B			32%	29%	*1.000*
6. Lack of IS	23%	11%	39%			C		B	C		32%	7%	*0.119*
7. Lack of personnel resources	23%	11%	39%			C		B	C		36%	0%	*0.015****
8. Management inattention	15%	6%	31%			C		B	C	D	24%	0%	*0.071*
9. Many options for return	10%	3%	24%			C			C	D	16%	0%	*0.277*
10. Poor partnership	10%	3%	24%			C			C	D	16%	0%	*0.277*
11. Company policies	10%	3%	24%			C			C	D	12%	7%	*1.000*
12. Lack of financial resources	5%	1%	17%			C				D	8%	0%	*0.528*
13. Legal issues	5%	1%	17%			C				D	4%	7%	*1.000*
G1.Technological barriers (1, 2, 3, 4 and 6)	**56%**	**49%**	**63%**	**A**			**A**				**59%**	**51%**	***0.367***
G2.Operational barriers (5, 8, 9 and 10)	**17%**	**11%**	**23%**		**B**			**B**			**22%**	**7%**	***0.024****
G3.Administrative barriers (7, 11, 12 and 13)	**11%**	**6%**	**17%**		**B**			**B**			**15%**	**4%**	***0.032****

Note: *p-value:* *** = $p \leq 0.05$; *two-tailed Fisher's exact test,* (categorical scale, 'yes' or 'no' response).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).
(5) = Outcomes of Fisher's exact test. (5) returns processing time (up to a week and over).

It is clear from column three that the absence of online, real-time data management systems and the inability to use information systems to collect returns' statistics, forecast returns and share reverse logistics information with partners (group A in column three) are the major impediments to managing reverse logistics. It also implies that a lack of importance as compared to other business operations (group B in column three) is also a barrier to reverse logistics.

The result in column four of Table 6.12 confirms the above findings a lack of information systems for efficient management of returns' information, statistics and forecasting returns (group A in column four) is a major barrier to managing reverse logistics in the Australian OM & EM industries. It confirms that a lack of importance given to reverse logistics is also a barrier (group B in column four).

The 13 barriers to managing reverse logistics are categorised into three groups: technological (G1); operational (G2); and administrative (G3) barriers and were based on their relevance as described in literature. These groupings enabled further analysis of the data. The average percentage of organisations in the three categories of barriers are presented in column two of Table 6.12. This analysis suggests that technological issues (56 per cent) are an important barrier in reverse logistics. The findings also show that operational (17 per cent) and administrative (11 per cent) barriers have less impact on reverse logistics. The findings differ from previous researchers (Morrell 2001; Rogers et al. 2003; Rogers & Tibben-Lembke 2001; Rogers & Tibben-Lembke 1998) who are of the opinions that administrative and operational barriers such as inefficient management of intermediaries, the lack of importance of reverse logistics, management inattention, lack of financial and personnel resources and company policies impact the better management of returned goods.

An exact 95 per cent binomial confidence interval and Fisher's exact test were undertaken to confirm the above findings. A summary of the results, grouped A and B, are presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 6.12. Details of Fisher's exact test results are presented in Table 9 in Appendix L. It is apparent from Table 6.12 that technological issues (group A in columns three and four), and inability to retrieve and manage returned products data to

assist in forecasting future returns are the main barriers in reverse logistics in the Australian OM & EM industries.

The findings show that, though OM & EM organisations identified that reverse logistics information management operations are important for handling returned goods (Table 6.9), they are yet to implement efficient information systems to support online real time management of reverse logistics data.

The barriers were further analysed to determine their impact on return processing time for returned goods. Return processing time were grouped into 'within a week'; and 'over a week'. The Fisher's exact test was undertaken to establish the impact of barriers on processing time. The result (*p-values*) for each barriers are shown in column five of Table 6.12. It indicates that a lack of dedicated personnel (*p-value=0.015*) and a lack of management support (*p-value=0.071*) affect the processing of returned goods in the Australian OM & EM industries. It implies that, if greater management attention was given and sufficient human resources were allocated to the reverse logistics process, the Australian OM & EM industries could process the returned goods within a week. If the returned goods are processed quicker, the OM & EM organisations can obtain financial benefits through enhancing floor space utilisation, productivity, inventory management and machinery utilisation (Azevedo, Ferreira & Leitao 2007; Bourlakis & Bourlakis 2006; Piplani, Pokharel & Tan 2004). As seen from column five of Table 6.12, it is clear that both the operational (*p-value=0.024*) and administrative (*p-value=0.032*) barriers are the main reasons for long return processing time in OM & EM industries. This is similar to (Morrell 2001; Rogers et al. 2003; Rogers & Tibben-Lembke 2001; Rogers & Tibben-Lembke 1998) opinion that administrative and operational barriers affect management of reverse logistics.

This research shows that operational and administrative barriers affect the performance of reverse logistics. As a result the OM & EM organisations are unable to quickly recover returns. While technological barriers are common in these industries they do not have a significant effect on return processing time. Therefore, hypothesis four (H4): ***Effective reverse logistics information management enables better rescheduling of work on returned goods and streamlines administrative processes in OM & EM and E-Business industries,*** is rejected.

6.5.5 Information technologies used to manage returns

This section describes the types of information technologies that are used to support reverse logistics data management in OM & EM organisations. It also analyses the importance of retuned products data for the management of reverse logistics operations.

Information technologies used to support the management of reverse logistics

To ascertain how reverse logistics information is managed respondents were presented with a list of 14 information technologies. Participants were asked to circle an option from a numerical scale which included a zero to indicate not used and 1 to 7 indicating very low to very high use of technology.

The data was initially analysed based on the frequency distributions of technologies used. The percentages are reported in column two of Table 6.13. The outcome shows that the majority of the Australian OM & EM organisations use land-line telephone/fax (97 per cent) and computers (92 per cent) for managing reverse logistics data. Mobile technology (67 per cent) is used by two-thirds of the responding OM & EM organisations. The other technologies are less used. This shows that OM & EM organisations use only basic information technologies to manage reverse logistics data.

However, to determine whether the other technologies are significant in anyway, an exact 95 per cent confidence interval and Fisher's exact test were used. A summary of the results, grouped A to G based on Duncan's grouping method (Duncan 1975) are presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 6.13. Details of Fisher's exact test results are presented in Table 5 in Appendix L.

Data in Table 6.13 confirms that land-line telephone, fax and computers (group A in columns three and four) are the main technologies used to manage reverse logistics in OM & EM industries. It also shows that mobile and other palm devices (group B in column three) are used to lesser extent for reverse logistics data management in these industries**.** The findings from Fisher's exact test indicate that other technologies (group B in column four) are less important.

TABLE 6.13:Technologies supporting reverse logistics data management

(1) Technologies used for reverse logistics management	(2) Percentage n=39	(3) 95% CI lower limit	(3) 95% CI upper limit	(3) Groups of technologies with same significance (based on binomial distribution)							(4) Groups of technologies with same significance (based on Fisher's exact test)						(5) Intensity of technology used: median	95% CI lower limit	95% CI upper limit	Groups of technologies with same significance (based on one sample Wilcoxon test)				
1. Land-line telephone/fax	97%	87%	100%	A							A						5.00	4.50	5.50	A				
2. Computers-laptop/desktop	92%	79%	98%	A	B						A						5.00	4.50	5.50	A				
3. Mobile phone/PDA/other palm device	67%	50%	81%		B	C						B					2.50	2.00	3.50		B			
4. Intranet	56%	40%	72%			C	D					B	C				2.50	1.50	3.50		B	C		
5. Tracking and tracing systems	49%	32%	65%			C	D	E				B	C	D			1.50	0.50	3.00		B	C	D	
6. Enterprise resource planning	41%	26%	58%			C	D	E					C	D			2.00	0.00	3.50		B	C	D	E
7. Barcode and scanning systems	33%	19%	50%			C	D	E	F				C	D	E		1.00	0.00	3.00		B	C	D	E
8.Data mining and data logging systems	33%	19%	50%			C	D	E	F				C	D	E		0.50	0.00	2.00		B	C	D	E
9. Electronic data interchange	31%	17%	48%				D	E	F					D	E		1.00	0.00	1.50			C	D	E
10. Extranet	28%	15%	45%				D	E	F					D	E		0.00	0.00	2.00		B	C	D	E
11. Internet	28%	15%	45%				D	E	F					D	E		0.00	0.00	1.50			C	D	E
12. Decision support systems	18%	8%	34%					E	F	G					E	F	0.00	0.00	0.50				D	E
13. Global positioning systems and geographical information system	8%	2%	21%						F	G						F	0.00	0.00	0.00					E
14. Radio frequency identification	3%	0%	13%							G						F	0.00	0.00	0.00					E

Note: (numerical scale, 0 for not used, 1 to 7 for very low to very high use).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).
(5) = Intensity of technology used, median value, and upper and lower limits of median value at 95 per cent confidence interval constructed from one sample Wilcoxon test. median value in (5) with the same letter in (5) are not significantly different.

To further confirm the above findings, and to identify the intensity of use the 14 information technologies for reverse logistics data management, they were analysed using one sample Wilcoxon test. A summary of the results, grouped A to E according to Duncan's grouping method (Duncan 1975), are presented in column five (one sample Wilcoxon confidence interval) of Table 6.13. It indicates that land-line telephone, fax and computers (*5.00 ± 0.50*) are the most intensively used technologies. Other findings are the same as the findings from Fisher test.

This implies that information technologies that support online, real-time management of reverse logistics data are yet to be deployed in OM & EM industries.

The findings of this research clearly indicate that Australian OM & EM industries are dependant upon standard technologies land-line telephone and fax for communication, and computers for data storing and processing rather than information technologies or systems which support online, real-time data management such as Internet, extranet, enterprise resources planning and electronic data interchange. This finding is different from literature which shows that managing logistics data electronically is useful to improve performance of reverse logistics operations (Humphreys, McIvor & Cadden 2006; Vaaland & Heide 2007; Wagner, Fillis & Johansson 2003).

It is obvious from the findings that the use of information technologies for reverse logistics data management is insignificant. Though this research aimed to understand information management issues in relation to reverse logistics management in Australian OM & EM industries, this minimal use of technology did not allow this research to further explore this issue.

Table 6.13 identified the types of technologies used to manage reverse logistics data. However, it is important to identify the importance of reverse logistics data management on operations. The next section discusses the impact that managing reverse logistics data has on operations in the overall reverse logistics process.

Investigation of the importance of reverse logistics data on reverse logistics operations management

To determine the importance of reverse logistics data management on reverse logistics operations, respondents were asked to identify the impact of data on 17 reverse logistics operations using a numerical scale zero to indicate no impact and 1 to 7 indicating very low to very high impact. Column one of Table 6.14 lists the 17 reverse logistics operations.

The data analysis is presented as frequency distribution (column two of Table 6.14), binomial confidence interval (column two of Table 6.14) and one sample Wilcoxon confidence interval (column three of Table 6.14). Frequency distributions and binominal test indicates that reverse logistics data is important for returned goods inventory management (92.3 per cent), customer relationship management (89.7 per cent), communication with partners, customers and employees (87.2 per cent), management of information (87.2 per cent), return authorisation and gate-keeping (87.2 per cent), collecting and delivering of returns (87.2 per cent), inspection, selection of recovery process and sorting of returns (87.2 per cent), redelivering of recovered goods (84.6 per cent), statistics and forecasts (76.9 per cent), resale, redistribution, repair and upgrade (74.4 per cent), refund customers (71.8 per cent) and recovery of components, parts and modules (64.1 per cent) (group A in column two).

The findings show that reverse logistics data is important for general management, product return and value recovery operations in reverse logistics. This finding supports (Humphreys, McIvor & Cadden 2006; Vaaland & Heide 2007; Wagner, Fillis & Johansson 2003) opinion that managing logistics data is useful to improve performance of reverse logistics operations.

Wilcoxon test (column three in Table 6.14) confirm that reverse logistics data is useful for general management and product return operations of reverse logistics. It also indicates that reverse logistics data is useful for regaining value through resale and repair of returned goods.

TABLE 6.14:Impact of data for managing reverse logistics operations

(1) Reverse logistics related operations	(2)						(3) Importance of reverse logistics data						
	Percentage n=39	95% CI lower limit	95% CI upper limit	Groups of technologies with same significance (based on binomial distribution)			median	95% CI lower limit	95% CI upper limit	Groups of technologies with same significance (based on one sample Wilcoxon test)			
1.Inventory management returned goods related	92.3%	79%	98%	A			5.00	4.00	5.50	A			
2.Customer relationship management	89.7%	76%	97%	A			4.50	3.50	5.00	A	B		
3.Communication	87.2%	73%	96%	A	B		4.00	3.00	5.00	A	B		
4.Information management	87.2%	73%	96%	A	B		4.00	3.00	4.50	A	B		
5.Return authorization and gate keeping	87.2%	73%	96%	A	B		4.00	3.00	4.50	A	B		
6.Collecting and delivering	87.2%	73%	96%	A	B		4.00	3.00	5.00	A	B		
7.Inspection, selection and sorting	87.2%	73%	96%	A	B		4.00	3.00	4.50	A	B		
8.Redelivering to customer / market	84.6%	69%	94%	A	B		4.00	3.00	5.00	A	B		
9.Capture future return information and statistics	76.9%	61%	89%	A	B		3.00	2.50	4.00	A	B	C	
10.Resale and redistribution	74.4%	58%	87%	A	B	C	3.00	2.50	4.00	A	B	C	
11.Repair and upgrade	74.4%	58%	87%	A	B	C	1.00	1.00	1.50				D
12.Refund / reimbursement	71.8%	55%	85%	A	B	C	1.50	1.00	2.00				D
13.Component, part and module recovering	64.1%	47%	79%	A	B	C	2.50	0.50	3.50		B	C	D
14.Reuse	59.0%	42%	74%		B	C	0.50	0.50	1.00				D
15.Recycling	59.0%	42%	74%		B	C	1.50	1.00	2.50			C	D
16.Donation	41.0%	26%	58%			C	1.50	0.00	2.00				D
17Incineration and landfill	41.0%	26%	58%			C	1.00	0.00	1.50				D
G1.General management operations (2, 3, 4 and 9)	**85.3%**	**80%**	**90%**	**A**			**4.00**	**3.50**	**4.00**	**A**			
G2.Product return operations (1, 5, 6, 7, 8 and12)	**85.0%**	**80%**	**89%**	**A**			**3.50**	**3.50**	**4.00**	**A**			
G3.Value recovery operations (10, 11, 13, 14, 15, 16 and17)	**59.0%**	**53%**	**65%**			**B**	**1.50**	**1.00**	**2.00**			**B**	

Note: (numerical scale, 0 for not important, 1 to 7 for very low to very high important).
(2) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (2) are not significantly different.
(3) = Importance of reverse logistics data, median value, and upper and lower limits of median value at 95 per cent confidence interval constructed from one sample Wilcoxon test, median value in (3) with the same letter in (3) are not significantly different.

These 17 operations were categorised into three groups; general management (G1), product return operations (G2) and value recovery operations (G3) for further insight into reverse logistics operations. A summary of the results, grouped A to B, are presented in column two of Table 6.14. This finding also confirms that reverse logistics data is important for (group A) general management (85.3 per cent) and product return operations (85 per cent) of reverse logistics. It also shows that reverse logistics data is less important for value recovery operations.

This finding was further confirmed with one sample Wilcoxon test (column three of Table 6.14).

Based on the findings from the data presented in Tables 6.13 and 6.14 it is clear that, although reverse logistics data is important in managing reverse logistics operations, the majority of the Australian OM & EM organisations mainly apply basic information technologies (land-line telephone, fax and computer) (Table 6.13, page 118) for reverse logistics data management.

6.6 Reverse logistics in OM & EM industries

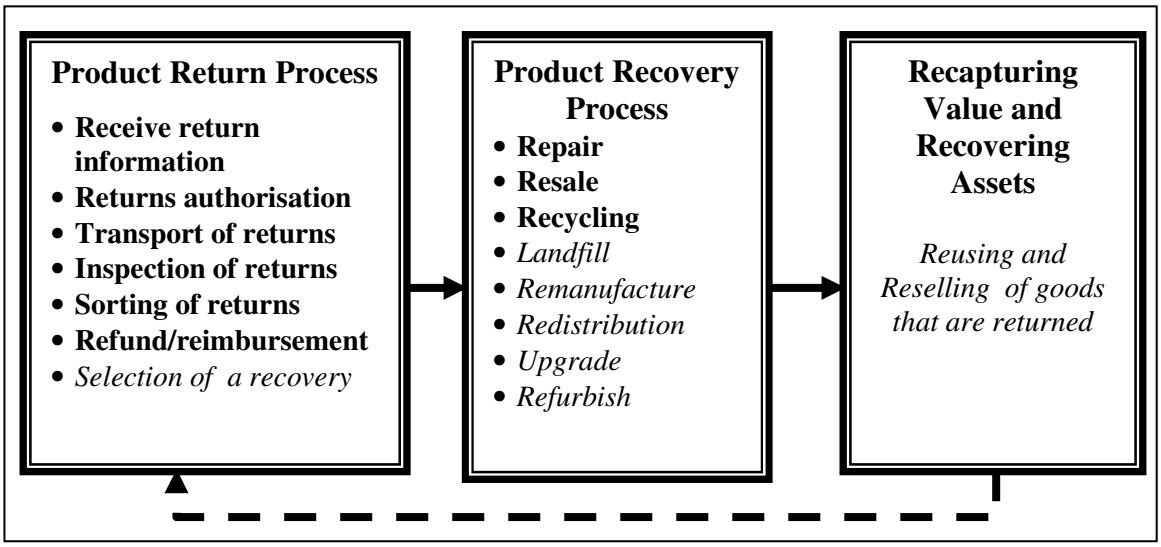
According to the data analysis discussed above, it is clear that in the OM & EM industries implementation of reverse logistics is a strategic advantage and a customer service. However it is also apparent that in this industry only the basic technologies (land-line telephone, fax and computers) are used to manage data, which results in inefficient information management impacting recovery operations for the returned goods.

Value from returned goods is in these industries is gained from repair, resale and recycling of returned goods, unlike in some European countries that perform a number of other recovery operations.

Based on the above findings the reverse logistics process model for OM & EM industries is modified from (Figure 2.1) to (Figure 6.1) making it relevant to OM & EM industries.

The important operations associated with product returning and recovery processes are shown in bold, while moderately important operations are shown in italics.

FIGURE 6.1 A model of the reverse logistics process in the OM & EM industries



Practical significant of Figure 6.1 is that in the OM & EM industries important operations to implement for product returns are receive return information, returns authorisation, transportation of returns, inspection of returns, sorting of returns and refund customers for returns. Some value can be gained from repair, resale and recycling.

Hypotheses one and three were partially supported, hypothesis two was supported and the other was rejected. A summary of result and key findings are presented in Table 6.15.

TABLE 6.15:A summary of outcome of hypotheses

Hypothesis	Result
Hypothesis H1: OM & EM and E-Business organisations implement returned goods management to achieve strategic advantages, attain financial benefits and to fulfil legal obligations.	Partially supported. Reverse logistics is a strategic advantage. It is an important customer service and strategic issue. Financial advantages and legal issues are yet to be strong motives in this industry.
Hypothesis H2: Logistics and information management are equally important for reverse logistics in OM & EM and E-Business organisations.	True and valid. Logistics management and information management are both important in handling of returned products.
Hypothesis H3: All returned goods in OM & EM and E-Business industries warrant one or more recovery operations in order to recapture value.	Partially supported. Product recovery operations are important to recapture value. Module, parts, components and material recovery and energy and environment recovery operations are not important.
Hypothesis H4: Effective reverse logistics information management enables better rescheduling of work on returned goods and streamlines administrative processes in OM & EM and E-Business industries.	Rejected. Information management is a very important barrier in reverse logistics in this industry at present. Administrative and operational barriers are comparatively less important.

6.7 Conclusion

The discussion in this chapter validated hypotheses H1, H2, H3 and H4. It identifies reverse logistics issues in the OM & EM industries.

Chapter 7
SURVEY OF REVERSE LOGISTICS IN THE AUSTRALIAN E-BUSINESS INDUSTRY

7.0 Introduction

While it is evident from literature that the rate of returned goods in the E-Business industry appears to be much higher than the return rate experienced by other industries, there is a lack of knowledge about how Australian E-Business organisations manage reverse logistics. To help fill this gap, this research investigated reverse logistics in the Australia E-Business industry.

This chapter describes the analysis of data collected from the survey of E-Business organisations in Australia. It identifies reverse logistics issues including reasons for reverse logistics, product return operations, value recovery operations, barriers to reverse logistics, information technologies used for reverse logistics information management and reasons for returns from E-Business sales. The data was initially analysed using frequency distributions and to further understand the findings binomial test and Fisher's exact test were undertaken to establish reverse logistics issues in the E-Business industry. One sample t-test was performed on value recovery operations and reasons for E-Business returns since data for these were collected in percentages. Data

on information management issues were ordinal (collected on numerical scale, 0 for no and 1 to 7 for very low to very high) therefore one sample Wilcoxon test was undertaken to further qualify the percentages.

The results are presented in Tables (7.7, 7.8, 7.10, 7.11, 7.12, 7.13 and 7.14) and discussed in this chapter. Based on the findings, the five proposed hypotheses are also tested for validity.

7.1 Survey method

A postal questionnaire survey was selected as an appropriate method to reach the randomly selected 310 Australian E-Business organisations. The purpose of this survey was to identify the reverse logistics in the E-Business industry. The survey instrument was designed to obtain information about why and how E-Businesses manage returns. It includes the reasons, product return operations, value recovery operations, barriers and information technologies used in the management of reverse logistics. It also collected data to determine the reasons why E-Businesses received an increased amount of returns.

7.2 Responses

This section describes the survey responses and how they were checked for non-response bias.

Early and late responses

Twenty-two completed and nine uncompleted responses were received from the survey, as well as 16 returned, undelivered questionnaires. A reminder letter (Appendix J) was sent after two weeks to all except to those from whom surveys were returned undelivered. Seventeen more completed responses and three returned undelivered questionnaires were received in the following next two weeks.

Table 7.1 provides the break-down of survey responses.

The overall response rate from the survey of Australian E-Business organisations was 13.40 per cent, excluding returned surveys. The response rate of 13.40 per cent is used in this research based on Collis and Hussey (2003) and Remenyi et al's (2003) opinion that a 10 per cent or less response from postal questionnaire surveys is not uncommon.

TABLE 7.1:Responses from the survey

Survey on Australian E-Business industry (n=310)	Number sent	Number returned undelivered	Number returned unusable	Number returned usable for analysis	Percentage of response
Before reminder letter	310	16	9	22	13.40%
After reminder letter	-	3	-	17	

Non-bias analysis of early and late responses

A number of pre-survey steps (Chapter 3.1) were undertaken to minimise the effects of non-response bias. As the reminder letters initiated more responses, the variables were evaluated using post-survey statistical test on percentages and the Chi Square test to ascertain non-response bias. Zikmund (2003) suggests that the Chi Square test is a suitable test to examine the homogeneity of two samples of nominal variables. Zero or low counts were discounted from further analysis. The results of the test are shown in Appendix K. The analysis confirms that the survey data is free from non-response bias.

7.3 Data analysis

Initially the data was coded and recoded into an electronic spreadsheet to convert them into numerical form and checked for errors. Data collected from the survey was mainly nominal and ordinal since they were acquired from categorical and numerical scales (Cavana et al. 2001). Data on the volume of goods returned due to each reason and processed through each recovery operations were collected by percentages. The analysis of data is based on frequency distributions, binomial test, Fisher's exact test, one sample t test and one sample Wilcoxon test to identify the important issues of reverse logistics in the E-Business industry.

Data elicited through categorical scale (yes/no) was initially analysed using frequency distributions to understand preliminary reverse logistics issues. To determine the

significance of the findings, an exact 95 per cent binomial confidence interval for the population proportion was constructed. This is based on NIST/SEMATECH (2003) that binomial distribution is a suitable analysis for discrete data and more accurate than normal approximation test for small sample sizes. Several researchers (Keren 2007; Krag et al. 1998) have used this method of data analysis on similar issues. Fisher's exact test was undertaken to confirm the above findings. It is an appropriate nonparametric technique for analysing (nominal or ordinal) discrete variables and it is more accurate than the Chi Square test for all sample sizes (http://www.minitab.com/ 2006; NIST/SEMATECH 2003). It compares the proportions of success of two groups to determine the significance of the difference between proportions (NIST/SEMATECH 2003). In this research, Fisher's exact test was used to compare the proportions of organisations that manage reverse logistics according to the issues (reasons, barriers, product return operations, value recovery operations and reasons for E-Business returns) investigated. As discussed in chapter six in relation to OM & EM industries, this method of proportion comparison has been used in earlier research (Kanji 1993; Krag et al. 1998; Stekel, Git & Falciani 2000).

Based on the findings of the above methods, reverse logistics issues relevant to the E-Business industry in Australia were established. The variables were grouped into pertinent business applications based on their relationship. Data analysis includes frequency distributions, binomial test, Fisher's exact test, t-test and Wilcoxon test.

Based on the analysis reasons for reverse logistics, product return operations, value recovery operations, barriers to reverse logistics and reasons for E-Business returns were established.

Data for information technologies used in E-Business returns were elicited through a numerical scale (0 for no, 1 to 7 for very low to very high) which was initially converted into binary variables; no (responses 0) and yes (responses 1-7). This data was analysed with frequency distributions, binomial test and Fisher's exact test. It identified types of information technologies used and impact of the reverse logistics data collected on reverse logistics operations. The data (responses 0 to 7) was further analysed using one sample Wilcoxon test to confirm the findings from binomial test and Fisher's exact test. Groebner et al. (2005) suggest that one sample Wilcoxon test is useful to analyse

ordinal data and determine the population median value. This method of data analysis is also supported by Krag et al. (1998). The median is the central item in a group of observations when they are presented in either a ascending or descending order (Groebner et al. 2005). Wilcoxon test constructs a 95 per cent confidence interval with a 95 per cent surety that the population median is contained (Gibbons 1976; Hollander & Wolfe 1973). This analysis established the types of information technologies used in reverse logistics and the impact of this collected data on reverse logistics operations.

Based on the results of the Fisher's exact test and the confidence intervals (exact binomial test, one sample t-test and one sample Wilcoxon test) the variables were summarised into groups with similar importance. This grouping is based on Duncan's grouping method (Duncan 1975) and presented in Tables (7.7, 7.8, 7.10, 7.11, 7.12, 7.13 and 7.14) in descending order of the importance as used by Mallela, Titus-Glover & Yu (2006). This analysis was undertaken to test the validity of hypotheses, H1, H2, H3, H4 and H5.

The data analysis elicited from 32 out of the 39 responding E-Business organisations which managed reverse logistics are discussed by first presenting the data as frequency distributions and then the analysis using binomial, Fisher's exact, one sample t and one sample Wilcoxon tests.

7.4 Preliminary findings

This section discusses some background information on the types of organisations that responded to the survey.

7.4.1 Industry categories

The responding E-Business organisations were categorised as either retail or wholesale. It was considered that separately examining these different selling modes could identify whether reverse logistics management differs in the retail and wholesale E-Business. The findings are presented in Table 7.2.

TABLE 7.2:Industry categories

Industry categories	Response	Manage reverse logistics
Retail	25 (8.59%)	22 (88.00%)
Wholesale	14 (4.81%)	10 (71.43%)
Total	**39 (13.40%)**	**32 (82.05%)**

It is clear from Table 7.2 that, while both retail and wholesale traders are likely to manage reverse logistics, it is more important for retailers.

7.4.2 Business models and markets

The data in Table 7.3 shows the E-Business models and the markets in which the responding organisations operate.

TABLE 7.3: Business models and markets

Business model	Market (row%)		
	Global	National	Regional
B2C E-Business	13 (59.1%)	21 (95.5%)	13 (59.1%)
B2B E-Business	8 (61.5%)	13 (100.0%)	6 (46.2%)

The data presented in Table 7.3 indicates that, in the Australian E-Business industry, reverse logistics management is applicable in both B2C and B2B E-Business models, however, it is more important in the B2C E-Business model. It is also evident that returned goods from E-Business sales in all markets (global, national and regional) require reverse logistics.

7.4.3 Title of respondents

Table 7.4 shows the designations of respondents. As with OM & EM industries, it is apparent that most E-Business organisations do not have a dedicated reverse logistics manager and choose to manage this function through already established positions such as director of E-Business (46.88 per cent), operations manager (25 per cent) and marketing manager (12.5 per cent).

TABLE 7.4:Titles of respondents

Designation	Organisation %
Director	15 (46.88%)
Operations Manager	8 (25.00%)
General Manager	4 (12.50%)
CEO	2 (6.25%)
Marketing Manager	1 (3.13%)
Accountant	1 (3.13%)
Returns Manager	1 (3.13%)
Total	**32 (100.0%)**

7.4.4 Time taken to process returned products

Table 7.5 shows the time allowed to customers to return products and the time taken by E-Business organisations to process these products. The processing time shows the efficiency of the returned product management process, while the time allowed to return goods shows the flexibility of product return policies.

TABLE 7.5:Industry categories and time taken to manage returns

Industry categories	Time allowed to return products (row%)			Processing time (row%)	
	One week	Two weeks	Over two weeks	Up to one week	More than one week
Retail	6 (27.27%)	5 (22.73%)	11 (50.00%)	14 (63.64%)	8 (36.36%)
Wholesale	2 (20.00%)	1 (10.00%)	7 (70.00%)	7 (70.00%)	3 (30.00%)
Overall	**8 (25.00%)**	**6 (18.75%)**	**18 (56.25%)**	**21 (65.63%)**	**11 (34.38%)**
Total	**32 (100.0%)**			**32 (100.0%)**	

Mukhopadhyay and Setoputro (2004) state that, by facilitating longer return periods, E-Business organisations gain business advantage through higher sales attracting more customers with better customer relationship management and increased customer trust and confidence. It is also clear that wholesalers allow a longer period for the return of goods than retailers, however, both wholesalers and retailers process returned goods within a week.

7.4.5 Annual income and reverse logistics costs

Table 7.6 shows the annual income and the cost of reverse logistics reported by the responding E-Business organisations.

TABLE 7.6:Annual income and reverse logistics costs

Industry categories	Annual income: AUD $million (row%)		Annual reverse logistics costs: AUD $million (row%)	
	Less than 5	5 or above	1 or less	1 to 5
Retail	11 (50.00%)	11 (50.00%)	22 (100.00%)	0 (0.00%)
Wholesale	4 (40.00%)	6 (60.00%)	9 (90.00%)	1 (10.00%)
Overall	**15 (46.88%)**	**17 (53.13%)**	**31 (96.87%)**	**1 (3.13%)**
Total	**32 (100.0%)**		**32 (100.0%)**	

It can be seen that 46 per cent of the E-Business organisations have an annual income up to AUD $5 million with annual reverse logistics costs of less than AUD $1 million. This suggests that, though these organisations are relatively small in terms of annual income, reverse logistics is considered to be an important business process.

7.5 Data analysis for hypotheses testing

This section establishes reverse logistics management issues reasons for managing reverse logistics, product return operations, value recovery operations, barriers to reverse logistics and information technologies used in the management of returned goods information. It also includes reasons why E-Businesses receive returned goods. The data analysis attempts to validate hypotheses 1, 2, 3, 4 and 5.

7.5.1 Reasons for reverse logistics

In this section, the individual and collective reasons for reverse logistics management in E-Business organisations are investigated and the first hypothesis, (H1) is tested for validity.

To establish why E-Business organisations manage returns, participants were presented with a list of reasons. Participants could choose more than one reason by indicating a response with a ‘yes’ or ‘no’.

Column one of Table 7.7 lists the 13 reasons for managing reverse logistics, as identified from literature. Column two of Table 7.7 indicates that, in E-Business industries, the most important reasons for managing reverse logistics are customer service support (94 per cent) and strategic advantage (88 per cent). Recovery of value

through resale of goods (69 per cent) is also important although moderate. It is also apparent that other reasons for reverse logistics, though less important, are fulfilling legal obligations (56 per cent), complying with retail returns policy (50 per cent) and achieving a competitive advantage (44 per cent).

However, to confirm the importance of each reason, an exact 95 per cent binomial confidence interval was constructed. A summary of the results, grouped A to E are presented in column three of Table 7.7. It is clear that group A reasons (customer service, strategic gain and regain value from resale of returns) are important reasons for reverse logistics in the Australian E-Business industry.

Fisher's exact test was undertaken to further confirm the above findings. A summary of the results, grouped A to F, are presented in column four of Table 7.7. Details of Fisher's exact test results are presented in Table 1 in Appendix M. The findings further confirm that, in the Australian E-Business industry, reverse logistics is implemented for customer service and for strategic advantage. Fisher's exact test result did not indicate regaining value through resale of returns to be significantly important. Other reasons such as legal obligations, retail return policy and achieving a competitive advantage (group C in column four) were less important.

Thus this research finding shows that the management of reverse logistics is a customer service support and a strategic gain in the Australian E-Business industry. Since the binomial test result indicates that regaining value though resale of returns is significant it is inferred that in the E-Business industry financial benefits can be gained from resale of returned goods. Literature also shows that returns in this industry are substantial (Sharma, Wickramasinghe & Singh 2005; Trebilcock 2002), and financial benefits from resale of returns goods are high (James, Thomas & Herbert 2002).

For further analysis of the data and to test the validity of hypothesis one (H1), the 13 reasons for managing reverse logistics were categorised into three groups: strategic advantage (G1); regulatory issues (G2); and financial advantage (G3). The average percentages of the three categories are presented in column two of Table 7.7. This clearly implies that reverse logistics management is a strategic advantage (57 per cent) in the E-Business industry.

TABLE 7.7:Reasons for reverse logistics management

(1) Reasons for reverse logistics management	(2) Percentage n=32	(3) 95% CI lower limit	(3) 95% CI upper limit	(3) Groups of reasons with same significance (based on binomial distribution)	(4) Groups of reasons with same significance (based on Fisher's exact test)
1. Customer service	94%	79%	99%	A	A
2. Strategic issues	88%	71%	96%	A B	A B
3. Resale of returns	69%	50%	84%	A B C	B C
4. Legal obligations	56%	38%	74%	B C	C D
5. Retail return policy	50%	32%	68%	C	C D
6. Competitive reason	44%	26%	62%	C	C D
7. Customer protection laws	31%	16%	50%	C D	D E
8. Clean logistics channel	3%	0%	16%	D E	E F
9. Legal disposal laws	3%	0%	16%	D E	E F
10. Recapture value	3%	0%	16%	D E	E F
11. Environmental protection laws	0%	0%	9%	E	F
12. Recover asset	0%	0%	9%	E	F
13. Protect margin	0%	0%	9%	E	F
G1. Strategic advantage (1, 2, 6 and 8)	**57%**	**48%**	**66%**	**A**	**A**
G2. Customer and environmental protection laws	**28%**	**21%**	**36%**	**B**	**B**
G3. Financial advantage (3, 10, 12 and 13)	**18%**	**12%**	**26%**	**B**	**C**

Note: (categorical scale, 'yes' or 'no' response).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).

An exact 95 per cent binomial confidence interval was constructed to determine whether reverse logistics is indeed a strategic advantage to the E-Business industry, with Fisher's exact test being undertaken to confirm the finding. A summary of the results, grouped A to C are presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 7.7. Details of Fisher's exact test results are presented in Table 7 in Appendix M.

The results from both the analyses confirm that, in the Australian E-Business industry, reverse logistics is a strategic advantage (group A in columns three and four). They also show that customer and environmental protection laws (group B in columns three and four) are important only to some extent and financial gains are moderately important.

Thus, for the E-Business industry, hypothesis one (H1): ***OM & EM and E-Business organisations implement returned goods management to achieve strategic advantages, attain financial benefits and to fulfil legal obligations,*** is only partially supported.

7.5.2 Operations in product returns process

The product return process entails a number of operations, beginning with the receipt of information about the goods to be returned and finishing with value recovery if any. To establish which operations are used in the product returns process, a list of operations was presented to respondents to elicit a response with a 'yes' or 'no'. The data collected on eight operations is presented in column two of Table 7.8. It implies that the majority (over 63 per cent) of Australian E-Business organisations perform the eight operations in the management of returned goods, selection of a recovery method (69 per cent) and gate-keeping on returns (63 per cent) being the least important operations.

TABLE 7.8:Product return process

(1) Reasons for reverse logistics management	(2) Percentage n=32	(3) 95% CI lower limit	(3) 95% CI upper limit	(3) Groups of operations with same significance (based on binomial distribution)		(4) Groups of operations with same significance (based on Fisher's exact test)		
1. Information received about the return	97%	84%	100%	A		A		
2. Refund/reimbursement	97%	84%	100%	A		A		
3. Transport of returned goods	94%	79%	99%	A	B	A		
4. Authorisation of returned good	91%	75%	98%	A	B	A	B	
5. Inspection of returned goods	91%	75%	98%	A	B	A	B	
6. Sorting of returned goods	88%	71%	96%	A	B	A	B	C
7. Selection of recovery method	69%	50%	84%	A	B		B	C
8. Gate-keeping of returned good	63%	44%	79%		B			C
G1. Information-centred operations (1, 2, 4 and 8)	**87%**	**80%**	**92%**	**A**		**A**		
G2. Logistics-centred operations (3, 5, 6 and 7)	**85%**	**78%**	**91%**	**A**		**A**		

Note: (categorical scale, 'yes' or 'no' response).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).

However, to confirm the importance of each operation, an exact 95 per cent confidence interval was again calculated, and confirmed with Fisher's exact test. A summary of the results, grouped A to C based on Duncan's grouping method (Duncan 1975), is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 7.8. Details of Fisher's exact test results are presented in Table 2 in Appendix M.

Fisher's exact test result in column four, Table 7.8 indicates that gate keeping is not an important operation in E-Business returns management.

As for the OM & EM industries the eight operations in product return process were categorised into two groups information-centred and logistics-centred operations based on their characteristics. These categorisations enabled further analysis of the data to test the validity of hypothesis two (H2). The average percentages of organisations indicating the importance of the groups of operations in the management of reverse logistics are presented in column two of Table 7.8. It is clear that both the logistics-centred operations (87 per cent) and information-centred operations (85 per cent) are essential in reverse logistics.

An exact 95 per cent binomial confidence interval and Fisher's exact test were undertaken to further confirm the above findings. A summary of the results, group A, is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 7.8. Details of Fisher's exact test results are presented in Table 8 in Appendix M. It is clear from Table 7.8 (columns three and four) that for reverse logistics in the Australian E-Business organisations both logistics and information management operations are important.

Based on these research findings, for the E-Business industry, hypothesis two (H2): ***Logistics and information management are equally important for reverse logistics in OM & EM and E-Business organisations,*** is true and valid.

To establish how E-Business organisations manage operations and related information in the product returns process, participants were asked to select how they manage these operations (managed in-house or by intermediaries) and to identify the information tool

(phone, email, post, online or other method) for information. The participants could choose more than one method by indicating a response with a 'yes' or 'no'.

Table 7.9 presents frequency distributions of operations for parties that manage these operations and the mode of information management used by them.

TABLE 7.9:Method of managing operations and information

Operations in product return process	Percentage						
	Managed by		Method of collecting returns information				
	In-house	Intermediaries	Phone/fax	Email	Post	Online IS	Other
Receive return information	97.0	0.0	63	75	34	16	6
Refund/reimbursement	97.0	0.0	31	22	25	31	9
Authorisation to return goods	87.5	3.1	53	63	9	19	0
Inspection of returned goods	87.5	3.1	19	6	38	3	22
Sorting of returned goods	84.4	3.1	16	3	28	3	13
Selection of a recovery method	68.8	0.0	22	13	25	6	9
Gate-keeping for return goods	62.5	0.0	22	22	19	9	6
Transport of returned goods	56.0	**38.0**	9	6	44	6	6

The findings show that E-Business organisations mainly manage their reverse logistics operations in-house except for transportation of returned goods (38.0 per cent) where intermediaries are used. Land-line telephone, fax and email are the main technologies used to manage reverse logistics information in this industry as well.

7.5.3 Value recovery operations

This section investigates the value recovery operations used on returned goods and hypothesis three (H3) is tested for validity.

Returned goods can be processed through different recovery methods based on their condition (Table 5.3, page 87). Participants were presented with a list of recovery operations and requested to identify the percentage of returned goods processed through each recovery in their organisations.

The data is presented in frequency distributions in column two of Table 7.10. It indicates that resale (91 per cent) of returned good is the most prevalent operation used to regain value from returned goods in the Australian E-Business industry. The other listed recovery operations appear to be of less important.

TABLE 7.10:Returned product recovery operations

(1) Returned product recovery operations	(2) Percentage n=32	(3) 95 CI lower limit	(3) 95 CI upper limit	(3) Groups of operations with same significance (based on binomial distribution)				(4) Groups of operations with same significance (based on Fisher's exact test)				(5) Percentage of goods recovered: Average	95 CI lower limit	95 CI upper limit	Groups of operations with same significance (based on one sample t test)			
1. Resale	91	75	98	A				A				60.6	47.8	73.3	A			
2. Repair	41	24	59		B				B			8.2	2.3	14.1		B	C	
3. Redistribution	38	21	56		B	C			B			11.7	4.1	19.4		B		
4. Landfill	25	11	43		B	C			B	C		8.0	0.2	15.8		B	C	
5. Reuse	22	9	40		B	C	D		B	C		3.4	0.6	6.2		B	C	
6. Donation	19	7	36		B	C	D		B	C		3.3	0.0	6.9		B	C	D
7. Upgrade	9	2	25		B	C	D			C	D	1.1	0.0	2.7			C	D
8. Recycling	9	2	25		B	C	D			C	D	2.0	0.0	5.3		B	C	D
9. Refurbishment	6	1	21			C	D			C	D	0.6	0.0	1.6				D
10. Remanufacture	6	1	21			C	D			C	D	1.1	0.0	2.8			C	D
11. Retrieval	0	0	9				D				D	0.0	-	-				D
12. Incineration	0	0	9				D				D	0.0	-	-				D
13. Hazardous waste mgt	0	0	9				D				D	0.0	-	-				D
G1. Product recovery (1, 2, 3, 5, 6 and 7)	**37**	**30**	**44**	**A**				**A**				**88.3**	**79.7**	**96.8**	**A**			
G2. Modules/parts/ components /materials recovery (8, 9, 10 and 11)	**6**	**2**	**11**			**B**				**B**		**3.8**	**0.0**	**7.8**			**B**	
G3. Energy and environmental recovery (4, 12 and 13)	**8**	**4**	**16**			**B**				**B**		**8.0**	**0.2**	**15.8**			**B**	

Note: (categorical scale, 'yes' or 'no' response and write-in answer for percentage of goods recovered).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).
(5) = Average percentage of returned goods recovered, upper and lower limits of average value at 95 per cent confidence interval (one sample t test). Average percentages in (5) with the same letter in (5) are not significantly different.

However, to confirm the importance of each recovery operation, an exact 95 per cent confidence interval and Fisher's exact test were undertaken. A summary of the results, grouped A to D according to Duncan's grouping method (Duncan 1975), is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 7.10. Details of Fisher's exact test results are presented in Table 3 in Appendix M.

The result in column three confirms that resale (group A in column three) is the main recovery operation used to regain value from returned goods in the E-Business industry. Fisher's exact test result presented in column four of Table 7.10 further confirms that resale (group A in column four) of returned goods is the main method of reclaiming value from E-Business returns in Australia. From Table 7.2 (page 129) and Table 7.3 (page 129) it is evident that in E-Business sales more goods are sold via the B2C E-Business model and returns are more prevalent in the retail industry. Based on this it is assumed that types of goods returned in E-Business will not warrant repair, redistribution, landfill, reuse and donation.

To further confirm the above findings the value recovery operations were further analysed using one sample t-test on the volume of returned goods processed by the respondents. A summary of the results, grouped A to D, based on Duncan's grouping method (Duncan 1975), is presented in column five in Table 7.10. This finding indicates that resale (*60.6 per cent*) is the only important recovery operation for value gains from E-Business returns. The other value recovery operations are less important.

For further analysis the 13 value recovery operations were categorised into three groups: product recovery (G1); module, part, component and material recovery (G2); and environmental and energy recovery (G3). This sorting enabled further analysis of the data to test the validity of hypothesis three (H3). The average percentage of organisations in the three categories indicating the importance of the groups of recovery operations are presented in column two of Table 7.10. Besides product recovery no other useful information was obtained.

An exact 95 per cent binomial confidence interval and Fisher's exact test were undertaken to confirm the findings. A summary of the results, grouped A and B are presented in columns three (binomial confidence interval) and four (Fisher's exact test)

in Table 7.10 to establish the importance of the categories of recovery operations. Details of Fisher's exact test results are presented in Table 9 in Appendix M. Binomial test and Fisher's exact test further confirm that in the Australian E-Business industry value from returned goods is regained from products rather than parts or components.

To further confirm the above findings a 95 per cent confidence intervals was computed using one sample t test. The result is reported in column five of Table 7.10 clearly confirming that product recovery (*88.3 ± 8.5 per cent*) enables reclaiming value from the returned goods in E-Business.

Thus, for the E-Business industry, hypothesis three (H3): ***All returned goods in OM & EM and E-Business industries warrant one or more recovery operations in order to recapture value,*** is only partially accepted.

7.5.4 Barriers to reverse logistics

In this section, individual and collective barriers to the management of reverse logistics in E-Business organisations are investigated and the fourth hypothesis (H4) is tested for validity.

To determine the barriers for managing reverse logistics in the E-Business industry, participants were presented with a list of barriers identified from literature and requested to indicate its relevance to their organisation. Participants could choose more than one reason by indicating a response with a 'yes' or 'no'.

Table 7.11 lists barriers (column one) and frequency distributions (column two). It is clear that the absence of online real-time information systems (75 per cent), the inability to share information with partners (72 per cent), inability to forecast returns (72 per cent) and collection of returns' statistics (59 per cent) are the main barriers in the management of reverse logistics in the E-Business industry.

TABLE 7.11:Barriers to the management of reverse logistics

(1) Barriers to the management of reverse logistics	(2) Percentage n=32	(3) 95 CI lower limit	(3) 95 CI upper limit	(3) Groups of barriers with same significance(based on binomial distribution)		(4) Groups of barriers with same significance (based on Fisher's exact test)		(5) Process time long	(5) Process time short	(5) Process time Fisher's exact test *P-value*
1. Absence of online real-time information system (IS)	75	57	89	A		A		64	81	*0.397*
2. Inability to share information with partners	72	53	86	A		A		82	67	*0.441*
3. Inability to use IS to forecast	72	53	86	A		A		64	76	*1.000*
4. Inability to use IS for statistics	59	41	76	A		A		64	57	*0.681*
5. Lack of IS	22	9	40		B		B	18	24	*1.000*
6. Many options for return	22	9	40		B		B	45	10	*0.032****
7. Lack of importance	22	9	40		B		B	18	24	*1.000*
8. Lack of financial resource	19	7	36		B		B	18	19	*1.000*
9. Company policies	16	5	33		B		B	18	14	*1.000*
10. Lack of personnel resources	9	2	25		B		B	9	10	*1.000*
11. Management inattention	6	1	21		B		B	9	5	*1.000*
12. Poor partnership	6	1	21		B		B	9	5	*1.000*
13. Legal Issues	6	1	21		B		B	0	10	*0.534*
G1.Technological barriers (1, 2, 3, 4 and 5)	**60**	**52**	**68**	**A**		**A**		**58**	**61**	***0.737***
G2.Operational barriers (6, 7, 11 and 12)	**14**	**9**	**21**		**B**		**B**	**20**	**11**	***0.180***
G3.Administrative barriers (8, 9, 10 and 13)	**13**	**7**	**20**		**B**		**B**	**11**	**13**	***1.000***

Note: *p-value: *** = $p \leq 0.05$; two-tailed Fisher's exact test,* (categorical scale, 'yes' or 'no' response).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).
(5) = Outcomes of Fisher's exact test. (5) returns processing time (up to a week and over).

To further understand the outcomes of frequency distributions, an exact 95 per cent confidence interval and Fisher's exact test were calculated. A summary of the results, grouped A to B according to Duncan's grouping method (Duncan 1975), is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 7.11. Details of Fisher's exact test results are presented in Table 4 in Appendix M.

The result in column three of Table 7.11 confirms the frequency distribution findings. Fisher's exact test result in column four of Table 7.11 further confirms the above findings.

The 13 barriers to managing reverse logistics are categorised into three groups based on their relevance as described in literature: technological (G1); operational (G2); and administrative (G3). These groupings enabled further analysis of the data and to test the validity of hypothesis four (H4). The average percentage of organisations in the three categories of barriers are presented in column two of Table 7.11. It is clear that technological issues (60 per cent) are a more important barrier in reverse logistics. Technological barrier was confirmed to be the most important in E-Business with 95 per cent binomial confidence interval (column three in Table 7.11) and Fisher's exact test (column four in Table 7.11).

The barriers were further analysed to determine their impact on return processing time for returned goods. Return processing times were grouped into 'within a week' and 'over a week'. The Fisher's exact test was undertaken to establish the impact of barriers on processing time. Processing time is important to recover value from returned goods. P-*values* from Fisher's exact test presented in column five of Table 7.11 indicate that having "many options for returns" (*p-value=0.032*) impact processing time for returned goods in E-Business.

Thus, for the E-Business industry, hypothesis four (H4): ***Effective reverse logistics information management enables better rescheduling of work on returned goods and streamlines administrative processes in OM & EM and E-Business industries,*** is rejected.

7.5.5 Information technologies used to manage returns

This section describes the outcome of the data analysis on the types of information technologies that support reverse logistics data management in the E-Business industry. It also analyses the importance of returned products' data for the management of reverse logistics operations in these organisations.

Information technologies used in the management of reverse logistics

To establish how the returned good information is managed, the respondents were asked to choose the types of technologies they used for processing information. A list of technologies identified from literature to be information processing technologies was presented to them in the survey. Participants were asked to circle an option from a numerical scale (a zero to indicate not use and 1 to 7 indicating very low to very high use of technology) to indicate the level of use of these technologies.

The data was initially analysed based on the frequency distribution of technologies used. The percentages are reported in column two of Table 7.12. The outcome shows that the majority of the Australian E-Business organisations use land-line telephone/fax (100 per cent) and computers (94 per cent) to manage reverse logistics data.

However, to determine whether the other technologies are in anyway relevant, an exact 95 per cent confidence interval and Fisher's exact test were used. A summary of the results, grouped A to F according to Duncan's grouping method (Duncan 1975), is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 7.12. Details of Fisher's exact test results are presented in Table 5 in Appendix M. The findings from both the analyses confirm that land-line telephone, fax and computers (group A in columns three and four) are the main technologies used to manage reverse logistics data in the Australian E-Business industry. This finding is similar to that in the OM & EM industries, however strange for the E-Business industry which is computer and Internet based. Although not confirmed in this research it is assumed that E-Business is focused more on forward logistics and less on reverse logistics.

TABLE 7.12: Technologies supporting reverse logistics data management

(1) Technologies used for reverse logistics management	(2) Percentage n=32	(3) 95 CI lower limit	(3) 95 CI upper limit	(3) Groups of technologies with same significance (based on binomial distribution)	(4) Groups of technologies with same significance (based on Fisher's exact test)	(5) Intensity of technology used median	(5) 95 CI lower limit	(5) 95 CI upper limit	(5) Groups of technologies with same significance (based on one sample Wilcoxon test)
1. Land-line telephone/fax	100	91	100	A	A	4.50	3.50	5.50	A B
2. Computers- laptop/desktop	94	79	99	A	A	6.00	5.00	6.50	A
3. Internet	56	38	74	B	B	3.50	2.00	3.50	B C
4. Mobile phone/PDA/other palm device	44	26	62	B C	B C	1.00	0.00	2.50	C D
5. Tracking and tracing system	31	16	50	B C D	B C D	0.50	0.00	3.00	C D
6. Barcode and scanning system	28	14	47	B C D	C D	0.00	0.00	2.00	C D
7. Intranet	25	11	43	B C D	C D E	0.00	0.00	2.00	C D
8. Electronic data interchange	16	5	33	C D	D E F	0.00	0.00	0.00	D
9. Decision support system	16	5	33	C D	D E F	0.00	0.00	0.00	D
10. Enterprise resource planning	16	5	33	C D	D E F	0.00	0.00	0.00	D
11. Data mining and logging system	13	4	29	C D	D E F	0.00	0.00	0.00	D
12. Extranet	13	4	29	C D	D E F	0.00	0.00	0.00	D
13.Radio frequency identification	6	1	21	D	E F	0.00	0.00	0.00	D
14. Global positioning and geographical information system	3	0	16	D	F	0.00	0.00	0.00	D

Note: (numerical scale, 0 for not used, 1 to 7 for very low to very high use).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).
(5) = Intensity of technology used, median value, and upper and lower limits of median value at 95 per cent confidence interval constructed from one sample Wilcoxon test. median value in (5) with the same letter in (5) are not significantly different.

This was further confirmed with one sample Wilcoxon test. A summary of the results, grouped A to D based on Duncan's grouping method (Duncan 1975), is presented in column five (one sample Wilcoxon confidence interval) of Table 7.12. No new information was gleaned from this analysis.

Although one of the aims of this research was to gain a deeper understanding of information management issues in relation to reverse logistics in the Australian E-Business industry, the lack of application of information technologies in this industry as well did not support this investigation.

The next section discusses the impact of managing reverse logistics data on operations.

Investigation of the importance of reverse logistics data for the management of reverse logistics operations

To determine the importance of reverse logistics data management, respondents were asked to identify the impact of data on the 17 reverse logistics operations using a numerical scale zero to indicate no impact and 1 to 7 indicating very low to very high impact. Column one of Table 7.13 lists the 17 reverse logistics operations. The data analysis is presented as frequency distribution (column two of Table 7.13), binomial confidence interval (column two of Table 7.13) and one sample Wilcoxon confidence interval (column three of Table 7.13). The findings are the same as in the OM & EM industries discussed in Chapter Six (pages 119 and 120) that reverse logistics data is important for general management and product return operations in reverse logistics..

TABLE 7.13:Impact of data for managing reverse logistics operations

(1) Reverse logistics related operations	(2)								(3) Importance of reverse logistics data							
	Percentage n=32	95 CI lower limit	95 CI upper limit	Groups of technologies with same significance (based on binomial distribution)					median	95 CI lower limit	95 CI upper limit	Groups of technologies with same significance (based on one sample Wilcoxon test)			
1.Customer relationship management	81	64	93	A					5.00	3.50	6.00	A			
2.Communication	78	60	91	A					3.50	3.00	5.00	A			
3.Redelivering to customer and market	75	57	89	A					3.50	2.50	4.00	A	B		
4.Resale and redistribution	75	57	89	A					3.50	2.00	4.00	A	B		
5.Inventory management returned goods related	72	53	86	A	B				3.50	2.50	4.50	A	B		
6.Inspection, selection and sorting	72	53	86	A	B				3.00	2.00	3.50	A	B		
7.Information management	69	50	84	A	B	C			3.00	2.00	4.00	A	B		
8.Collecting and delivering	63	44	79	A	B	C	D		2.50	2.00	3.50	A	B		
9.Refund reimbursement	63	44	79	A	B	C	D		2.50	1.50	3.50	A	B		
10.Reuse	63	44	79	A	B	C	D		2.50	1.50	3.50	A	B		
11.Return authorisation and gate-keeping	59	41	76	A	B	C	D	E	2.00	1.00	3.50	A	B	C	
12.Capture future return information statistics	56	38	74	A	B	C	D	E	2.00	1.00	2.50		B	C	
13.Repair and upgrade	47	29	65	A	B	C	D	E	1.00	0.50	2.50		B	C	D
14.Recycling	34	19	53		B	C	D	E	0.50	0.00	1.00			C	D
15.Donation	31	16	50			C	D	E	0.50	0.00	1.00			C	D
16.Component, part and module Recovering	28	14	47				D	E	0.00	0.00	1.00			C	D
17.Incineration and landfill	25	11	43					E	0.00	0.00	0.50				D
G1.General Management Operation (1, 2, 7 and 12)	**71**	**62**	**79**	**A**					**3.50**	**3.00**	**3.50**	**A**			
G2.Product return Operations (3, 5, 6, 8, 9 and 11)	**67**	**60**	**74**	**A**					**3.00**	**2.50**	**3.50**	**A**			
G3.Value recovery operations (4, 10, 13, 14, 15, 16 and 17)	**43**	**37**	**50**				**B**		**1.00**	**0.50**	**0.50**			**B**	

Note: (numerical scale, 0 for not important, 1 to 7 for very low to very high important).
(2) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (2) are not significantly different.
(3) = Importance of reverse logistics data, median value, and upper and lower limits of median value at 95 per cent confidence interval constructed from one sample Wilcoxon test, median value in (3) with the same letter in (3) are not significantly different.

7.5.6 Reasons for E-Business returns

In this section, the individual and collective reasons why E-Business receive an increased amount of returns are investigated. The fifth hypothesis (H5) only for E-Business industry is also tested for validity.

As with other businesses, in E-Business, customers return goods due to different reasons and, from literature, it is evident that rate of returns in E-Business industry is high (Section 2.8.3, page 19). Thirteen reasons for return identified from literature were presented to the participants. They were requested to identify the percentage of returned goods.

Frequency distribution of data analysed is presented in column two of Table 7.14. It shows that goods are returned because of defects or damage at the point of delivery (75 per cent), errors in ordering (72 per cent), wrong product delivery (66 per cent) and customer change of mind on receipt of goods (66 per cent). While invalid (41 per cent) and warranty (41 per cent) reasons also account for returns in the E-Business industry, they are of less important.

However, to confirm the importance of the above reasons, an exact 95 per cent confidence interval and Fisher's exact test were again calculated. A summary of the results, grouped A to D according to Duncan's grouping method (Duncan 1975), is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 7.14. Details of Fisher's exact test results are presented in Table 6 in Appendix M.

The result indicates that defects and damage to products at the point of delivery, errors in ordering, customers changing their mind, incorrect product delivery, warranty and invalid reasons (group A in column three) are the main reasons for an increased volume of returns in the E-Business industry. This findings differ from literature (Harris & Goodman 2001; Lee 2002; Smith 2005) which indicate that E-Business returns are usually due to late delivery, trade-ins, over-stocked and seasonal business cycles.

TABLE 7.14:Reasons for E-Business returns

(1) Reasons for E-Business customer returns	(2) Percentage n=32	(3) 95 CI lower limit	(3) 95 CI upper limit	(3) Groups of operations with same significance (based on binomial distribution)				(4) Groups of operations with same significance (based on Fisher's exact test)					(5) Percentage of goods returned Average	95 CI lower limit	95 CI upper limit	Groups of operations with same significance (based on one sample t test)				
1. Defective/damaged product	75	57	89	A				A					20.2	10.2	30.2	A				
2. Error in ordering	72	53	86	A				A					18.4	9.9	26.9	A				
4. Customer decision	66	47	81	A				A	B				26.1	14.3	37.9	A				
3. Wrong product delivery	66	47	81	A				A	B				9.7	4.1	15.2	A	B	C		
6. Warranty	41	24	59	A	B				B	C			12.3	4.8	19.9	A	B			
5. Invalid reason	41	24	59	A	B				B	C			5.3	2.4	8.2		B	C	D	
7. Late delivery	25	11	43		B	C				C	D		2.1	0.0	4.2			C	D	E
8. Upgrade/service purpose	13	4	29		B	C	D				D	E	1.7	0.0	3.8				D	E
9. Seasonal return	9	2	25		B	C	D				D	E	3.9	0.0	9.3		B	C	D	E
10. Excess return	9	2	25		B	C	D				D	E	0.5	0.0	1.0					E
11. Ambiguity of product manual	6	1	21			C	D				D	E	0.2	0.0	0.6					E
12. End of life return	6	1	21			C	D				D	E	0.2	0.0	0.5					E
13. End of use return	0	0	9				D					E	0.0	-	-					E
G1. Virtual Conceptualisation (2, 3, 4, 5, 7 and 11)	**46**	**39**	**53**	**A**				**A**					**61.8**	**49.6**	**74.0**	**A**				
G2. After-sales service (1, 6, 8 and 12)	**34**	**25**	**42**	**A**					**B**				**34.3**	**22.3**	**46.2**		**B**			
G3. Business agreement (9, 10 and 13)	**6**	**2**	**13**			**B**					**C**		**4.4**	**0.0**	**9.8**					**C**

Note: (categorical scale, 'yes' or 'no' response and write-in answer for percentage of goods recovered).
(3) = Exact 95 per cent binomial confidence interval, percentages in (2) with the same letter in (3) are not significantly different.
(4) = Outcome of Fisher's exact test, percentages in (2) with the same letter in (4) are not significantly different (*p-value >0.05*).
(5) = Average percentage of returned goods, upper and lower limits of average value at 95 per cent confidence interval (one sample t test). Average percentages in (5) with the same letter in (5) are not significantly different.

Column four of Table 7.14 confirm that product problems at the point of delivery, errors in ordering, customers changing their mind after placing the order and delivery of wrong product (group A in column four) are the important reasons for an increased volume of returned goods in the Australian E-Business industry.

Analysis of data with one sample t-test further confirmed that defects and damage to products at the point of delivery (*20.2 per cent*), ordering error (*18.4 per cent*), customers decision not to accept the goods (*26.1 per cent*), delivery of incorrect product (*9.7 per cent*) and warranty requirement (*12.3 per cent*) (group A in column five) are reasons for returns.

The 13 reasons for E-Business returns were categorised into three groups: virtual conceptualisation (G1); after-sale service (G2); and business agreements (G3). This categorisation aided further analysis of data and testing of the validity of hypothesis five (H5). The average percentage of organisations in the three categories indicating the importance of the groups of reasons for E-Business returns are presented in column two of Table 7.14. This indicates virtual conceptualisation of goods (46 per cent) and after sales service (34 per cent) warrant return of goods in the Australian E-Business industry.

This was further confirmed with an exact 95 per cent binomial confidence interval and Fisher's exact test. A summary of the results, grouped A to C, is presented in columns three (binomial confidence interval) and four (Fisher's exact test) in Table 7.14. Details of Fisher's exact test results are presented in Table 11 in Appendix M. This finding also indicates that virtual conceptualisation is an issue for E-Business returns. Binomial test (group A in column three) indicates that after sale service is also an important reason for E-Business industry returns, however, Fisher's exact test did not support the findings. Both the above tests confirm that returns due to business agreement are not important in this industry. This findings differs from literature, which indicates that returns due to business agreements such as end of season, end of use (lease) and excess is prevalent (Lee 2002; Sarkis, Meade & Talluri 2004).

One sample t-test (column five Table 7.14) also confirms that problems with virtual conceptualisation (*61.8 ± 12.2 per cent*) is the main reason for goods returned in the

Australian E-Business industry. This findings support literature which shows that non-defective returned goods can account for up to 55 per cent or more of total returns (Lee 2002). It also confirms that after sale service (*34.3 ± 12.0 per cent*) also generate one third of the industry returns.

Based on the above findings form the E-Business industry, hypothesis five (H5): ***Online customers return goods because they find the goods they receive are different from how they conceptualised them on a computer screen, due to after sales service and business agreements***, is only partially supported.

7.6 Reverse logistics in the E-Business industry

This research identifies that reverse logistics is a customer service support and a strategic advantage in the Australian E-Business industry. It also shows that value is regained from resale of returned goods in E-Business.

E-Businesses recognised that information management as well as logistics management are important in the management of reverse logistics. However, it is clear that data and information management of returned products is an important barrier.

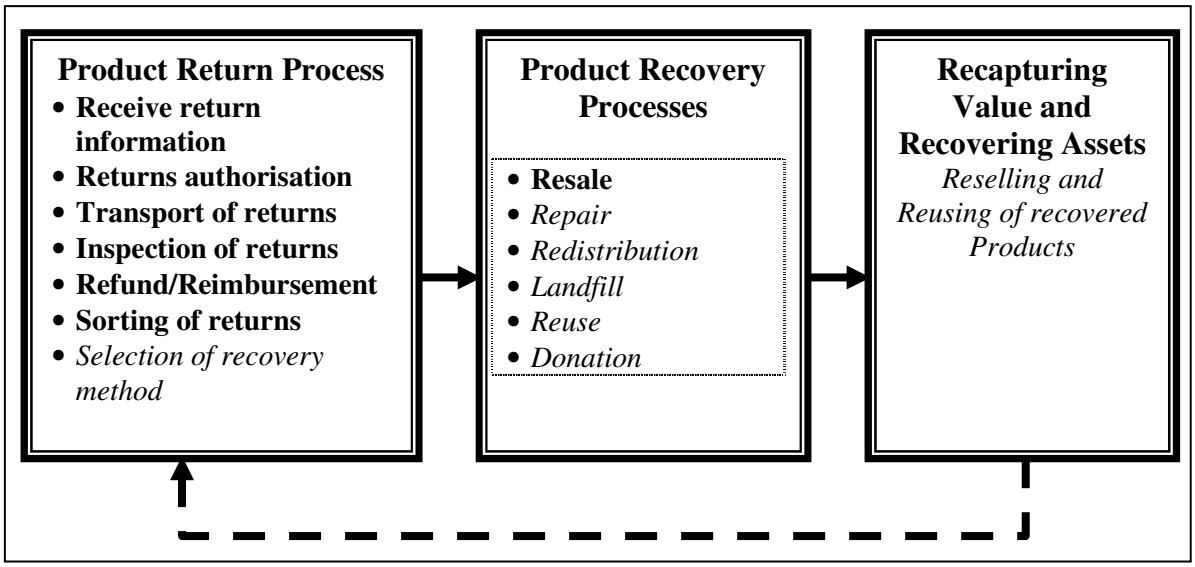
Based on the above findings the reverse logistics process model for the E-Business industry is modified from (Figure 2.1) to (Figure 7.1) making it relevant to this industry.

The important operations associated with product return and recovery processes are shown in bold, while moderately important operations are shown in italics.

This research reveals that, in E-Business the only important value recovery operation is resale of goods.

The model (Figure 7.1) can be used as a guide to manage reverse logistics in E-Business industry. Practical implications of this model are that an E-Business organisation can implement reverse logistics using the model as a guide to gain value from returns.

FIGURE 7.1 A model of the reverse logistics process in the E-Business industry



Hypotheses one, three and five were partially supported, hypothesis two was supported and the other was rejected. A summary of result and key findings are presented in Table 7.15.

TABLE 7.15:A summary of outcome of hypotheses

Hypothesis	Result
Hypothesis H1: OM & EM and E-Business organisations implement returned goods management to achieve strategic advantages, attain financial benefits and to fulfil legal obligations.	Partially supported. Reverse logistics is a strategic advantage. It is an important customer service and strategic issue. Financial advantages and legal issues are important up to some extend.
Hypothesis H2: Logistics and information management are equally important for reverse logistics in OM & EM and E-Business organisations.	True and valid. Logistics management and information management are both important in handling of returned products.
Hypothesis H3: All returned goods in OM & EM and E-Business industries warrant one or more recovery operations in order to recapture value.	Partially supported. Product recovery operations are important to recapture value. Module, parts, components and material recovery and energy and environment recovery operations are not important in this industry.
Hypothesis H4: Effective reverse logistics information management enables better rescheduling of work on returned goods and streamlines administrative processes in OM & EM and E-Business industries.	Rejected. Information management is a very important barrier in reverse logistics in this industry at present. Administrative and operational barriers are comparatively less important.
Hypothesis H5: Online customers return goods because they find the goods they receive are different from how they conceptualised them on a computer screen, due to after sales service and business agreements.	Partially supported. Customer incapability to accurately conceptualise goods and efficiency in forward logistics processes is main reasons for returns in E-Business industry.

7.7 Conclusion

The implications of the findings on reverse logistics in the Australian E-Business (Chapter Seven) and OM & EM industries (Chapter Six) are discussed Chapter Eight.

Chapter 8
DISCUSSION OF REVERSE LOGISTICS AND INFORMATION MANAGEMENT ISSUES, FURTHER RESEARCH DIMENSIONS AND CONCLUSION

8.0 Introduction

This chapter attempts to address the implications of the findings on reverse logistics in OM & EM (referred to as Manufacturing in this chapter) industries and E-Business industry by discussing the answers to the research questions and the validity of each hypothesis.

Research question: Q1 – "Why have Manufacturing and E-Business industries implemented reverse logistics?"

Hypothesis H1: OM & EM and E-Business organisations implement returned goods management to achieve strategic advantages, attain financial benefits and to fulfil legal obligations.

The research findings indicate that reverse logistics is a *strategic advantage* in both Manufacturing and E-Business industries. By allowing customers to return goods these organisations use reverse logistics to deliver *customer service.* Although literature

review (Chapter Two) emphasised that reverse logistics provides financial benefits this research indicates that the Australian Manufacturing industries have not yet realised this potential. The E-Business industry on the other hand, capture some financial value from resale of returned goods.

In Australia, consumer protection law discussed in Chapter Two requires organisations to allow customers to return a product to the supplier if they are unsatisfied with the product (ACCC 2001). Environmental protection laws at this stage only apply to industry disposal of discarded products. It does not require consumers to return goods to the point of origin as in some other parts of the world where consumers for example, have to return certain types of goods (white goods) to the supplier for environmental protection. Therefore the findings of this research indicates that consumer and environmental protection law does not have an impact on reverse logistics in Australia. Accordingly reverse logistics for consumer and environmental protection law is only moderately supported. Therefore hypothesis one is partially supported.

Further research on the value from reverse logistics and impact of more stringent environmental protection laws if introduced, will add a greater insight into reverse logistics.

Research question Q2: "What are the logistics and information management operations in facilitating handling of the returned goods in Manufacturing and E-Business industries?"

Hypothesis H2: Logistics and information management are equally important for reverse logistics in OM & EM and E-Business organisations.

This research indicates that logistics management and information management are both important in handling of returned products in both the Australian Manufacturing and E-Business industries. It identifies that *receiving information* about goods to be returned, *authorisation* to return goods, organising *collection and transportation* of returned goods, *inspection* of returned goods to identify problems *sorting* of returned goods for

recovery and *refund* to customers for returns are important operations in both the Manufacturing and E-Business industries.

Research findings discussed in Chapters Six and Seven clearly indicate that both information centred and logistics centred operations are important for reverse logistics process. It is thus concluded that efficient information management supports logistics operations which entail physical handling of goods returned to the origin. Therefore hypothesis two is supported.

Research question Q3: "What recovery operations are performed on returned goods to capture value in Manufacturing and E-Business industries?"

Hypothesis H3: All returned goods in OM & EM and E-Business industries warrant one or more recovery operations in order to recapture value.

Based on the volume of goods recovered and number of participating organisations, this research established that *product recovery operations* are important to recapture value from goods that are returned in both Manufacturing and E-Business industries. The research identifies that in Manufacturing industries *repair, resale and recycle* of goods are the most prevalent value recovery operations. However, in the E-Business industry it is clear that the most common recovery operation that enables recapture of value is *resale* of goods returned.

Literature review discussed in Chapter Two identified thirteen value recovery operations (Table 5.3, page 87) for returned goods. Research findings for Manufacturing industries and E-Business industry in Chapters Six and Seven indicate that in Australia, at present time only few recovery operations are applied to goods returned. Therefore hypothesis three is only partially supported.

Further research issues to identify the importance of other recovery operations discussed in Chapter Two may become prevalent when reverse logistics is recognised as an important business process in the Australian industries. Also the impact of a more stringent law on environmental protection will require a greater emphasis on reverse

logistics as seen in other parts of the world, and therefore is expected to have an impact on recovery process.

Research questions:

Q4 - "What are the barriers to reverse logistics in Manufacturing and E-Business industries?"

Q5 Q5a – "What information technologies are used to manage reverse logistics information?"

Q5b - "How can reverse logistics management be improved with electronic information management?"

Hypothesis H4: Effective reverse logistics information management enables better rescheduling of work on returned goods and streamlines administrative processes in OM & EM and E-Business industries.

This research confirms the literature review finding (Chapter Two) that information management is a very important barrier in reverse logistics. However, impact of reverse logistics information on rescheduling of work on returned goods and on streamlining administration processes could not be established from the data in this project. Therefore hypothesis four is rejected.

This research project had aimed to establish information management issues for reverse logistics in the Australian Manufacturing and E-Business industries. To do this the information flow process required for reverse logistics was established from literature review (Figure 2.1). However this research identified that firstly reverse logistics is not a well established business process neither in Manufacturing nor in E-Business industries in Australia. It also establishes that all the operations (product return and value recovery) identified from literature are not practised in the two industries.

Therefore the information management issues for reverse logistics remain an important further research issue. As reverse logistics gains recognition as a business process, it is

anticipated that information management for reverse logistics will become equally important.

Research question Q6: "Why does the E-Business industry receive an increased amount of returns?"

Hypothesis H5: Online customers return goods because they find the goods they receive are different from how they conceptualised them on a computer screen, due to after sales service and business agreements.

Hypothesis five is relevant to the E-Business organisations only. This was developed based on the literature findings discussed in Chapter Two that in this industry return of goods from consumers to the suppliers is on the rise. The scope of this research did not allow customer points of view therefore reasons for return discussed in this research is gleaned from the suppliers only.

This research identifies that, based on organisations' records of customers' comments, damage to goods at point of delivery, defects, errors in ordering, customers change of mind after placing order, wrong product delivery and warranty are the most common reasons for the E-Business industry returns. Due to these reasons it is clear that reverse logistics is an important business process in the E-Business industry.

The findings also indicate that in E-Business *forward logistics* operations such as errors in picking, packaging and delivery also require return management.

The largest volume of returned goods in the E-Business industry is due to customers changing their mind when they see the delivered goods. This implies that further research into why customers change their mind on receipt of goods ordered online is required.

Although hypothesis five is only partially supported it highlights that in the E-Business industry forward logistics of goods and customer ordering systems will have an impact on reverse logistics.

8.1 Conclusion

This research was a first attempt to investigate reverse logistics issues in the Australian Manufacturing and E-Business industries. Although the response rate is low analysis and conclusions drawn for reverse logistics are based on three statistical tests binomial, Fisher's exact and Wilcoxon.

This research highlights that reverse logistics is strategic, a valuable customer service support and for value recovery from returned goods. It also indicates that legal requirements for customer and environmental protection will reinforce reverse logistics as an important business process.

For the management of reverse logistics this research also highlights that both logistics centred and information centred operations are equally important.

Methods of capturing value from returned goods are only preliminary (resale, repair and recycle) in the Australian organisations and methods of collecting data are very basic.

The most important barriers to reverse logistics identified are information related, however, a lack of resources, a lack of top management support and ad hoc return policies also have an impact.

From this research it is clear that reverse logistics as a business process is not yet recognised, evident from the application of basic technologies to the management of returned goods data. An important process would warrant a more specific or dedicated information management system.

As the E-Business industry matures it is clear from the findings of this research that reverse logistics will be an important business process in this industry.

The contribution of this study to the existing body of knowledge on reverse logistics management is valuable. The findings should encourage Manufacturing and E-Business organisations to devote more attention to reverse logistics management.

RESEARCH PUBLICATIONS

Referred International Journal Paper:

1. Dissanayake, D., and Singh, M., 2007, 'Managing Returns in E-Business', accepted to be published in Journal of Internet Commerce, Volume 7, Issue 6, pp 35-49.

Referred International Conference Papers:

1. Dissanayake, D., and Singh, M., 2006, Managing returns in E-Business Organisations, International Conference of International Association for Development of the Information Society (IADIS) 2006, e-Society 2006, Dublin, Ireland, 13–16 July.

2. Dissanayake, D., Singh, M., 2006, 'Reverse Logistics Processes: An Australian Study', proceedings of the 2nd International Information Management and Business Conference 2006, Sydney Australia, February 13th to 16th, pp 164-74.

3. Dissanayake, D., and Singh, M., 2005, 'An Overview of Reverse Logistics Management in the Australian Manufacturing Industries', International Conference on Electronic Business 2005, December 5th to 9th Hong Kong.

4. Dissanayake, D., Singh, M., Sharma, S., 2005, 'Reverse Logistics Management in Manufacturing Organisations in Australia – a Study', proceedings of the Global Information Technology Management Conference 2005, Alaska, USA June 6th to 8th, pp 18-21.

Doctoral Consortium:

1. Dissanayake, D., 2006, Doctoral Consortium on of 10th Pacific Asia Conference on Information Systems (PACIS 2006), 6th-9th July 2006, Mandarin Oriental, Kuala Lumpur, Malaysia.

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APPENDICES

APPENDIX A

Data collection instrument - survey of Manufacturing organisations

A SURVEY OF TECHNOLOGY APPLICATION IN REVERSE LOGISTIC MANAGEMENT

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The answers to the survey will be kept in strict confidence.
The names of participating companies and individuals will not be released.

A STUDY ON REVERSE LOGISTICS MANAGEMENT

Reverse logistics enables reuse of discarded products from commercial returns and excess inventory of products and materials. It includes processing returned merchandise due to damage, seasonal inventory, restock, salvage, recalls, and excess inventory. It also includes recycling programs, hazardous material management programs, obsolete equipment disposition, and asset recovery.

Reverse logistics results in direct and indirect benefits, such as regaining value, achieving a competitive advantage and sustaining a better environment.

This research aims to investigate operational, technological and management issues pertinent to successful reverse logistics management with Information Technology.

Questionnaire for Reverse logistics Management

Please answer questions in ***Part A & Part B*** by crossing ***appropriate cell/s.***

Part A - Organisation Profile & Introduction

1.1 What is the industry classification of your organisation?

Food, drink and tobacco
Coal, petroleum, chemicals and allied products
Textile Products
Paper, printing and publishing
Stone, Clay, Glass, and Concrete Products
Electrical, electronic products and parts
Vehicle, ships, aerospace and parts
Metal and allied products
Timber and furniture products
Rubber, plastic and leather Products
Others (please specify) …….

1.2 How long has this organisation been operating reverse logistics?

Less than 1 year 1 to 5 years 6 to 10 years 11 to 15 years more than 15 years

1.3 What is the annual turnover of your organisation? [AUD$ Million]

Less than 50 51 to 100 101 to 250 251 to 500 501 or more (please specify) …

1.4 In what geographical area does your business operate?

Global National Regional

1.5 How many full time workers does your organisation employ?

Less than 50 51 to 100 101 to 250 251 to 750 more than 751 (please specify) ……

1.6 What is your title as determined by your organisation?

……..

1.7 What is your role in the Reverse Logistics Management Process in the organisation?

…….

Part B – Reverse Logistics in the Organisation

2.1 Does your organisation accept returned products or allow customers/partners to return products?
Yes No

If your answer for question 2.1 is "No", then please return the questionnaire in the stamped envelope. If your answer is "Yes", please continue.

2.2 What is the of total return products recovered [resale, reuse, recover, reprocess] per year? []
Less than 10 11 to 25 26 to 50 51 to 75 More than 75

2.3 What is the annual reverse logistic management cost in your organisation? [AUD$ Million]
Less than 1 1 to 10 11 to 25 26 to 50 More than 50 (please specify) ……

2.4 What are the three most returned ***[in quantity/volume of]*** products in your business? [Please write product name, approximate quantities/volumes and its unit price]

Product name	Quantities/volumes approximate	Unit price
1.		
2.		
3.		

2.5 What are the three most valuable ***[in unit price of]*** products returned in your business? [Please write product name, approximate unit price and quantities/volumes]

Product name	Quantities/volumes approximate	Unit price
1.		
2.		
3.		

Part C – Operations and Implementation

3.1 Please indicate which of the following preliminary operations take place prior to reprocessing of returned products. Please answer the question by crossing ***appropriate cell/s***

- ❑ Inform – partner/customer inform the manufacturer or his agent about returns
- ❑ Return Authorization – examine authenticity of return and authorize to return
- ❑ Gate-keeping - screening of defective and unwarranted returned merchandise at the entry point
- ❑ Collection – collect and deliver returns to inspection site
- ❑ Inspection – examine/assess returns for recovering/reprocessing
- ❑ Selection – choose a reprocess/recovery operation [such as reuse, resale, repair, upgrade]
- ❑ Sorting – arrange return according to anticipated recovery
- ❑ Others (please specify). ……..…….…….
- ❑ ……..……..

3.2 Which of the following recovery options are available in your organisation? Please answer the question by crossing ***appropriate cell/s***

- ❑ Redistribution
- ❑ Resale
- ❑ Reuse
- ❑ Repair
- ❑ Upgrade
- ❑ Refurbish [*Module Recovery*]
- ❑ Remanufacture [*Component Recovery*]
- ❑ Retrieval [*Part Recovery*]
- ❑ Recycling [*Material Recovery*]
- ❑ Incineration [*Energy Recovery*]
- ❑ Landfill [*Environment Recovery*]
- ❑ Hazardous Waste management
- ❑ Others (please specify) …….…. ……..

Part D – Use of Technologies and Performances

4.1 Which of the following techniques/technologies are you applying to manage reverse logistics at your organisation? Please mark the appropriate number to indicate level of usage of each technique. For your answer, mark the appropriate number in each cell.

Table - 1

Information Exchange / Communication Techniques	Is this Technology **employed in reverse logistics?**	Level of usage of this Technique in **Reverse Logistics** ①=Extremely low use ⑦=Extremely high use						
1. Land-line Telephone/Fax	Yes / No	1	2	3	4	5	6	7
2.Mobile Phone / Other Palm device	Yes / No	1	2	3	4	5	6	7
3.Computers - Personal / Desktop	Yes / No	1	2	3	4	5	6	7
4.Radio Frequency Identification	Yes / No	1	2	3	4	5	6	7
5.Electronic Data Interchange-EDI	Yes / No	1	2	3	4	5	6	7
6.Barcode Technology	Yes / No	1	2	3	4	5	6	7
7.Decision Support System	Yes / No	1	2	3	4	5	6	7
8.. Data Mining & Data Logging	Yes / No	1	2	3	4	5	6	7
9.Track & Tracing Technology	Yes / No	1	2	3	4	5	6	7
10.Global Positioning System /Geographical Information system	Yes / No	1	2	3	4	5	6	7
11.Entrepreneurship Resource Planning	Yes / No	1	2	3	4	5	6	7
12.Intranet	Yes / No	1	2	3	4	5	6	7
13.Extranet	Yes / No	1	2	3	4	5	6	7
14.Internet	Yes / No	1	2	3	4	5	6	7
15Others(please specify) ……..	Yes / No	1	2	3	4	5	6	7
16Others (please specify) ……..	Yes / No	1	2	3	4	5	6	7
17Others (please specify) ……..	Yes / No	1	2	3	4	5	6	7

4.2 What is the impact of the above reverse logistics data on following operations in your organisation?

Table - 2

Operations in Reverse Logistics	**Level of** impact of reverse logistics data on this operation ① = Extremely low ⑦ = Extremely high						
Communication	1	2	3	4	5	6	7
Information management	1	2	3	4	5	6	7
Customer relationship management	1	2	3	4	5	6	7
Capture future return information & statistics	1	2	3	4	5	6	7
Inventory management – returned goods related	1	2	3	4	5	6	7
Redelivering to Customer / Market	1	2	3	4	5	6	7
Return Authorization / Gate-keeping	1	2	3	4	5	6	7
Collecting & delivering return goods to factory	1	2	3	4	5	6	7
Inspect /examine /select /sort returns to reprocess	1	2	3	4	5	6	7
Resale / Redistribution of returns	1	2	3	4	5	6	7
Reuse of returns	1	2	3	4	5	6	7
Donation of returns	1	2	3	4	5	6	7
Repair / Upgrade of returns	1	2	3	4	5	6	7
Component / Part / Module – Recovering	1	2	3	4	5	6	7
Recycling	1	2	3	4	5	6	7
Incineration / Landfill	1	2	3	4	5	6	7
Refund / Reimbursement	1	2	3	4	5	6	7
Others (please specify) ……	1	2	3	4	5	6	7
Others (please specify) ……	1	2	3	4	5	6	7

4.3 What difficulties/problems does your organisation encounter in reverse logistics management? Please answer the question by crossing appropriate cell/s

☐ Lack of information available on future returns
☐ Lack of information sharing among partners
☐ Lack of information system on return management
☐ Lack of online information sharing among partners
☐ Lack of information on recovered/reprocessed products available in/to market
☐ Lack of communication
☐ Invisible state of return
☐ Long lead-time for reprocessing/recovering
☐ Returns wait long time between operations
☐ Returns handling
☐ Returns storing
☐ Resources wasted/idled
☐ Added work / Rework – return handling & storing
☐ Distribution & Redistribution of returns
☐ Unauthorized/Unwarranted returns

Others (please specify) ……..……

……..……...…

……..……...…

4.4 What are the reasons for your organisation to manage reverse logistics?

……..……...…

……..……...…

……..……...…

4.5 What are the benefits of reverse logistics in your organisation?

……..…

……..…

……..……...…

4.6 What are the benefits of technology application in reverse logistics in your organisation?

……..……...…

……..……...…

……..……...…

Thank you for your assistance in completing this questionnaire.

** ** ** ** ** ** **

Please indicate if you would be willing to participate in following up research, which will be totally confidential.

(Please select one) Yes No

If you would be interested in receiving summary report of the findings, please complete following details:

Name: ……
Position: ……
Organisation: ……
Address: ……
……
Telephone: …… Fax: ……Email: ……

APPENDIX B

Cover letter – survey of Manufacturing organisations

Date:2nd November 2004

Attention:

Dear Manager,

I am a Doctoral student in the Faculty of Business at RMIT University, conducting research on **Reverse Logistics**. The aim of the project is to develop effective management strategies for Reverse Logistics Management with information technologies. A questionnaire is enclosed for the purpose of investigating your view in this area. It will take you 18 minutes to fill it in.

Reverse logistics enables the reuse of discarded products from commercial returns and excess inventory of products and materials. Information technology enabled reverse logistics management results in direct and indirect benefits, such as regaining value, operational efficiency, achieving a competitive advantages; customer satisfaction, organisation image and reputation and sustaining a better environment.

This research aims to investigate operational, technological and management issues pertinent to successful reverse logistics management with information technology. Your identity will remain confidential. You are required to identify yourself only if you would like to obtain a copy of the final report of this survey.

If you have queries about this research, please email me **x02446@ems.rmit.edu.au** or please contact my supervisor Associate Professor Mohini Singh, **mohini.singh@rmit.edu.au** or the Chair of the Business Portfolio Human Research Ethics Sub-committee, phone (03) 9925 5594, fax (03) 9925 5595, email: **rdu@rmit.edu.au**.

Thank you in anticipation of your co-operation in completing and returning the attached questionnaire. Please return the completed questionnaire **on or before 15th November 2004**.
I am looking forward to hearing from you.

Yours sincerely

Dushantha Nimal Dissanayake
PhD Candidate,
Research Development Unit,
Business Portfolio, RMIT University,
GPO Box 2476V, Melbourne 3001,
Victoria.

APPENDIX C

Reminder letter – survey of Manufacturing organisations

Date: 15th November 2004

Attention:

Dear Manager,

Reminder

Recently you were sent a questionnaire titled **"A SURVEY OF TECHNOLOGY APPLICATION IN REVERSE LOGISTIC MANAGEMENT"**.

If you have sent the questionnaire back to me, thank you for your help and please disregard this reminder.

If you have not returned it, can you please kindly do so as soon as possible. In order for this study to be valid, a response rate of 50 at least is required. Hence I need your support.

Should you require a second questionnaire you are welcome to email me **x02446@ems.rmit.edu.au**, and one will be mailed to you together with a prepaid envelope for your response.

urs sincerely

Dushantha Nimal Dissanayake
PhD Candidate,
Research Development Unit,
Business Portfolio, RMIT University,
GPO Box 2476V, Melbourne 3001,
Victoria.

APPENDIX D

Data collection instrument - survey of OM & EM organisations

A SURVEY OF TECHNOLOGY APPLICATION IN REVERSE LOGISTIC MANAGEMENT

Dushantha Nimal Dissanayake [Mr]

Research Development Unit,
Business Portfolio,
RMIT University,
GPO Box 2476v
Melbourne 3001
Victoria

June 2005

The answers to the survey will be kept in strict confidence.
The names of participating companies and individuals will not be released.

A STUDY ON REVERSE LOGISTICS MANAGEMENT

Reverse logistics results in direct and indirect benefits, such as regaining value, achieving a competitive advantage and sustaining a better environment. Reverse logistics enables reuse of products discarded due to commercial returns and manufacturer callbacks. It includes processing returned merchandise due to damage, seasonal inventory, restocking, salvaging, recalls, and excess inventory. It may include recycling programs, hazardous material management programs, obsolete equipment disposition and asset recovery.

This research aims to investigate the management of reverse logistics with Information Technology for the achievement of a competitive advantage, sustaining a better environment and regaining value from returned goods.
A summary report of the findings will be available to participants on request.

Please answer questions in by ticking the ***appropriate cell(s) or filling the appropriate space(s)/table(s).***

Part 1 - Organisation Profile & Introduction

1.1 Please list the main product(s) of your company.

a) …… b) …… c) ……. d) ……...…

1.2 What is the average life cycle [in months] of the company's main product(s)?
Less than 6 6 to 12 13 to 24 25 to 36 More than 36 (please specify) ……

1.3 What is the annual turnover of your organisation? [AUD$ Million]
Less than 100 101 to 250 251 to 500 501 to 750 751 or more (please specify) ……

1.4 In what geographical area does your business operate? Global National Regional

1.5 How many full time workers does your organisation employ?
Less than 100 101 to 250 251 to 500 501 to 1000 1001 or more (please specify) ……

1.6 What is your title as determined by your organisation? …..…….…….

Part 2– Reverse Logistics in the Organisation

2.1 Does your company accept returned products? Yes No
If your answer for 2.1 is "No", then please return the questionnaire in the stamped envelope. If "Yes", please continue.

2.2 Which of the following **sales strategies** does your company use? Please tick all that apply.

Sales strategies	**Rank the usage of this strategy** ⓪ = Not use ① = Extremely low ⑦ = Extremely high							
Retailing	0	1	2	3	4	5	6	7
Wholesaling	0	1	2	3	4	5	6	7
B2B-Ebusiness	0	1	2	3	4	5	6	7
B2C-Ebusiness	0	1	2	3	4	5	6	7
Catalog sales	0	1	2	3	4	5	6	7
Telephone sales	0	1	2	3	4	5	6	7
Other	0	1	2	3	4	5	6	7

2.3 What is the annual **reverse logistic management cost** in your organisation? [AUD$ Million]
Less than 1 1 to 5 6 to 15 16 to 25 More than 25 (please specify) ……

2.4 What is the average **return processing time** of the company's main products? [Weeks]
Less than a week 1 to 4 4 to 8 8 to 12 More than 12 (please specify) ……

Part 3 – Operations and Implementation

3.1 Please select the reasons for allowing products to be returned at your organisation? Please tick all that apply.

- ❑ Strategic issues [goodwill, image & turnover etc]
- ❑ Customer service
- ❑ Clean logistics channel
- ❑ Protect margin
- ❑ Competitive reasons
- ❑ Recapture value
- ❑ Recover assets
- ❑ Customer protection laws [warranty, guaranty etc]
- ❑ Legal disposal issues
- ❑ Environment protection law
- ❑ Retail Return policy
- ❑ Legal Obligations
- ❑ Others (please specify) ……..…….

3.2 Are any of the following a barrier to reverse logistics management at your company? Please tick all that apply.

- ❑ Company policies
- ❑ Many Options to Returns
- ❑ Lack of Financial resources
- ❑ Legal issues
- ❑ Lack of information systems
- ❑ Lack of Importance of reverse logistics relative to other issues
- ❑ Management inattention
- ❑ Lack of Personnel resources
- ❑ Poor Partnerships
- ❑ Others (please specify) ……..…….

3.3 How do you manage the following operations for returned goods and information at your organisation? Please tick all that apply.

Operations	**By your company**	**By a Third Party**	**via phone/fax**	**via email**	**via post**	**via online IS**	**others**
Receive return information							
Authorization to return goods							
Gate-keeping for return goods							
Transport of returned goods							
Inspection of returned goods							
Selection of a recovery method							
Sorting of returned goods							
Refund / Reimbursement							
Others (please specify)……							

3.4 What do you do with the returned goods? Please fill in the following table.

Methods of recovery/ reprocess	**Percentage of total return**	**By your company**	**by a Third Party**	**by a Forth Party**	**Example of returned goods Please write name of the goods**
Redistribute					
Resell					
Reuse					
Repair					
Upgrade					
Donate					
Refurbish					
Remanufacture					
Retrieval					
Recycle					
Incinerate					
Landfill					
Hazardous Waste Manage.					
Others (please specify)					
	100%				

Part 4 – Use of Technologies and Performances

4.1 Which of the followings techniques are you applying to manage reverse logistics at your organisation? Please mark the appropriate number to indicate level of usage of each technology.

Table - 1

Information Exchange / Communication Techniques	Level of usage of this Technique in **Reverse Logistics** ⓪ = Not use ①=Extremely low use ⑦=Extremely high use							
Land-line Telephone / Fax	0	1	2	3	4	5	6	7
Mobile phone / PDA / Other Palm device	0	1	2	3	4	5	6	7
Computers - Laptop / Desktop	0	1	2	3	4	5	6	7
Radio Frequency Identification -RFID	0	1	2	3	4	5	6	7
Electronic Data Interchange-EDI	0	1	2	3	4	5	6	7
Barcode & Scanning System	0	1	2	3	4	5	6	7
Decision Support System	0	1	2	3	4	5	6	7
Data Mining & Data Logging System	0	1	2	3	4	5	6	7
Tracking & Tracing System	0	1	2	3	4	5	6	7
Global Positioning & Geographic Information System	0	1	2	3	4	5	6	7
ERP- Enterprise Resource Planning	0	1	2	3	4	5	6	7
Intranet	0	1	2	3	4	5	6	7
Extranet	0	1	2	3	4	5	6	7
Internet	0	1	2	3	4	5	6	7
Others (please specify) ……..	0	1	2	3	4	5	6	7

4.2 If you manage reverse logistics via Information & Communication Technologies, Please answer following questions

4.2.1 Is your **return management information system** online real time? Yes No

4.2.2 Is returned products' information shared with business partners? Yes No

4.2.3 Is this information used to forecast future returns? Yes No

4.2.4 Is this information used to collect returned goods statistics? Yes No

4.3 What is the impact of the above reverse logistics data collected from information technologies on following operations in your organisation?

Table - 2

Operations in Reverse Logistics	**Level of** impact of reverse logistics data on this operation ⓪ = No impact ① = Extremely low ⑦ = Extremely high							
Communication	0	1	2	3	4	5	6	7
Information management	0	1	2	3	4	5	6	7
Customer relationship management	0	1	2	3	4	5	6	7
Capture future return information & statistics	0	1	2	3	4	5	6	7
Inventory management – returned goods related	0	1	2	3	4	5	6	7
Redelivering to Customer / Market	0	1	2	3	4	5	6	7
Return Authorization / Gate-keeping	0	1	2	3	4	5	6	7
Collecting & delivering return goods to factory	0	1	2	3	4	5	6	7
Inspect /examine /select /sort returns to reprocess	0	1	2	3	4	5	6	7
Resale / Redistribution of returns	0	1	2	3	4	5	6	7
Reuse of returns	0	1	2	3	4	5	6	7
Donation of returns	0	1	2	3	4	5	6	7
Repair / Upgrade of returns	0	1	2	3	4	5	6	7
Component / Part / Module – Recovering	0	1	2	3	4	5	6	7
Recycling	0	1	2	3	4	5	6	7
Incineration / Landfill	0	1	2	3	4	5	6	7
Refund / Reimbursement	0	1	2	3	4	5	6	7
Others (please specify) ……	0	1	2	3	4	5	6	7

4.4 Can you please indicate what you gain from reverse logistics in your organisation?

4.4.1 Resale of returned goods Yes No Approximately AUS$ …….

4.4.2 Capture value from components Yes No Approximately AUS$ …….

4.4.3 Others (please specify) …….

4.4.4 Others (please specify) …….

Would you be willing to participate in a short telephone / personal follow-up interview to help me identify more reverse logistics issues? (Please select one) Yes No

If "Yes" please provide your contact information. We appreciate your cooperation for our research study and will contact you in the near future to arrange a suitable time.

Email:…….. Telephone:…….……

Name: …….…… Position: ……

Address:……..

Thank you for your assistance in completing this questionnaire.

** ** ** ** ** ** **

If you would be interested in receiving a summary report of the findings, please complete the following details:

Name: …… Position: ……

Organisation:……Address:……..

Telephone:……Fax: ……Email:……..

APPENDIX E

Cover letter - survey of OM & EM organisations

Date: 6th June 2005

Attention:

Dear Manager,

I am a Doctoral student in the Faculty of Business at RMIT University, conducting research on **Reverse Logistics**. The aim of the project is to develop effective management strategies for Reverse Logistics Management using information technologies. A questionnaire is enclosed for the purpose of investigating your view in this area. It will take you 18 minutes to fill it in.

Reverse logistics enables the reuse of products discarded due to commercial returns as well as manufacturers' callbacks. Information technology has direct and indirect benefits for reverse logistics management, such as regaining value, operational efficiency, achieving a competitive advantages as well as ensuring customer satisfaction, organisation image and reputation and sustaining a better environment.

This research aims to investigate operational, technological and management issues pertinent to successful reverse logistics management. Your identity will remain confidential. However if you would like to obtain a copy of the final report of this survey, you will need to identify yourself.

If you have queries about this research, please email me **x02446@ems.rmit.edu.au** or please contact my supervisor Associate Professor Mohini Singh, **mohini.singh@rmit.edu.au** or the Chair of the Business Portfolio Human Research Ethics Sub-committee, phone (03) 9925 5594, fax (03) 9925 5595, email: **rdu@rmit.edu.au**.

I would greatly appreciate your cooperation for the research project.

Thank you in anticipation of your co-operation in completing and returning the attached questionnaire.
Please return the completed questionnaire **on or before 19th June 2005**.
I am looking forward to hearing from you.

Yours sincerely

Dushantha Nimal Dissanayake
PhD Candidate,
Research Development Unit,
Business Portfolio, RMIT University,
GPO Box 2476V, Melbourne 3001,
Victoria.

APPENDIX F

Reminder letter - survey of OM & EM organisations

Date: 19th June 2005

Attention:

Dear Manager,

Reminder

Recently you were sent a questionnaire titled **"A SURVEY OF TECHNOLOGY APPLICATION IN REVERSE LOGISTIC MANAGEMENT"**.

If you have sent the questionnaire back to me, thank you for your help and please disregard this reminder.

If you have not returned it, can you please kindly do so as soon as possible. In order for this study to be valid, a response rate of 50 at least is required. Hence I need your support.

I deeply appreciate your cooperation for the research project.

Should you require a second questionnaire you are welcome to email me **x02446@ems.rmit.edu.au**, and one will be mailed to you together with a prepaid envelope for your response.

Yours sincerely

Dushantha Nimal Dissanayake
PhD Candidate,
Research Development Unit,
Business Portfolio, RMIT University,
GPO Box 2476V, Melbourne 3001,
Victoria.

APPENDIX G

Test of early and late responses - survey of OM & EM organisations

Table 1 Result of chi square tests on early and late responses - reasons for managing returns

Reasons For Managing Returns [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Strategic Issues	0.0059	17	12	23	16	In Sig.	1
Customer Service	0.6285	18	14	23	16	In Sig.	1
Clean Channel	0.0025	3	2	23	16	In Sig.	1
Competitive Reason	1.8132	12	5	23	16	In Sig.	1
Customer Protection law	0.3047	6	3	23	16	In Sig.	1
Legal Disposal Law	1.3099	6	2	23	16	In Sig.	1
Environment Protection law	0.6229	10	5	23	16	In Sig.	1
Retail return policy	0.3047	6	3	23	16	In Sig.	1
Legal obligations	0.6258	13	7	23	16	In Sig.	1
Protect Margin	0.068	1	1	23	16	In Sig.	1
Resale of returns	0.4473	8	4	23	16	In Sig.	1
Recapture Value	0.2301	3	3	23	16	In Sig.	1
Recover Asset	0.1862	4	2	23	16	In Sig.	1

Table 2 Result of chi square tests on early and late responses - barriers of managing reverse logistics

Barriers of Managing Reverse Logistics [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Absent of Online Real Time Information System	0.0536	15	11	23	16	In Sig.	1
Unable to share of Information with partners	0.1412	13	10	23	16	In Sig.	1
Unable to use IS to Forecast	0.2098	16	10	23	16	In Sig.	1
Unable to use IS for Statistics	0.2098	16	10	23	16	In Sig.	1
Lack of Information System	2.2246	7	2	23	16	In Sig.	1
Many options for return	-	4	0	23	16	-	1
Lack of Importance	0.4473	8	4	23	16	In Sig.	1
Management Inattention	0.1862	4	2	23	16	In Sig.	1
Poor Partnership	0.5958	3	1	23	16	In Sig.	1
Company Policies	0.1442	2	2	23	16	In Sig.	1
Lack of Personnel Resources	0.3047	6	3	23	16	In Sig.	1
Lack of Financial Resources	-	2	0	23	16	-	1
Legal Issues	-	0	2	23	16	-	1

Table 3 Result of chi square tests on early and late responses - information technologies

Information Management Technologies [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Land-line Telephone/Fax	0	22	16	23	16	In Sig.	1
Mobile phone/PDA/Other Palm device	0.9171	14	12	23	16	In Sig.	1
Computers-Laptop/Desktop, Servers	0.086	21	15	23	16	In Sig.	1
Internet	0.1417	7	4	23	16	In Sig.	1
Tracking and Tracing System	1.4291	13	6	23	16	In Sig.	1
Barcode and Scanning System	0.2098	7	6	23	16	In Sig.	1
Intranet	0.4186	12	10	23	16	In Sig.	1
Electronic Data Interchange	0.0029	7	5	23	16	In Sig.	1
Decision Support System	0.0117	4	3	23	16	In Sig.	1
Enterprise Resource Planning	0.9106	8	8	23	16	In Sig.	1
Data Mining and Data Logging System	0.0536	8	5	23	16	In Sig.	1
Extranet	0.1226	6	5	23	16	In Sig.	1
Radio Frequency Identification	-	1	0	23	16	-	1
Global Positioning and GIS	-	3	0	23	16	-	1

Table 4 Result of chi square tests on early and late responses–product return process

Product Return Operation [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Receive return information	0	23	16	23	16	In Sig.	1
Authorization to return goods	0.3861	23	15	23	16	In Sig.	1
Gate-keeping for return goods	2.2246	16	14	23	16	In Sig.	1
Refund / Reimbursement	0.086	21	15	23	16	In Sig.	1
Inspection of returned goods	0	23	16	23	16	In Sig.	1
Selection of a recovery method	2.8244	18	15	23	16	In Sig.	1
Sorting of returned goods	0.068	22	15	23	16	In Sig.	1
Transport of returned goods	0.4108	21	16	23	16	In Sig.	1

Table 5 Result of chi square tests on early and late responses–value recovery operations

Returned Product Recovery Operations [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Redistribution	0.3047	6	3	23	16	In Sig.	1
Resale	0.6258	10	9	23	16	In Sig.	1
Reuse	0.3278	4	4	23	16	In Sig.	1
Repair	0.4473	15	12	23	16	In Sig.	1
Upgrade	1.015	4	5	23	16	In Sig.	1
Donation	-	0	1	23	16	-	1
Refurbish	1.015	4	5	23	16	In Sig.	1
Remanufacture	0.4401	5	5	23	16	In Sig.	1
Retrieval	-	0	0	23	16	-	1
Recycling	0.1412	10	6	23	16	In Sig.	1
Incineration	0.068	1	1	23	16	In Sig.	1
Landfill	0.9171	9	4	23	16	In Sig.	1
Hazardous Waste Mgt	0.068	1	1	23	16	In Sig.	1

APPENDIX H

Data collection instrument - survey of E-Business organisations

MANAGING RETURNS IN E-BUSINESSES

Dushantha Nimal Dissanayake [Mr]

Research Development Unit,
Business Portfolio,
RMIT University,
GPO Box 2476v
Melbourne 3001
Victoria

November 2005

The answers to the survey will be kept in strict confidence.
The names of participating companies and individuals will not be released.

A STUDY ON REVERSE LOGISTICS MANAGEMENT

Reverse logistics is managing return of goods due to customer return policy, good customer relationship management and warranty. This survey is to establish the management of returns from B2C and B2B E-Business from the buyer to supplier. In most of electronic channels, customers purchase goods by virtual conceptualisation of size and quality. Previous research revealed that 94 of online buyers commit to purchase on the Internet if a return policy is available.

This research aims to investigate the management of reverse logistics in E-Business.

Your responses will be confidential and used for research only. Your support by filling and returning this survey will be greatly appreciated. A summary report of the findings will be available to participants on request.

Please answer the following questions by ticking the ***appropriate cell(s) or filling in information in the space provided.***

Part 1 - Organisation Profile & Introduction

1.1 What industry do you operate in? Please tick all that apply.

- ☐ Accommodation, Cafes and Restaurants
- ☐ Agriculture, Forestry and Fishing
- ☐ Communication Services
- ☐ Construction
- ☐ Cultural and Recreational Services
- ☐ Education
- ☐ Electricity, Gas and Water Supply
- ☐ Finance and Insurance
- ☐ Government Administration and Defense
- ☐ Health and Community Services
- ☐ Manufacturing
- ☐ Mining
- ☐ Personal and Services
- ☐ Property and Business Services
- ☐ Retail trade
- ☐ Transport and Storage
- ☐ Wholesale Trade
- ☐ Other (please specify)……

1.2 How many full time workers does your organisation employ?

Less than 25 25 to 100 101 to 250 over 250 (please specify) ……

1.3 In what geographical area does your business operate?

Geographical area	**Percentage of total market**	**Percentage of E-Business market**
Regional	…..	…..
National	…..	…..
Global	…..	…..
Total	**100**	**100**

1.4 In what year was your company's E-Business developed? ……..

1.5 What is your title as determined by your organisation? …..……

Part 2– Reverse Logistics in the Organisation

2.1 Does your company allow your customers to return the goods you sell? Yes No

If your answer for 2.1 is "No", then please return the questionnaire in the stamped envelope. If "Yes", please continue.

2.2 If "Yes" for 2.1 within how many days of purchase, customers should return the goods? ….....

2.3 Which of the following **sales strategies** does your company use? Please tick all that apply.

Sales Strategies	**Volume of Annual Sale [Aus $ Million]**
B2B-Ebusiness sales	……...
B2C-Ebusiness sales	……...
Other Internet sales	……...
Telephone sales	……...
Television sales	……...
Catalog sales	……...
Retailing [Direct sales to customer at stores]	……...
Wholesaling [Direct sales to dealers at stores]	……...
Other methods of sales	……...
Total Volume of Annual Sales →	……...

2.4 Has your company assigned E-Business return management to any dedicated group or individual? **Yes / No**

2.5 What is the annual **reverse logistic management cost** in your organisation? [AUD$ Million]

Less than 1 1 to 5 5 to 10 10 to 25 Over 25 (please specify) …

2.6 What is the average **return processing time** for the returned goods in your company? [in weeks]

Less than a week 1 to 4 4 to 8 8 to 12 Over 12 (please specify) …

2.7 Please list the reasons for allowing goods to be returned.

Reasons for goods returning	**Volume of return as a percentage of total returns**
Error during ordering	…..
Good delivered later than expected date	…..
Delivery of wrong products	…..
Defective / Damaged product	…..
Ambiguity of operating manual / instruction	…..
For upgrading / servicing the products	…..
Customer decision	…..
Improper / invalid reason for return	…..
Warranty and guaranty returns	…..
End of use [lease]	…..
End of life	…..
Excess returns	…..
Seasonal returns	…..
Others……..	…..
Total Returned product	**100%**

Part 3 – Operations and Implementation

3.1 Please select the reasons for having a return policy in your organisation? Please tick all that apply.

- ❑ Strategic issues [goodwill, image & turnover etc]
- ❑ Customer service
- ❑ Clean logistics channel
- ❑ Protect margin
- ❑ Competitive reasons
- ❑ Recapture value
- ❑ Recover assets
- ❑ Customer protection laws [warranty, guaranty etc]
- ❑ Legal disposal issues
- ❑ Environment Protection law
- ❑ Retail Return Policy
- ❑ Legal Obligations
- ❑ Others (please specify) …….……
- ❑ Others (please specify) …….…….

3.2 Are any of the following a barrier to reverse logistics management at your company? Please tick all that apply.

- ❑ Company policies
- ❑ Many Options to Returns
- ❑ Lack of Financial resources
- ❑ Legal issues
- ❑ Lack of information systems
- ❑ Lack of Importance of reverse logistics relative to other issues
- ❑ Management inattention
- ❑ Lack of Personnel resources
- ❑ Poor Partnerships
- ❑ Others (please specify) …….……

3.3 How do you manage the following operations for returned goods at your organisation? Please tick all that apply.

Operations	**By your company**	**By a Third Party**	**via phone/fax**	**via email**	**via post**	**via online IS**	**others**
Receive return information							
Authorization to return goods							
Gate-keeping for return goods							
Transport of returned goods							
Inspection of returned goods							
Selection of a recovery method							
Sorting of returned goods							
Refund / Reimbursement							
Others (please specify)……							

3.4 What do you do with the returned goods? Please fill in the following table.

Methods of recovery/reprocess	**Percentage of total return**	**Managed In-House**	**Managed by a Third**
Redistribute	……..		
Resell	……..		
Reuse	……..		
Repair	……..		
Upgrade	……..		
Donate	……..		
Refurbish	……..		
Remanufacture	……..		
Retrieval	……..		
Recycle	……..		
Incinerate	……..		
Landfill	……..		
Hazardous Waste Management	……..		
Others (please specify)……	……..		
	100%		

Part 4 – Use of Technologies to Manage Returns

4.1 Which of the following techniques/technologies are you applying to manage reverse logistics at your organisation? Please mark the appropriate number to indicate level of usage of each technique.

Information Exchange / Communication Techniques	Level of usage of this Technique in **Reverse Logistics** ⓪ = Not use ①=Extremely low use ⑦=Extremely high use							
Land-line Telephone / Fax	0	1	2	3	4	5	6	7
Mobile phone / PDA / Other Palm device	0	1	2	3	4	5	6	7
Computers - Laptop / Desktop	0	1	2	3	4	5	6	7
Radio Frequency Identification -RFID	0	1	2	3	4	5	6	7
Electronic Data Interchange-EDI	0	1	2	3	4	5	6	7
Barcode & Scanning System	0	1	2	3	4	5	6	7
Decision Support System	0	1	2	3	4	5	6	7
Data Mining & Data Logging System	0	1	2	3	4	5	6	7
Tracking & Tracing System	0	1	2	3	4	5	6	7
Global Positioning & Geographic Information System	0	1	2	3	4	5	6	7
Enterprise Resource Planning- ERP	0	1	2	3	4	5	6	7
Intranet	0	1	2	3	4	5	6	7
Extranet	0	1	2	3	4	5	6	7
Internet	0	1	2	3	4	5	6	7
Others (please specify) ……..	0	1	2	3	4	5	6	7
Others (please specify) ……	0	1	2	3	4	5	6	7

4.2 If you manage reverse logistics via Information & Communication Technologies, Please answer the following questions

4.2.1 Is your **return management information system** online real time? Yes No

4.2.2 Is returned products' information shared with business partners? Yes No

4.2.3 Is this information used to forecast future returns? Yes No

4.2.4 Is this information used to collect returned goods statistics? Yes No

4.3 What is the impact of reverse logistics data collected from information technologies on managing the following reverse logistics operations in your organisation?

Operations in Reverse Logistics	**Level of** impact of reverse logistics data on this operation ⓪ = No impact ① = Extremely low ⑦ = Extremely high							
Communication	0	1	2	3	4	5	6	7
Information management	0	1	2	3	4	5	6	7
Customer relationship management	0	1	2	3	4	5	6	7
Capture future return information & statistics	0	1	2	3	4	5	6	7
Inventory management – returned goods related	0	1	2	3	4	5	6	7
Redelivering to Customer / Market	0	1	2	3	4	5	6	7
Return Authorization / Gate-keeping	0	1	2	3	4	5	6	7
Collecting & delivering return goods to factory	0	1	2	3	4	5	6	7
Inspect /examine /select /sort returns to reprocess	0	1	2	3	4	5	6	7
Resale / Redistribution of returns	0	1	2	3	4	5	6	7
Reuse of returns	0	1	2	3	4	5	6	7
Donation of returns	0	1	2	3	4	5	6	7
Repair / Upgrade of returns	0	1	2	3	4	5	6	7
Component / Part / Module – Recovering	0	1	2	3	4	5	6	7
Recycling	0	1	2	3	4	5	6	7
Incineration / Landfill	0	1	2	3	4	5	6	7
Refund / Reimbursement	0	1	2	3	4	5	6	7
Others (please specify) ……	0	1	2	3	4	5	6	7

4.4 Can you please indicate the advantages of reverse logistics in your organisation?

4.4.1 Resale of returned goods Yes No Approximately AUS$ …….
4.4.2 Capture value from return goods Yes No Approximately AUS$ …….
4.4.3 Others (please specify) …….
4.4.4 Others (please specify) …….
4.4.5 Others (please specify) …….

Would you be willing to participate in a short telephone / personal follow-up interview to help me identify more reverse logistics issues? (Please select one) Yes No

If "Yes" please provide your contact information. We appreciate your cooperation for our research study and will contact you in the near future to arrange a suitable time.

Email:…….. Telephone:……..…….……
Name: ……..…… Position: ……..……
Address: ……..

Thank you for your assistance in completing this questionnaire.
** ** ** ** ** ** **

If you would be interested in receiving a summary report of the findings, please complete the following details:
Name: …..……. Position: ……..……..…
Organisation:…….……..……..
Address: ……..……..
Telephone:……Fax: ……Email:……..……..

APPENDIX I

Cover letter - survey of E-Business organisations

Date: 7th November 2005

Attention:

Dear Manager,

I am a Doctoral student in the Faculty of Business at RMIT University, conducting research on **Reverse Logistics in E-businesses**. The aim of the project is to develop effective management strategies for Reverse Logistics Management using information technologies. A questionnaire is enclosed for the purpose of investigating your view in this area. It will take you 20 minutes to fill it in.

Reverse logistics enables the reuse of products discarded due to commercial returns as well as manufacturers' callbacks. Information technology has direct and indirect benefits for reverse logistics management, such as regaining value, operational efficiency, achieving competitive advantages as well as ensuring customer satisfaction, organisation image and reputation and sustaining a better environment.

This research aims to investigate operational, technological and management issues pertinent to successful reverse logistics management in E-businesses. Your identity will remain confidential. However if you would like to obtain a copy of the final report of this survey, you will need to identify yourself.

If you have queries about this research, please email me **x02446@ems.rmit.edu.au** or please contact my supervisor Associate Professor Mohini Singh, **mohini.singh@rmit.edu.au** or the Chair of the Business Portfolio Human Research Ethics Sub-committee, phone (03) 9925 5594, fax (03) 9925 5595, email: **rdu@rmit.edu.au**.

I would greatly appreciate your cooperation for the research project.

Thank you in anticipation of your co-operation in completing and returning the attached questionnaire. Please return the completed questionnaire **on or before 21st November 2005**.
I am looking forward to hearing from you.

Yours sincerely

Dushantha Nimal Dissanayake
PhD Candidate,
Research Development Unit,
Business Portfolio, RMIT University,
GPO Box 2476V, Melbourne 3001,
Victoria.

APPENDIX J

Reminder letter - survey of E-Business organisations

Date: 21st November 2005

Attention:

Dear Manager,

Recently you were sent a questionnaire titled **"MANAGING RETURNS IN E-BUSINESSES"**.

If you have sent the questionnaire back to me, thank you for your help and please disregard this reminder.

If you have not returned it, can you please kindly do so as soon as possible. In order for this study to be valid, a response rate of 50 at least is required. Hence I need your support.

I deeply appreciate your cooperation for the research project.

Should you require a second questionnaire you are welcome to email me **x02446@ems.rmit.edu.au**, and one will be mailed to you together with a prepaid envelope for your response.

Yours sincerely

Dushantha Nimal Dissanayake
PhD Candidate,
Research Development Unit,
Business Portfolio, RMIT University,
GPO Box 2476V, Melbourne 3001,
Victoria.

APPENDIX K

Test of early and late responses - survey of E-Business organisations

Table 1 Result of chi square tests on early and late responses - reasons for customers to return goods

Reasons For Customers to Return Goods	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Error in ordering	0.0299	11	12	15	17	In Sig.	1
Late delivery	0.3938	3	5	15	17	In Sig.	1
Wrong product delivery	0.3995	9	12	15	17	In Sig.	1
Ambiguity of operation manual	-	0	2	15	17	-	1
Customer decision	0.0136	10	11	15	17	In Sig.	1
Invalid reason	0.6413	5	8	15	17	In Sig.	1
Upgrade/Service purpose	1.1302	1	3	15	17	In Sig.	1
Warranty/Guaranty reason	0.6413	5	8	15	17	In Sig.	1
Defective/Damage product	0.3982	11	13	15	17	In Sig.	1
End of life return	-	0	2	15	17	-	1
Others	0.4235	3	2	15	17	In Sig.	1
Seasonal return	0.578	2	1	15	17	0.05	1
End of use return	-	0	0	15	17	-	1
Excess return	0.2703	1	2	15	17	In Sig.	1

Table 2 Result of chi square tests on early and late responses - reasons for managing returns

Reasons For Managing Returns [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Strategic Issues	1.13021	14	14	15	17	In Sig.	1
Customer Service	0.00834	14	16	15	17	In Sig.	1
Clean Channel	-	1	0	15	17	-	1
Competitive Reason	1.13021	8	6	15	17	In Sig.	1
Customer Protection Law	0.00834	5	5	15	17	In Sig.	1
Legal Disposal Law	-	0	1	15	17	-	1
Environment Protection	-	0	0	15	17	-	1
Retail return policy	0.05697	9	7	15	17	In Sig.	1
Legal obligations	0.09975	8	10	15	17	In Sig.	1
Protect Margin	-	0	0	15	17	-	1
Resale of returns	1.17143	8	14	15	17	In Sig.	1
Recapture Value	-	0	1	15	17	-	1
Recover Asset	-	0	0	15	17	-	1

Table 3 Result of chi square tests on early and late responses - barriers of managing reverse logistics

Barriers of Managing Reverse Logistics [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Absent of Online Real Time Information System	1.1012	10	14	15	17	In Sig.	1
Unable to share of Information with partners	0.3826	10	13	15	17	In Sig.	1
Unable to use IS to Forecast	1.0015	12	11	15	17	In Sig.	1
Unable to use IS for Statistics	0.4315	8	11	15	17	In Sig.	1
Lack of Information System	1.4122	2	5	15	17	In Sig.	1
Many options for return	1.4122	2	5	15	17	In Sig.	1
Lack of Importance	1.4122	2	5	15	17	In Sig.	1
Management Inattention	-	0	2	15	17	-	1
Poor Partnership	0.0083	1	1	15	17	In Sig.	1
Company Policies	0.116	2	3	15	17	In Sig.	1
Lack of Personnel Resources	-	3	0	15	17	-	1
Lack of Financial Resources	0.0289	3	3	15	17	In Sig.	1
Legal Issues	-	0	2	15	17	-	1

Table 4 Result of chi square tests on early and late responses - information management technologies

Information Management Technologies [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Land-line Telephone/Fax	0	15	17	15	17	In Sig.	1
Mobile phone/PDA/Other Palm device	0.1626	6	8	15	17	In Sig.	1
Computers-Laptop/Desktop, Servers	0.0083	14	16	15	17	In Sig.	1
Internet	1.0858	7	11	15	17	In Sig.	1
Tracking and Tracing System	1.8781	3	7	15	17	In Sig.	1
Barcode and Scanning System	0.3826	5	4	15	17	In Sig.	1
Intranet	0.3938	3	5	15	17	In Sig.	1
Electronic Data Interchange	0.4235	3	2	15	17	In Sig.	1
Decision Support System	0.4235	3	2	15	17	In Sig.	1
Enterprise Resource Planning	0.4235	3	2	15	17	In Sig.	1
Data Mining and Data Logging System	0.0179	2	2	15	17	In Sig.	1
Extranet	0.0179	2	2	15	17	In Sig.	1
Radio Frequency Identification	0.0083	1	1	15	17	In Sig.	1
Global Positioning and GIS	-	0	1	15	17	-	1

Table 5 Result of chi square tests on early and late responses–product return process

Product Returning Operations [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Receive return information	0.319	14	17	15	17	In Sig.	1
Authorization to return goods	0.2703	14	15	15	17	In Sig.	1
Gate-keeping for return goods	0.0753	9	11	15	17	In Sig.	1
Refund / Reimbursement	0.319	14	17	15	17	In Sig.	1
Inspection of returned goods	0.578	13	16	15	17	In Sig.	1
Selection of a recovery method	0.057	10	12	15	17	In Sig.	1
Sorting of returned goods	0.0179	13	15	15	17	In Sig.	1
Transport of returned goods	0.5566	15	15	15	17	In Sig.	1

Table 6 Result of chi square tests on early and late responses–value recovery operations

Returned Product Recovery Operations [Variables]	Chi Square Value	Counted Response		Total Response		Difference	df
		Early	Late	Early	Late		
Redistribution	0.2121	5	7	15	17	In Sig.	1
Resale	0.2703	14	15	15	17	In Sig.	1
Reuse	0.3852	4	3	15	17	In Sig.	1
Repair	0.6413	5	8	15	17	In Sig.	1
Upgrade	0.2703	1	2	15	17	In Sig.	1
Donation	0.0289	3	3	15	17	In Sig.	1
Refurbish	0.0083	1	1	15	17	In Sig.	1
Remanufacture	-	2	0	15	17	-	1
Retrieval	-	0	0	15	17	-	1
Recycling	0.578	2	1	15	17	In Sig.	1
Incineration	-	0	0	15	17	-	1
Landfill	0.3938	3	5	15	17	In Sig.	1
Hazardous Waste Mgt	-	0	0	15	17	-	1

APPENDIX L

Results of Fisher's exact test to establish reverse logistics issues in Manufacturing industries

APPENDIX L - Table 1Result of Fisher's exact test to establish reasons why Manufacturing organisations manage reverse logistics

Code		SA1	SA2	LO1	SA3	LO2	FA1	LO3	LO4	LO5	FA2	FA3	SA4	FA4
Reasons for managing returns		Customer service	Strategic issues	Legal obligations	Competitive reasons	Environmental protection	Resale of returns	Customer protection laws	Retail return policy	Legal disposal laws	Recapture value	Recover asset	Clean channel	Protect margin
Code	Pi \ Pj	P1=0.821	P2=0.744	P3=0.513	P4=0.436	P5=0.385	P6=0.308	P7=0.231	P8=0.231	P9=0.205	P10=0.154	P11=0.154	P12=0.128	P13=0.051
SA1	P1=0.821													
SA2	P2=0.744	*0.584*												
LO1	P3=0.513	*0.008***	*0.060*											
SA3	P4=0.436	*0.001**	*0.011***	*0.650*										
LO2	P5=0.385	*0.000**	*0.003**	*0.363*	*0.818*									
FA1	P6=0.308	*0.000**	*0.000**	*0.106*	*0.349*	*0.635*								
LO3	P7=0.231	*0.000**	*0.000**	*0.018****	*0.092*	*0.220*	*0.610*							
LO4	P8=0.231	*0.000**	*0.000**	*0.018****	*0.092*	*0.220*	*0.610*	*1.000*						
LO5	P9=0.205	*0.000**	*0.000**	*0.009***	*0.051****	*0.135*	*0.437*	*1.000*	*1.000*					
FA2	P10=0.154	*0.000**	*0.000**	*0.002**	*0.012***	*0.040****	*0.178*	*0.567*	*0.567*	*0.769*				
FA3	P11=0.154	*0.000**	*0.000**	*0.002**	*0.012***	*0.040****	*0.178*	*0.567*	*0.567*	*0.769*	*1.000*			
SA4	P12=0.128	*0.000**	*0.000**	*0.001**	*0.005**	*0.018****	*0.098*	*0.377*	*0.377*	*0.545*	*1.000*	*1.000*		
FA4	P13=0.051	*0.000**	*0.000**	*0.000**	*0.000**	*0.001**	*0.006***	*0.047****	*0.047****	*0.087*	*0.263*	*0.263*	*0.430*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX L - Table 2 Result of Fisher's exact test to determine information and logistics management processes in Manufacturing industries

Code		ICO1	LCO1	ICO2	LCO2	LCO3	ICO3	LCO4	ICO4
Product returning operations		Receive information about returns	Inspect returned goods	Authorise returned goods	Sort returned goods	Transport returned goods	Refund/ reimbursement	Selection of recovery method	Gate-keeping of returned goods
Code	Pj / Pi	P1=1.000	P2=1.000	P3=0.974	P4=0.949	P5=0.949	P6=0.923	P7=0.846	P8=0.769
ICO1	P1=1.000								
LCO1	P2=1.000	*1.000*							
ICO2	P3=0.974	*1.000*	*1.000*						
LCO2	P4=0.949	*0.494*	*0.494*	*1.000*					
LCO3	P5=0.949	*0.494*	*0.494*	*1.000*	*1.000*				
ICO3	P6=0.923	*0.240*	*0.240*	*0.615*	*1.000*	*1.000*			
LCO4	P7=0.846	*0.025****	*0.025****	*0.108*	*0.263*	*0.263*	*0.481*		
ICO4	P8=0.769	*0.002**	*0.002**	*0.014***	*0.047****	*0.047****	*0.114*	*0.567*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX L - Table 3 Result of Fisher's exact test to identify methods of value recovery form returned goods in Manufacturing industry

Code		PR1	PR2	MPCMR1	EER1	MPCMR2	PR3	PR4	MPCMR3	PR5	EER2	EER3	PR6	MPCMR4
Value Recovery Operations		Repair	Resale	Recycle	Landfill	Remanufacture	Redistribution	Upgrade	Refurbishment	Reuse	Incineration	Hazardous waste mgt	Donation	Retrieval
Code	Pi \ Pj	P2=0.692	P2=0.487	P3=0.410	P4=0.333	P5=0.256	P6=0.231	P7=0.231	P8=0.231	P9=0.205	P10=0.051	P11=0.051	P12=0.026	P13=0.000
PR1	P1=0.692													
PR2	P2=0.487	*0.106*												
MPCMR1	P3=0.410	*0.022***	*0.649*											
EER1	P4=0.333	*0.003**	*0.250*	*0.640*										
MPMCR2	P5=0.256	*0.000**	*0.060*	*0.230*	*0.620*									
PR3	P6=0.231	*0.000**	*0.033****	*0.145*	*0.451*	*1.000*								
PR4	P7=0.231	*0.000**	*0.033****	*0.145*	*0.451*	*1.000*	*1.000*							
MPCMR3	P8=0.231	*0.000**	*0.033****	*0.145*	*0.451*	*1.000*	*1.000*	*1.000*						
PR5	P9=0.205	*0.000**	*0.017****	*0.085*	*0.307*	*0.789*	*0.784*	*0.784*	*0.784*					
EER21	P10=0.051	*0.000**	*0.000**	*0.000**	*0.003**	*0.025****	*0.047****	*0.047****	*0.047****	*0.087*				
EER3	P11=0.051	*0.000**	*0.000**	*0.000**	*0.003**	*0.025****	*0.047****	*0.047****	*0.047****	*0.087*	*1.000*			
PR66	P12=0.026	*0.000**	*0.000**	*0.000**	*0.000**	*0.007***	*0.014***	*0.014***	*0.014***	*0.029****	*1.000*	*1.000*		
MPCMR4	P13=0.000	*0.000**	*0.000**	*0.000**	*0.000**	*0.001**	*0.002**	*0.002**	*0.002**	*0.005**	*0.494*	*0.494*	*1.000*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX L - Table 4 Result of Fisher's exact test to ascertain barriers for managing reverse logistics in Manufacturing industry

Code		TB1	TB2	TB3	TB4	OB1	AB1	TB5	OB2	AB2	OB3	OB4	AB3	AB4
Barriers to the management of reverse logistics		Absence of online real-time IS	Inability to use IS to forecast	Inability to use IS for statistics	Inability to share of information with partners	Lack of Importance	Lack of personnel resources	Lack of IS	Management inattention	Company policies	Many options for the return of goods	Poor partnership	Lack of financial resources	Legal issues
Code	Pi \ Pj	P1=0.667	P2=0.667	P3=0.667	P4=0.589	P5=0.308	P6=0.231	P7=0.231	P8=0.154	P9=0.103	P10=0.103	P11=0.103	P12=0.051	P13=0.051
TB1	P1=0.667													
TB2	P2=0.667	*1.000*												
TB3	P3=0.667	*1.000*	*1.000*											
TB4	P4=0.589	*0.640*	*0.640*	*0.640*										
OB1	P5=0.308	*0.003**	*0.003**	*0.003**	*0.022**									
AB1	P6=0.231	*0.000**	*0.000**	*0.000**	*0.003**	*0.610*								
TB5	P7=0.231	*0.000**	*0.000**	*0.000**	*0.003**	*0.610*	*1.000*							
OB2	P8=0.154	*0.000**	*0.000**	*0.000**	*0.000**	*0.178*	*0.567*	*0.567*						
AB2	P9=0.103	*0.000**	*0.000**	*0.000**	*0.000**	*0.047****	*0.224*	*0.224*	*0.737*					
OB3	P10=0.103	*0.000**	*0.000**	*0.000**	*0.000**	*0.047****	*0.224*	*0.224*	*0.737*	*1.000*				
OB4	P11=0.103	*0.000**	*0.000**	*0.000**	*0.000**	*0.047****	*0.224*	*0.224*	*0.737*	*1.000*	*1.000*			
AB3	P12=0.051	*0.000**	*0.000**	*0.000**	*0.000**	*0.006***	*0.047****	*0.047****	*0.263*	*0.675*	*0.675*	*0.675*		
AB4	P13=0.051	*0.000**	*0.000**	*0.000**	*0.000**	*0.006***	*0.047****	*0.047****	*0.263*	*0.675*	*0.675*	*0.675*	*1.000*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX L - Table 5 Result of Fisher's exact test to determine technologies support reverse logistics in Manufacturing industries

Code		ST1	ST2	ST3	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11
Information technologies		Landline telephone or fax	Computers laptop/desktop	Mobile phone/PDA/ other Palm device	Intranet	Tracking and tracing systems	Enterprise resource planning	Barcode and scanning systems	Data mining and data logging systems	Electronic data interchange	Extranet	Internet	Decision support systems	Global position satellites and GIS	Radio frequency identification-
Code	Pi \ Pj	P1=0.974	P2=0.923	P3=0.667	P4=0.564	P5=0.487	P6=0.410	P7=0.333	P8=0.333	P9=0.308	P10=0.282	P11=0.282	P12=0.180	P13=0.077	P14=0.026
ST1	P1=0.974														
ST2	P2=0.923	*0.615*													
ST3	P3=0.667	*0.001**	*0.010***												
AT1	P4=0.564	*0.000**	*0.001**	*0.485*											
AT2	P5=0.487	*0.000**	*0.000**	*0.169*	*0.650*										
AT3	P6=0.410	*0.000**	*0.000**	*0.040****	*0.257*	*0.649*									
AT4	P7=0.333	*0.000**	*0.000**	*0.006***	*0.068*	*0.250*	*0.640*								
AT5	P8=0.333	*0.000**	*0.000**	*0.006***	*0.068*	*0.250*	*0.640*	*1.000*							
AT6	P9=0.308	*0.000**	*0.000**	*0.003**	*0.039****	*0.165*	*0.479*	*1.000*	*1.000*						
AT7	P10=0.282	*0.000**	*0.000**	*0.001**	*0.021****	*0.103*	*0.341*	*0.807*	*0.807*	*1.000*					
AT8	P11=0.282	*0.000**	*0.000**	*0.000**	*0.001**	*0.103*	*0.341*	*0.807*	*0.807*	*1.000*	*1.000*				
AT9	P12=0.180	*0.000**	*0.000**	*0.000**	*0.000**	*0.008***	*0.046****	*0.194*	*0.194*	*0.291*	*0.421*	*0.421*			
AT10	P13=0.077	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.001**	*0.010***	*0.010***	*0.019****	*0.036****	*0.036****	*0.310*		
AT11	P14=0.026	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.001**	*0.001**	*0.001**	*0.003**	*0.003**	*0.056*	*0.615*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX L - Table 6 Result of Fisher's exact test to determine reasons why Manufacturing organisations manage reverse logistics

Code		SA	LO	FA
Reasons for reverse logistics		Strategic advantage	Customer and environmental protection rules and regulations	Financial advantage
Code	Pi / Pj	P1=0.532	P2=0.313	P3=0.167
SA	P1=0.532			
LO	P2=0.313	*0.000**		
FA	P3=0.167	*0.000**	*0.000**	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = p ≤ 0.005; two-tailed Fisher's exact test).*

APPENDIX L - Table 7 Result of Fisher's exact test to determine information and logistics centred process in reverse logistics in Manufacturing industries

Code		ICO	LCO
Reverse logistics processes		Information centred processes	Logistics centred processes
Code	Pi / Pj	P1=0.917	P2=0.936
ICO	P1=0.917		
LCO	P2=0.936	*0.666*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value; two-tailed Fisher's exact test).*

APPENDIX L - Table 8 Result of Fisher's exact test to establish methods of value recovery from returned goods in Manufacturing industries

Code		PR	MPCMR	EER
Value recovery operations		Product recovery	Module, parts, components and material recovery	Energy and Environmental recovery
Code	Pi / Pj	P1=0.312	P2=0.224	P3=0.145
PR	P1=0.312			
MPCMR	P2=0.224	*0.065*		
EER	P3=0.145	*0.001**	*0.120*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = p ≤ 0.005; two-tailed Fisher's exact test).*

APPENDIX L - Table 9 Result of Fisher's exact test to identify barriers of managing reverse logistics in Manufacturing industries

Code		TB	OB	AB
Barriers for managing reverse logistics		Technological barriers	Operational barriers	Administrative barriers
Code	Pi / Pj	P1=0.564	P2=0.167	P3=0.109
TB	P1=0.564			
OB	P2=0.167	*0.000**		
AB	P3=0.109	*0.000**	*0.188*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; two-tailed Fisher's exact test).*

APPENDIX M

Results of Fisher's exact test to establish reverse logistics issues in E-Business industry

APPENDIX M - Table 1 Result of Fisher's exact test to identify reasons why E-Businesses manage reverse logistics

Code		SA1	SA2	FA1	LO1	LO2	SA3	LO3	SA4	FA2	LO4	FA3	FA4	LO5
Reasons to manage returns		Customer service	Strategic Issues	Resale of returns	Legal obligations	Retail return policy	Competitive reason	Customer protection law	Clean channel	Recapture value	Disposal law	Protect margin	Recover asset	Environmental protection
Code	Pi \ Pj	P1=0.938	P2=0.875	P3=0.688	P4=0.563	P5=0.500	P6=0.438	P7=0.313	P8=0.031	P9=0.031	P10=0.031	P11=0.000	P12=0.000	P13=0.000
SA1	P1=0.938													
SA2	P2=0.875	*0.672*												
FA1	P3=0.688	*0.022***	*0.129*											
LO1	P4=0.563	*0.001**	*0.011***	*0.439*										
LO2	P5=0.500	*0.000**	*0.003**	*0.203*	*0.802*									
SA3	P6=0.438	*0.000**	*0.000**	*0.077*	*0.454*	*0.802*								
LO3	P7=0.313	*0.000**	*0.000**	*0.006***	*0.077*	*0.203*	*0.439*							
SA4	P8=0.031	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.006*						
FA2	P9=0.031	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.006*	*1.000*					
LO4	P10=0.031	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.006*	*1.000*	*1.000*				
FA3	P11=0.000	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.001**	*1.000*	*1.000*	*1.000*			
FA4	P12=0.000	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.001**	*1.000*	*1.000*	*1.000*	*1.000*		
LO5	P13=0.000	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.001**	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX M - Table 2 Result of Fisher's exact test to determine information and logistics management processes in E-Business industry

Code		ICO1	ICO2	LCO1	ICO3	LCO2	LCO3	LCO4	ICO4
Product returning operations		Receive return information	Refund/ reimbursement	Transport of returned goods	Authorisation for the return of goods	Inspection of returned goods	Sorting of returned goods	Selection of a recovery method	Gate-keeping for return goods
Code	Pi / Pj	P1=0.969	P2=0.969	P3=0.938	P4=0.906	P5=0.906	P6=0.875	P7=0.688	P8=0.625
ICO1	P1=0.969								
ICO2	P2=0.969	*1.000*							
LCO1	P3=0.938	*1.000*	*1.000*						
ICO3	P4=0.906	*0.613*	*0.613*	*1.000*					
LCO2	P5=0.906	*0.613*	*0.613*	*1.000*	*1.000*				
LCO3	P6=0.875	*0.355*	*0.355*	*0.672*	*1.000*	*1.000*			
LCO4	P7=0.688	*0.006***	*0.006***	*0.022****	*0.060*	*0.060*	*1.000*		
ICO4	P8=0.625	*0.000**	*0.000**	*0.005**	*0.016****	*0.016****	*0.060*	*0.129*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX M - Table 3 Result of Fisher's exact test to identify methods of value recovery from returned goods in E-Business industry

Code		PR1	PR2	PR3	EER1	PR4	PR5	PR6	MPCMR1	MPCMR2	MPCMR3	MPCMR4	EER2	EER3
Value Recovery Operations		Resale	Repair	Redistribution	Landfill	Reuse	Donation	Upgrade	Recycling	Refurbish	Remanufacture	Retrieval	Incineration	Hazardous Waste Mgt
Code	Pi / Pj	P1=0.906	P2=0.406	P3=0.375	P4=0.250	P5=0.219	P6=0.188	P7=0.094	P8=0.094	P9=0.063	P10=0.063	P11=0.000	P12=0.000	P13=0.000
PR1	P1=0.906													
PR2	P2=0.406	*0.000**												
PR3	P3=0.375	*0.000**	*1.000*											
EER1	P4=0.250	*0.000**	*0.287*	*0.419*										
PR4	P5=0.219	*0.000**	*0.177*	*0.274*	*1.000*									
PR5	P6=0.188	*0.000**	*0.099*	*0.164*	*0.763*	*1.000*								
PR6	P7=0.094	*0.000**	*0.008***	*0.016****	*0.184*	*0.302*	*0.474*							
MPCMR1	P8=0.094	*0.000**	*0.008***	*0.016****	*0.184*	*0.302*	*0.474*	*1.000*						
MPCMR2	P9=0.063	*0.000**	*0.008***	*0.016****	*0.184*	*0.148*	*0.257*	*1.000*	*1.000*					
MPCMR3	P10=0.063	*0.000**	*0.002**	*0.005**	*0.082*	*0.148*	*0.257*	*1.000*	*1.000*	*1.000*				
MPCMR4	P11=0.000	*0.000**	*0.000**	*0.005**	*0.005**	*0.011***	*0.024****	*0.238*	*0.238*	*0.492*	*0.492*			
EER2	P12=0.000	*0.000**	*0.000**	*0.005**	*0.005**	*0.011***	*0.024****	*0.238*	*0.238*	*0.492*	*0.492*	*1.000*		
EER3	P13=0.000	*0.000**	*0.000**	*0.005**	*0.005**	*0.011***	*0.024****	*0.238*	*0.238*	*0.492*	*0.492*	*1.000*	*1.000*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX M - Table 4 Result of Fisher's exact test to identify barriers for managing reverse logistics in E-Business industry

Code		TB1	TB2	TB3	TB4	OB1	OB2	TB5	AB1	AB2	AB3	AB4	OB3	OB4
Barriers to reverse logistics		Absence of online real-time IS.	Inability to share information with partners	Inability to use IS to forecast	Inability to use IS for statistics	Many options for return	Lack of importance	Lack of IS	Lack of financial resources	Company policies	Lack of personnel resources	Legal issues	Managemen t inattention	Poor partnership
Code	Pj / Pi	P1=0.750	P2=0.719	P3=0.719	P4=0.594	P5=0.219	P6=0.219	P7=0.219	P8=0.188	P9=0.156	P10=0.094	P11=0.063	P12=0.063	P13=0.063
TB1	P1=0.750													
TB2	P2=0.719	*1.000*												
TB3	P3=0.719	*1.000*	*1.000*											
TB4	P4=0.594	*0.287*	*0.430*	*0.430*										
OB1	P5=0.219	*0.000**	*0.000**	*0.000**	*0.005**									
OB2	P6=0.219	*0.000**	*0.000**	*0.000**	*0.005**	*1.000*								
TB5	P7=0.219	*0.000**	*0.000**	*0.000**	*0.005**	*1.000*	*1.000*							
AB1	P8=0.188	*0.000**	*0.000**	*0.000**	*0.002**	*1.000*	*1.000*	*1.000*						
AB2	P9=0.156	*0.000**	*0.000**	*0.000**	*0.000**	*0.750*	*0.750*	*0.750*	*1.000*					
AB3	P10=0.094	*0.000**	*0.000**	*0.000**	*0.000**	*0.302*	*0.302*	*0.302*	*0.474*	*0.708*				
AB4	P11=0.063	*0.000**	*0.000**	*0.000**	*0.000**	*0.148*	*0.148*	*0.148*	*0.257*	*0.426*	*1.000*			
OB3	P12=0.063	*0.000**	*0.000**	*0.000**	*0.000**	*0.148*	*0.148*	*0.148*	*0.257*	*0.426*	*1.000*	*1.000*		
OB4	P13=0.063	*0.000**	*0.000**	*0.000**	*0.000**	*0.148*	*0.148*	*0.148*	*0.257*	*0.426*	*1.000*	*1.000*	*1.000*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX M - Table 5 Result of Fisher's exact test to determine technologies supporting reverse logistics in E-Business industry

Code		ST1	ST2	ST3	AT1	AT2	AT3	AT4	AT5	AT6	AT7	AT8	AT9	AT10	AT11
Information technologies		Telephone/fax	Computers-laptop/desktop	Internet	Mobile phone/PDA/other palm device	Tracking and tracing systems	Barcode and scanning Systems	Intranet	Electronic data interchange	Decision support systems	Enterprise resource planning	Data mining and data logging systems	Extranet	Radio frequency identification	Global positioning and GIS
Code	Pi / Pj	P1=1.000	P2=0.938	P3=0.563	P4=0.438	P5=0.313	P6=0.281	P7=0.250	P8=0.156	P9=0.156	P10=0.156	P11=0.125	P12=0.125	P13=0.063	P14=0.031
ST1	P1=1.000														
ST2	P2=0.938	*0.492*													
ST3	P3=0.563	*0.000**	*0.001**												
AT1	P4=0.438	*0.000**	*0.000**	*0.454*											
AT2	P5=0.313	*0.000**	*0.000**	*0.077*	*0.439*										
AT3	P6=0.281	*0.000**	*0.000**	*0.04****	*0.297*	*1.000*									
AT4	P7=0.250	*0.000**	*0.000**	*0.021****	*0.188*	*0.782*	*1.000*								
AT5	P8=0.156	*0.000**	*0.000**	*0.001**	*0.027****	*0.237*	*0.365*	*0.536*							
AT6	P9=0.156	*0.000**	*0.000**	*0.000**	*0.027****	*0.237*	*0.365*	*0.536*	*1.000*						
AT7	P10=0.156	*0.000**	*0.000**	*0.000**	*0.027****	*0.237*	*0.365*	*0.536*	*1.000*	*1.000*					
AT8	P11=0.125	*0.000**	*0.000**	*0.000**	*0.011***	*0.129*	*0.213*	*0.337*	*1.000*	*1.000*	*1.000*				
AT9	P12=0.125	*0.000**	*0.000**	*0.000**	*0.011***	*0.129*	*0.213*	*0.337*	*1.000*	*1.000*	*1.000*	*1.000*			
AT10	P13=0.063	*0.000**	*0.000**	*0.000**	*0.001**	*0.022****	*0.043****	*0.082*	*0.426*	*0.426*	*0.426*	*0.672*	*0.672*		
AT11	P14=0.031	*0.000**	*0.000**	*0.000**	*0.000**	*0.006***	*0.013***	*0.026****	*0.196*	*0.196*	*0.196*	*0.355*	*0.355*	*1.000*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX M - Table 6 Result of Fisher's test to establish reasons why E-Business customers return goods

Code		ASS1	VC1	VC2	VC3	VC4	ASS2	VC5	ASS3	BA1	BA2	VC6	ASS4	BA3
Reasons for return of goods		Defective/ damaged product	Error in ordering	Wrong product delivery	Customer decision	Invalid reason	Warranty/guarantee	Late delivery	Upgrade/service	Seasonal return	Excess return	Ambiguity in the operating manual	End of life return	End of use return
Code	Pj / Pi	P1=0.750	P2=0.719	P3=0.656	P4=0.656	P5=0.406	P6=0.406	P7=0.250	P8=0.125	P9=0.094	P10=0.094	P11=0.063	P12=0.063	P13=0.000
ASS1	P1=0.750													
VC1	P2=0.719	*1.000*												
VC2	P3=0.656	*0.585*	*0.788*											
VC3	P4=0.656	*0.585*	*0.788*	*1.000*										
VC4	P5=0.406	*0.011***	*0.023****	*0.079*	*0.079*									
ASS2	P6=0.406	*0.000**	*0.023****	*0.079*	*0.079*	*1.000*								
VC5	P7=0.250	*0.000**	*0.000**	*0.000**	*0.000**	*0.287*	*0.287*							
ASS3	P8=0.125	*0.000**	*0.000**	*0.000**	*0.000**	*0.022****	*0.022****	*0.337*						
BA1	P9=0.094	*0.000**	*0.000**	*0.000**	*0.000**	*0.008***	*0.008***	*0.184*	*1.000*					
BA2	P10=0.094	*0.000**	*0.000**	*0.000**	*0.000**	*0.008***	*0.008***	*0.184*	*1.000*	*1.000*				
VC6	P11=0.063	*0.000**	*0.000**	*0.000**	*0.000**	*0.002**	*0.002**	*0.082*	*1.672*	*1.000*	*1.000*			
ASS4	P12=0.063	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.002**	*0.082*	*1.672*	*1.000*	*1.000*	*1.000*		
BA3	P13=0.000	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.000**	*0.005**	*0.113*	*0.238*	*0.238*	*0.492*	*0.492*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; ** = $p \leq 0.01$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*

APPENDIX M - Table 7 Result of Fisher's exact test to determine reasons why E-Business organisations manage reverse logistics

Code		SA	LO	FA
Reasons for reverse logistics		Strategic advantage	Customer and environmental protection rules and regulations	Financial advantage
Code	Pi / Pj	P1=0.570	P2=0.281	P3=0.180
SA	P1=0.570			
LO	P2=0.281	*0.000**		
FA	P3=0.180	*0.000**	*0.051***	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = p ≤ 0.005; two-tailed Fisher's exact test).*

APPENDIX M - Table 8 Result of Fisher's exact test to determine information and logistics centred process in reverse logistics in Manufacturing industries

Code		ICO	LCO
Reverse logistics processes		Information centred processes	Logistics centred processes
Code	Pi / Pj	P1=0.867	P2=0.852
ICO	P1=0.867		
LCO	P2=0.852	*0.858*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value:; two-tailed Fisher's exact test).*

APPENDIX M - Table 9 Result of Fisher's exact test to establish methods of value recovery from returned goods in E-Business industry

Code		PR	MPCMR	EER
Value recovery operations		Product recovery	Module, parts, components and material recovery	Energy and Environmental recovery
Code	Pi / Pj	P1=0.365	P2=0.083	P3=0.055
PR	P1=0.365			
MPCMR	P2=0.083	*0.000**		
EER	P3=0.055	*0.000**	*0.428*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = p ≤ 0.005; two-tailed Fisher's exact test).*

APPENDIX M - Table 10 Result of Fisher's exact test to identify barriers of managing reverse logistics in E-Business industry

Code		TB	OB	AB
Barriers for managing reverse logistics		Technological barriers	Operational barriers	Administrative barriers
Code	Pi / Pj	P1=0.600	P2=0.141	P3=0.125
TB	P1=0.600			
OB	P2=0.141	*0.000**		
AB	P3=0.125	*0.000**	*0.854*	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; two-tailed Fisher's exact test).*

APPENDIX M - Table 11 Result of Fisher's exact test to determine reason why E-Business customers return goods

Code		VC	ASS	BA
Reasons for E-Business returns		Virtual conceptualisation	After-sales service	Business agreement
Code	Pi / Pj	P1=0.458	P2=0.336	P3=0.063
VC	P1=0.458			
ASS	P2=0.336	*0.037***		
BA	P3=0.063	*0.000**	*0.000**	

This table presents the results (*p-value*) of the Fisher's exact test for null hypothesis (two proportions are homogeneous); to determine the significance of the difference between all pairs of proportions. If *p-value* is significant, two items are confirmed as significantly different. (*p-value: * = $p \leq 0.005$; *** = $p \leq 0.05$; two-tailed Fisher's exact test).*