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# Reverse Logistics in Automotive Industry

--A multiple case study in automotive industry

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## ABSTRACT

As nowadays' forward logistics of automobile industry have been developed in a good stage, according to various car manufacturers; third-party logistics companies are more concerned about the car forward logistics. However, with the mature of automotive consumer market competition, innovation and the rise of global environmental awareness, the car reverse logistics must be given due attention as well. The economic value of reverse logistics has become increasingly prominent, lead to a scene of focus only on the car forward logistics is not enough. The purpose of the thesis is to examine the current status of reverse logistics in the automotive industry. Thus, three objectives are put forward: 1) what is the importance of reverse logistics implementation in the Automotive Industry? 2) What are the existing problems of reverse logistics in the Automotive Industry? 3) How to improve management of current end-of-life automotive based on an environmental view? The objectives are fulfilled with the performance of reverse logistics in automotive industries from three automotive companies. Based on a multiple-case study, qualitative approach is used as the main research method to illustrate and present *what* and *how* questions. In addition, face-to-face interviews are adopted as well. Some concrete answers are got to meet with the research questions: the importance of reverse logistics presents by it can achieve the value of the enterprise and create a good reputation; about the existing problems currently, the system of reverse logistics is not mature enough, which indicates there is still large space for improvement; due to the last research question, enterprises can establish environmental policies and regulations for end-of-life automotive. After the research, the thesis describing how the reverse logistics performed in automotive industries.

Key words: Reverse Logistics, automotive industry, green logistics, environment

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# 1. Introduction

## 1.1 Background

Reverse logistics is the first to be presented in 1992 by Stock (Autry, 2005). There are many definitions of reverse logistics appear gradually. In general, logistics indicates the products are transported from producer to customer, while reverse logistics is in an opposite way (Autry, 2005). After research, the correlation among reverse logistics and commercial and social fields were put forward. In 1990s, a number of companies in developed countries began to practice in the field of reverse logistics. At the same time, some countries' government departments introduced legislation to force companies' related adverse reflux responsible for items such as the European Union and Japan. With the increasing of people's awareness in environmental protection and strengthen the degree of regulatory constraints, the economic value of reverse logistics gradually revealed.

Nowadays, the innovative global automotive consumer market is getting more and more matures, as well as the market competition, rising consumer status, sound environmental regulations and resource utilization. For instance, through recall defective automotive could improve customer satisfaction, thereby enhancing the recyclability of the product and the product throughout its life cycle to reduce pollution of the environment. The reverse logistics application in the automotive industry has been increasingly important. Reverse logistics is a new concept rise recent decades which not developed for a long time, there are some studies on reverse logistics in automotive business in recent years, but this paper will follow up the previous studies and more focus on present status. Therefore, this raises the authors' interests to do a research on comprehensive study of reverse logistics and its application in the automotive industry.

## 1.2 Research questions

This paper is a comprehensive study of reverse logistics, and the purpose is to examine the current status of reverse logistics in the automotive industry. The research questions to achieve the purpose as follows:

- What is the importance of reverse logistics in the Automotive Industry?
- What are the existing problems of reverse logistics in the Automotive Industry?
- How to improve the efficiency of reverse logistics management based on an environmental view?

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### **1.3 Limitation**

A lot of companies which perform well in reverse logistics have been informed by email, but only three of them respond. For the topic of reverse logistics in automotive industry, three case companies were adopted, and it is a limitation here. But all these three companies are representative and interesting, because they are large enterprises and famous around the world.

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## 2. Methodology

Three case companies were chosen in this paper. Due to the topic related companies' sensitive information, the managers are unwilling to mention the brand name in public, so in order to provide a better understanding for this paper that used alternative word to present different case companies. It is adopted qualitative research in empirical findings, mainly concerning the content of interviewed with managers, some supplementary information collected from the Internet and literature review, but it is the difficulties in carrying out this findings caused by the limited secondary data. Deductive approach through comparing multiple cases information and analysis these data to get conclusion, the specific method will be explained in this section.

### 2.1 Quantitative & Qualitative approach

According to Burrell and Morgan (1979), quantitative and qualitative methods are two distinctive methods which cannot commensurate with each other. These two methods are used for designing researches in cases, although there have a few basically differences through comparison between these two approaches. Table 1 below shows the differences in qualitative and quantitative research approach through comparison.

*Table 1. Contrast between Quantitative and Qualitative Approaches (Burrell and Morgan, 1979)*

<b>Contrasts between Quantitative and Qualitative Approaches</b>		
	<b><u>Quantitative</u></b>	<b><u>Qualitative</u></b>
<b>Purpose</b>	Explores causes, makes predictions	Aims to describe phenomenon or generate theory
<b>Perspective</b>	Objectivity increased through use of precise measurement	Subjective view of participants
<b>Sample</b>	Large, representative samples Random selection of subjects or random assignment to group	Small samples Purposive selection of participants based on their experience
<b>Data</b>	Generated from responses to questionnaires or some objective measurement (e.g., temperature)	Consist of words (interviews, diaries, other written documents) or pictures or other artifacts in which the significance has been rendered into words
<b>Analysis</b>	Statistical	Interpretive

Thompson & Walker (1998) has put forward the notion of qualitative research: this method is through illustrating and identifying the elements of the situation and relationships between the resources to provide a depth phenomenon to the researcher and help them get to a more detailed situation. In addition, the qualitative approach is able to give a direction which can indicate the further study and researches, as well as

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providing the whole strategy for strengthen the guiding practice.

Due to comparison, the result shows quantitative approach is more concentrate on quantities and the way of measurements, the method like quantitative is usually adopted when the case is accomplished through collecting quantitative information, meanwhile, making some calculation of the data which has been gathered. There is a kind of scientific way which is used for dealing with quantifiable data, by utilizing numbers, diagrams, statistics and tables as main approaches for dealing with the data in quantitative research study (Biggam, 2008; Walliman, 2005).

After considering about the purpose of the study and based on the different characteristics of qualitative and quantitative research approach, a descriptive multiple-case study in qualitative research is chosen to accomplish the research questions. For the reason of qualitative approach can be utilized for analyzing qualities and making distinctions (Walliman, 2005).

Yin (2012) states that qualitative data can give a strong fundamental of description of the information, he claims that the differences and similarities descriptive is an appropriate way for multiple-case study, it provided by the differences and similarities of cases. Qualitative approach is a method that could be easy and convenient to illustrate the descriptive theory. In this study, qualitative approach is going to be used for interpreting reverse logistics and its specific components in theoretical framework, evaluating the present performance situation of reverse logistics implemented in automotive industries. The research questions are consist with what questions occurs and how to solve the existing problems. Moreover, the following descriptive and qualitative approaches are going to utilize to acquire the solution of how to improve management of current end-of-life automotive based on an environmental view.

## **2.2 Deductive and Inductive approach**

As the study has been defined as a qualitative research study, in the light of Williman (2005), there are two methods usually used for measuring with the qualitative research. The two methods used for helping to draw the acquisition of new knowledge are named deductive and inductive approach. Normally, there is a specific joint name describing the two-approached called reasoning style. However, the deductive method is working as a process of testing the theoretical framework from an existing established generalization or theory, through comparison in order to see whether the theory applies to the specific instances. Inductive approach is working more like a process by establishing or creating a completely new theory from observation from the specific instances, thus to establish generalization about the situation and phenomenon according to the investigation and discovery (Williman, 2005).

To sum up, it can be regarded as that the two approaches both used for finding the information but from completely opposite directions; deductive approach is inferred the particular from the general while the inductive method is inferred general theories

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based on the particular. Considering the situation of this study, it is defined as by using both deductive and inductive way to answer the research questions.

### **2.3 Case selection**

Seawright & Gerring (2008) have highlighted it is really an essential step to adopt to real world cases when accomplishing a case study research work, in order to get more constructive results and conclusions. Before all the work starts, the primordial work to think about for the researcher is to consider choosing an appropriate case for the study.

In this study, three automotive companies have been selected as the case companies by mainly two reasons; they all practice reverse logistics to different degrees and for access reasons with the possibility to do interviews. The authors aim to develop a multiple-case study due to several reasons for example the research questions, the requirement of theoretical framework in this thesis work. Through comparison of three automotive industries major in the same area, enable the data collection and conclusion presented with more reliable and convincing evidences.

The authors did the work by analyzing multiple-companies in their same characteristics but with different modes of operation. Therefore, the performance of the automotive companies in reverse logistics can be presented in a more comprehensive way, since it is obvious to figure out and sum up what are the commons and differences between the three cases, as well as the weaknesses and strengths of the performance in each company. The three cases chosen by the authors in a certain extent for decreasing the bias and acquire a more general conclusion by comparing the similarities with differences.

### **2.4 Data collection**

Data collection is the process to show how information is gathered, there are various ways to collection which including face to face interviewing, phone interviewing, e-conversation and search on the Internet, and data collection is play an important role in a research paper, the inaccurate data may lead to an invalid result (Gill et al., 2008).

Prepare for questionnaires could sent to by paper-pencil-questionnaires or web-based questionnaires, the former way is save researcher's time and money, get the answers are more fact due to the anonymous way, the latter way means the interviewees will receive an e-mail on which with an address link, click it and submitted through web (Leedy & Ormrod, 2001). For this study, data collection mainly from primary data that interviews with single person, so the authors just need to prepare the relevant research questions for the logistics manager of each case company.

Face-to-face interviews enabling establish rapport situation and potential participants

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so that can gather information easier, but it allows the ambiguous answers from interviewees that will get impractical information, and consuming too much time and costs expensive (Leedy & Ormrod, 2001). Compare with face-to-face interviews, telephone interviews are consuming less time and less costs, it without geographical restrictions but lower response rate than face-to-face interviews. Computer Assisted Personal Interviewing (CAPI) is a form of personal interviewing, through enter the information directly into the database to save time in data processing, but it has higher requires in machine setting (Leedy & Ormrod, 2001).

There are three case companies in this research paper, so it has three different ways to interview caused by the geographical restrictions. Due to the time limitation, authors just interviewed one manager in each company.

Interview Company A's logistics manager who in England is through e-mail conversation, before that we were through phone contact to reservation, for the pre-contact so authors got response smoothly. The first e-mail that the authors sent was explained the topic of the thesis and information needed. After received the response from Company A's logistics manager, the authors sent the interview questions to the manager. The response e-mail is very detail for the reverse logistics processing, the logistics manager has freehand sketching three figures to authors, it presented in empirical findings in formal figures. Preparing the face-to-face interview to Company B's logistics manager in an earlier date when one of author in Guiyang (China), to gain a nearly complete company information was expected to exceed. The interview situation have a relax atmosphere, it during 1.5 hours. The interview record by hands writing, author be prepared the questions before interview printed out, and according to the answers to fulfill it. When finished the interview, author summarized all the information and make sure with the Company B's logistics manager. Connection Company C with telephone, the limit caused the ambiguous answers from the logistics manager, because of the interview contents related sensitive information so the data collected was got not very comprehensive.

For supplementary information collected is based on secondary data, such as enterprises annual reports, search on the Internet and study with literature review, but it have insufficient information in the area of reverse logistics, and more about forward logistics.

Before face-to-face interviews the Guiyang local manager, it is very lucky for the manager is author parents' friend, so the author could contact the manager before interview and reservation the detail time; The manager who works in England is another author's friend, she told us that could edit all the interview questions through e-mail sent to her, and she will reply us as soon as possible; Company C's manager is through the telephone to interview, his voice was a little impatient and told us he was very busy now, we consulted for a long time so that he was accepted the interview during ten minutes, but we did not get the complete information due to some limits, such as the time limit and interview questions related sensitive information. The

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interview questions as follows:

1. Background information of your company?
2. What do you think of the necessity of implementing reverse logistics / returns management?
3. The importance and significance of efficient reverse logistics.
4. The major problems existed when implement reverse logistics in the automotive field.
5. Reverse logistics operation at the strategic level.
6. Are there any facing challenges of reverse logistics?
7. The main factors that have impacts on reverse logistics.
8. The performance and present situation of CSR (Corporate Social Responsibility) in your company.

## **2.5 Validity & Reliability**

### *Validity*

Yin (2012) illustrates that validity can be divided in construct validity, internal validity and external validity. Construct validity indicates if the researcher's reported events according to the real phenomena, without insert the researcher's own prejudice. The researcher should try to use a fair and equitable manner to reduce the errors in maximum. In this paper, authors have interviewed with the managers of companies, based on a manager's perspective to collect relevant information may better than a normal staff. But in other words, the manager works in the company, thus it cannot be avoided that most of the information provided by the managers is positively. Internal validity could described the researcher may try to establish a cause relationships and find some problems that should pay attention to (Yin, 2012), the existing theoretical framework is not suitable exactly used in this thesis, the concerning internal validity to this thesis may inference relationships between three case companies. Through the comparison theoretical part with empirical findings, the authors figure out some of the content exists in case companies while the theoretical framework not mention about. Therefore, the theoretical framework may not suit for this study exactly. External validity is defining the case studies beyond theoretical framework, which enable the theoretical section could meet with the empirical findings (Yin, 2012). And choose multi-case companies to compare in order to cover the shortage of sufficient information, the interview questions defined by a way that authors thought it can describe the research purpose of this paper. Moreover, the limitation also presented in not possible to generalize in a statistical manner, because there have the limit numbers

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of case companies.

### *Reliability*

Reliability address issues relating to rigor within a qualitative research, the traditional understanding focuses on the standardized, neutral and non-biased (Mason, 1996). Yin (2012) stated that reliability is tested by used alternative questions with the same meaning during interviews, which appear to do a standard approach to qualitative interviews or observation studies. In this study, authors studied the literature review with valid journal, book and report, for the primary data collected by face to face interview with written record, email conversation that keep the original mail in inbox. For the secondary data collected were search from the companies' home page, annual report or the literature reviews, that is in order to guarantee the reliability for this thesis. The authors came up with several interview questions based on the research purpose. For achieving high reliability of the thesis, when selected the literatures, the authors tried to search literatures that based on cases from different degree to ensure the extent of information.

### *Ethical and societal dimensions of the study*

When this thesis have finished, the authors will send it back to the Company A's logistics manager in ethical dimension, which means that the manager had the possibility to deny and check the interpretations of answers. Societal effects of the study are about the environmental improvement suggestions to automotive companies.

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### **3. Theoretical Framework**

The appearance of reverse logistics in automotive industry area has four areas: first, product return in reverse logistics; second, recall the automotive in reverse logistics; third, saving and protection environmental in manufacturing processes; fourth, recycling waste products in reverse logistics (Greve & Davis, 2012). It will describe in below text in detail.

#### **3.1 Reverse logistics**

Reverse logistics and reverse processes emphasized green logistics in traditionally (Carter & Ellram, 1998; Murray, 2000), that means added environmentally into logistics strategies, including product return, recycling, waste disposal, refurbishing, repair and remanufacturing (Autry, 2005). Many companies have recognized the economic impact on reverse logistics (Klausner & Hendrickson, 2000), effective reverse logistics could improve company outcomes, and remanufacturing, repair, and recycling have been proved impact on company's value reclamation (Andel, 1997; Giuntini & Andel, 1995). In the early nineties, a formal definition of reverse logistics was put together by the council of Logistics management, stressing the recovery aspects or reverse logistics (Brito & Dekker, 2004). The term often used to refer to the role of logistics in recycling, waste disposal, and management of hazardous materials; a broader perspective includes all relating to logistics activities carried out in source reduction, recycling, substitution, reuse of materials and disposal (Brito & Dekker, 2004).

Since the reverse logistics have some characteristics such as high investment risks, complex structure, location scattered and so on, if the manufacturers operations by exclusive, although could reduce transaction costs but it has increased inventory costs and transportation costs, the slowly demands response speed and low service level will resulting the decline in customer decline, enterprises lack of competitiveness (Blumberg, 1999). Reverse logistics could help companies build brand awareness and get positively influences customer satisfaction (Blumberg, 1999), for returning disposable products from end users to origin have many reasons, the most commons may include product quality defects and lack of consumer satisfaction (Barsky & Ellinger, 2001; Gonzalez-Torre et al., 2010). That shows reverse logistics performance is diversification, reverse logistics contain the product components, materials and its packaging from customers (Hazen et al., 2011), is the processes that recovered the old, outdated or damaged products and its packaging from customers (Gonzalez-Torre et al., 2010). The motivation of reverse logistics have some aspects, most commons are including environmental regulation, economic interests (reflected in reducing waste disposal costs, longer product life and saving raw materials and components), and commercial consideration (Rogers & Tibben-Lembke, 2001).

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## **Product return**

Automotive manufacturers are playing an important role in whole automotive supply chain. In the processes of reverse logistics, there are “several-for-one” relationships between the enterprises which in supply chain downstream with end users for automotive manufacturers (Reynaldo & Ertel, 2009). If automotive enterprise adopted a slack return and recall policy, could reduce the complaints reports that including downstream wholesalers, retailers and ultimately customers, it allowed automotive manufacturers strengthen communication with supply chain downstream enterprises, to reduce and solve the problems of information asymmetry, which coordinate the relationships among automotive enterprises, downstream wholesalers, retailers and ultimately customers (Reynaldo & Erterl, 2009).

Product Return refers to the return of raw materials and components which have been procured but unqualified acceptance, as well as the transportation, inspection and storage-related logistics relevant to the return of sold products (Figenbaum & Thomas, 1986).

According to Ko & Evans (2005), the return of product can be divided into five types as followed:

### **Different types of Product return**

1. Non-defective product return which including non-defective returns from consumers and retailers or distributors.
2. Return of defective product, defective product exists mainly due to the production technology and quality management results in quality function defects. Talking about defective product, another calling of this kind of situation is called product recall by Srivastava & Srivastava (2006) , which means manufacturers will have to recover the on hand product from wholesalers, retailers or end-user. Typical reasons for product recalls are sold products are found defective.
3. Product returns in handling and transport process damaged
4. Return of order processing errors or mistakes in the packaging process, some companies may have poor internal management, lead to the employees make mistakes in order processing.
5. Return caused by delivery delays

Buhl et.al, (2009) highlighted product recall system and general three bags of product return are basically two concepts. Three bags of product return and replacement is for individual consumers, the product itself cannot explain any problems; while handling product recall system is a way for manufacturers’ batch problem causes the emergence. Among them, identifying of quality defects is regarded as the most critical core responsibility for producers (Mukhopadhyay & Setopurtro, 2004).

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Mukhopadhyay & Setopurtro (2004) also mentioned that in developed countries, a product recall can be presented in two ways: one is the "voluntary certification, mandatory recall," another is "compulsory certification, a voluntary recall."

Davis et al., (1998) has summarized product return reasons according to the different headstream the return product comes.

### **Different reasons for product return according to their headstream**

- Reason for the return from the customer

Since the formation of a buyer's market, in order to compete for the market place, some retailers such as supermarkets launched "not satisfied with the returns" policy. Enhance the status of the customer in the market, thus some customers began to have wrong habits of return, which in specific regardless of whether the purchased goods have quality problems, they will be asked to return, even though they knew they did not return the goods quality problems.

- The reason for the return from the retailer

Retailers aim to improve their reputation and maintain the loyalty of their customers; satisfy the customer's return without any restraint. As long as the customer asked to return, retailers will try to meet the customers' requirements, make returns processing, rather than to the screening of the returned goods if the customer meets the specific requirements of return, such as the product is defective before return. Sometimes returns happen simply because of the retailer's sales staff did not give the customer a good understanding of the product performance and advantages; long return period of the product (Vlachos & Dekker, 2003).

- Return from internal reasons

Due to poor internal management and technical issues, such as: product quality problems; product packaging intact, the internal parts missing; product or the number of errors occur when manually enter orders; in the warranty period or out of the warranty period, the product needs to be faulty return and repair; product defects and quality issues. All these reasons can form returns. Due to the lack of uniform criteria, the refund amount is also varied. In addition, because the use of the product packaging or manual, sometimes they cannot make the usage of them properly, resulting in the demolition of the customer problems when solve the product packaging, or need to spend a lot of time to understand the product's instructions for use thus lead to the return (Vlachos & Dekker, 2003).

- Returns from the reasons for the formation of the supply chain

Logistics and supply chain management requires node in the supply chain companies, collaborative work and mutual trust from each other, but everyone

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cannot rule out that accidental delays will happen in the production or delivery of the supply chain, this delay will affect the final product delivery, normally customer will pay because of delayed and demands the return of the goods; product was damaged during shipment process; goods stolen in transit, and then be returned; same order erroneously repeated in delivery and so on. These factors will result in return which also cause the return logistics formation illustrated by Davis et al., (1998).

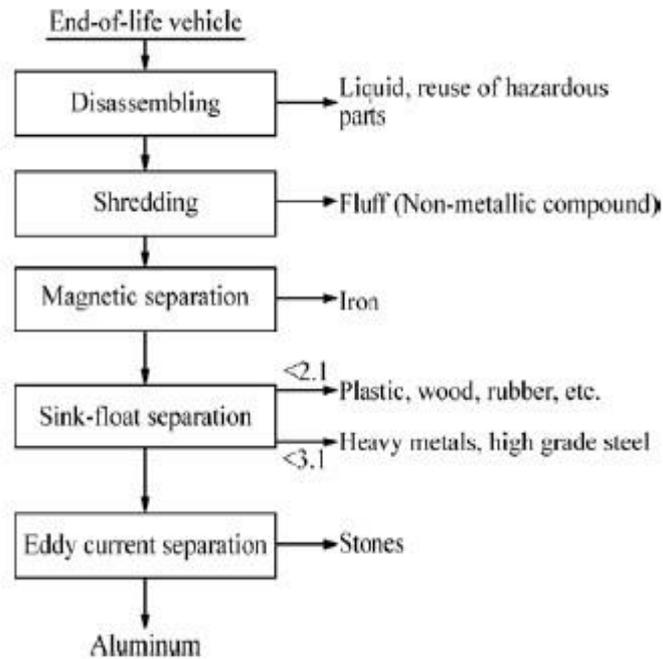
- Returns for other reasons

Reasons such as: the use of some products after the expiry, according to national regulations needs to be recovered remanufactured, recycled or incinerated (Vlachos & Dekker, 2003).

### **Recycling**

Nawrocky et al., (2010) stated the opinion of the necessity of sorting strategy with high efficiency becomes more and more important for the enterprises and industry which have recycling work. The concept of recycling attracts increasingly eyes from worldwide based on more and more people have been realized the importance of the sustainable for future generation. Not only because recycling can provide the decreasing of waste but also can effectively avoid unnecessary waste of reusable energy and material through recovering the product (House et al., 2011).

In order to achieve a better performance in recycling of end-of-life vehicles (ELVs), many recycle experts of modern automotive put forward a number of procedures which is very useful for recovering valuable resources and materials from end-of-life vehicles (ELVs), Cui & Roven (2010) has raised a model in their study to illustrate the typical recycling procedures of end-of-life automotive which is shown below:



**Figure 1. Typical end-of-life vehicle recycling process (Cui & Roven, 2010)**

The figure has generally illustrated the process of recovery aluminum metal from wasted vehicles, the procedure of disassembling and the physical discrete process. Based on Cui & Roven (2010), the disassembly of automotive vehicles sometimes can be regards as a selective disassembly, selecting out the hazardous or usable parts is an necessary step in automotive recycling. It is a systemic method which enables removes a part, a series of components or the sub-components of a product; or divided a product in small little parts based on the provided goal.

The following steps for establishing a disassembly procedure plan have been put forwarded:

1. The first step is the analysis of input and output product, this step is to figure out the reusable, valuable and hazardous parts and resources of the product. Through cost calculation, the most optimal disassembly can be ensured (Hanko et al., 2002).
2. The second step is the analysis of assembly, in this step, participate components, elements level and former assembly queue should be identified (Hanko et al., 2002).
3. The third step is the analysis of uncertainties and risks, uncertainties often happens in disassembly when the product has defective components and joint parts in it, improve or decrease the lifetime of the product when the customers using them and disassembly damage (Hanko et al., 2002).
4. The last step is the identification the strategy of the disassembly; this step is to

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determine the dismantling is using a non-destructive way or a destructive way (Hanko et al., 2002).

### **Waste treatment**

Waste treatment is another priority measurement for nowadays environmental protection and maintains the sustainability for future, which refers to the methods have to be done to guarantee the waste has the least negative impact and hazardous influences to the environment, waste treatment has also been divided into many specific forms in different areas in worldwide due to the law (Yu & Chau, 2009). With the growing attention to energy saving, automotive industries have increased their speed on developing more technologies and methods acquire the function of energy-sufficient. The most regular way of waste treatment in automotive industry is the energy transaction; generally the conversion happens from heat energy to electric energy (Yu & Chau, 2009).

There are many methods used for waste classification, which is based on the nature, status and source categories, such as chemical properties can be divided into organic waste and inorganic waste; hazardous conditions can be classified according to their hazardous waste and general waste (Yu & Chau, 2009). Karam & Nicell (1997) stated in their study that many countries in Europe and America divided the waste according to their source or other sources, which will be divided into industrial waste, mining waste, municipal waste, agricultural waste and waste of radioactive.

### **Waste treatment - Waste prevention**

The main way of controlling of the environmental pollution and waste which are harmful to human health is to impose on waste resources, harmless and reduction treatment (Karam & Nicell, 1997). The recycling and second utilization of the resources means the waste recycling, energy recovering and the resources collection. The recycling of industrial waste must according to the specific characteristics of a given industry production, as well as pay attention to the technical feasibility, the competitive product and economic benefits and other factors (Yu & Chau, 2009). Harmless sound disposal of waste disposal is defined as through appropriate treatment or disposal of waste or hazardous constituents without bringing harmful influences to the environment, or convert the waste into harmless substance to the environment (Yu & Chau, 2009). Based on Karam & Nicell (1997), commonly methods used to solve this situation are: landfills; incineration and composting

## **3.2 Green logistics**

Environmental aspects of reverse logistics are critically important, traditional logistics may described in transport, warehousing, packaging and inventory management from producer to user, but due to protect environment so that consideration for recycling and waste disposal (Rodrigue et al., 2001). Green Logistics is aim to reduce the

environmental externalities, through deal with logistics related aspects such as transportation, warehousing and inventories to reduce environmental issues, which including greenhouse gas emissions in logistics operations, noise and accidents (Dekker et al., 2012). Green design for products indicate that before manufacture a product will considering the impact on environmental, for instance, the used materials, and it could be recycling or not when the products end its service life (Mackenzie, 1991).

Rodrigue et al., (2001) stated six basic characteristics with regards to environmental of logistics systems (see Table 1), and they gave the explanation in detail: Saving logistics cost are often at variance with environmental protection, but people becoming less willing accept to afford these externalized environmental costs, Rodrigue et al., (2001) thought reduce logistics does not necessarily to reduce environmental impacts; Time/ Speed is the key in logistics, through reduce time by using the most polluting but fast way to transport; Logistics reliability means the least polluting modes and on-time delivery to customer; In general, warehousing actually to congestion and pollution, but modern logistics systems delivery speed and reliability could reduction of inventories; With the increasing population of e-commerce, it implies more packaging and more transported, that will weigh the environmental load (Rodrigue et al., 2001).

**Table 2: Paradoxes of Green Logistics (Rodrigue et al., 2001)**

<b>Dimension</b>	<b>Outcome</b>	<b>Paradox</b>
Costs	Reduction of costs through improvement in packaging and reduction of wastes. Benefits are derived by the distributors.	Environmental costs are often externalized
Time / Flexibility	Integrated supply chains. JIT and DTD provide flexible and efficient physical distribution systems.	Extended production, distribution and retailing structures consuming more space, more energy and producing more emissions (CO <sub>2</sub> , particulates, NO <sub>x</sub> , etc.).
Network	Increasing system-wide efficiency of the distribution system through network changes (Hub-and-spoke structure).	Concentration of environmental impacts next to major hubs and along corridors. Pressure on local communities.
Reliability	Reliable and on-time distribution of freight and	Modes used, trucking and air transportation, are the least

	passengers.	environmentally efficient.
Warehousing	Reducing the needs for private warehousing facilities.	Inventory shifted in part to public roads (or in containers), contributing to congestion and space consumption.
E-commerce	Increased business opportunities and diversification of the supply chains.	Changes in physical distribution systems towards higher levels of energy consumption.

McKinnon (2010) illustrated that logistics accounts for around 5.5% of global greenhouse gas emissions, especially freight transport, and gas emitted by airfreight and trucking has been increasing. While, through decarbonization measure to cut costs for reduce emissions, so that generating the benefits of economic and environment (McKinnon, 2010).

Logistics as a blanket term to reduce the environmental impact of the supply chain, for instance, source reduction and material substitution, these activities might better be labeled “green logistics” (Rogers & Tibben-Lembke, 2001). While, in some way it could be classified as reverse logistics, Figure 2 has shown the differences and overlap between green logistics and reverse logistics. See figure below, the left circle is stand for reverse logistics, and it contains Product returns, Marketing returns, Secondary markets, Recycling, Remanufacturing, Reusable packaging; and the right circle is stand for green logistics, it contains Packaging reduction, Air & noise emissions, Environmental impact of mode selection, Recycling, Remanufacturing, Reusable packaging; it is obvious that the middle circle is the junction of reverse logistics and green logistics, it means reverse logistics and green logistics have all contain these three aspects.



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environmental, realized the sustainable development in automotive industry is the issues that cannot be ignored (Hilton & Levinson, 1998).

### **3.4 Circular economy**

Circular economy through resource development to realize circular materials flow as “resource-product-litter-renewable resources”, and its foundation principle could be based on “3R” (reduce, reuse, recycle) to implement circular economy (Lou & Zeng, 2007). In the automotive industry, “reduce” could be improved manufacturing processes to reduce consume raw materials, saving manufacturing costs and reduce litter emissions; Reuse means increasing the using times of components to reduce the resources consume and pollutants emission; Recycle required that when components complete its functions these could back into available resources instead of waiting for disposal (Kumar & Yamaoka, 2007). Automotive has brought to a great convenience for humans, but there is very dangerous to drive extended automotive, it will cause the environmental pollution and accidents. In the past, automotive producer adopted light weight, durable plastics and consider the lower price as automotive materials, but the growing disposition of plastics from scraped automotive has put increasing seriously (Duval & MacLean, 2007). Awareness of economic has increasing relatively with automotive industry, in the economic sense, a business’ long-term viability depends on its market stagnation, production technology and profitability (Williams, 2006). Manufacturers through improve economics scale to increased profit margins, for instance, high-volume sales and enter international markets, adopted “break-even” point acts, which means automotive manufacturers are used in less costly for stockpile new automotive rather than producing capacity (Williams, 2006). In automotive industry, reuse components, repair parts, recycling materials and chemical recycling are considered particularly to environment and use economical resources (Bellmann & Khare, 1999). With the rapid development of economic, resources are overdrawn, environmental are destructed, various countries have realized the necessity of performance sustainable strategy, while circular economy is an inevitable strategy of sustainable development (Lou & Zeng, 2007).

Open-air to discard waste automotive, not only waste materials and pollute environmental, but also cause land be occupied. Therefore, scraped automotive recycling, utilization and disposal have attracted high attention in various countries (Cui & Roven, 2010). Based on environmental protection view, recycle these plastics can be manufactured into plastic products, while these recycled plastic products could not be used in manufacturing automotive, but could through incineration recovery energy (Duval & MacLean, 2007). Implementation automotive recycling and develop circular economy is a way to solve the social problems of pollution that caused by automotive.

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### **3.5 Corporate Social Responsibility**

The current definition of this concept by EU says as “corporate social responsibility (CSR) indicates to enterprises on a voluntary basis, will integrate social and environmental concerns into their business operations as well as the relationship between the enterprise and its stakeholders in” (Bocquet et al., 2013). Golob & Bartlett (2007) reported that as significant communication tool for better understanding and supporting with different kinds of stakeholders. CSR practices in an embedded culture that companies are directly influenced by CSR principles, so companies could realize the benefits that receives from practice CSR commitment (Costa & Menichini, 2013). The CSR adoption must consideration all the stakeholders’ satisfaction, based on the view of create value in the economic, the environmental and the society, then, companies could gain competitive advantages from productivity efficiency, reputation, customers loyalty and financial resources (Costa & Menichini, 2013).

As so-called the Corporate Social Responsibility, indicates that enterprises should assume the interests of their staffs, customers, external environment, communities and other stakeholders responsibility while creating profits for their shareholders, the companies should be aware of the core concept of CSR is to legitimate benefits of workers, including a wide range of non-discrimination, not using child labor, without forced labor and have complete working conditions and health and safety system (Carroll, 1999).

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## **4. Empirical findings**

Automotive as one of important economic pillar industries, but the rapid growth speed led some problems, for instance, the quality problems caused automotive return, recall and recovery. While, automotive returned, production waste, and recycling packaging materials have constituted automotive reverse logistics system (Reynaldo & Ertel, 2009). Therefrom, automotive manufacturer through the processes of recycling production wasted and packaging materials to saving resources and improving the utilization of automotive, hence reducing the impact of automotive wasted on the environmental, meanwhile reducing the manufacturing costs and brings the considerable economic benefits for manufacturers.

### **4.1 Case company overviews**

In this section, three companies were chosen as case company; for the reasons of the companies' managers do not want the real name of the company mentioned in the paper, so the name of the case companies will be instead of Company A/B/C. All of the case companies' nature is the wholly foreign-owned company.

Company A is a world's leading luxury automotive manufacturer, which was founded in England. The most unusual way is it makes extensive manual labor, high labor costs in Britain caused the high production costs automotive of Company A. The cars produced from Company A are an outstanding representative of the top cars, made brand became the immortality world-renowned symbol. Company B is a Germany automotive manufacturer, the world's top automotive companies in the forefront. In the start-up phase, Company B was focused on the development and production of aircraft engines. From the initial development of an aircraft engine manufacturing plant into a limousine driven, and production of world-renowned aircraft engines, off-road vehicles and motorcycles Enterprise Group. At the present stage, Company B is committed to creating a car which all parts could be recycled. Company C is also a world famous German car brand, which is known by worldwide from its high-quality, high-performance automotive product. In spite of the high-end luxury sedan, Company C is the world's most famous bus and heavy truck manufacturer as well.

### **4.2 Reverse logistics practice in Company A**

According to the interview with company A, the manager mentioned that the high technology content of their product cause the difficulty, costly and long production of the manufacturing processes. So it requires the company have to implement reverse logistics and return management, enable the company to meet with the customers' demand within a reasonable time. In addition, the company can control the cost of the product.

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## CSR

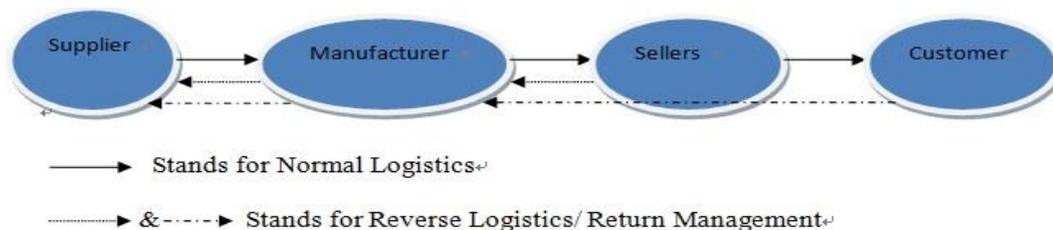
The logistics manager stated that the significance of the implementation of this aspect of management is not only to effectively control the cost of the product, but also to understand and improve the quality of the product. Moreover, reverse logistics can improve the efficiency of the returned goods circulation efficiency and accomplish completion of effective capital return. The manager also told that the importance and significance of the efficient reverse logistics is to reduce product costs, improve quality and increase the corporate supply management, as well as enhance the competitiveness of the enterprises and provide the customers' a sense of trust to the company. And the cycle of raw materials is also conducive to environmental protection and sustainable development of resources.

Talking about the existing problems in implementing reverse logistics in automotive industry, Manager gives the answers in two aspects: Firstly, the company does not have a specific management center for reverse logistics and product return, so the management processes are use the same human resources. This situation can sometimes result in a lack of human resources, thus resulting in delays. Secondly, Company A does not have a unified and clear policy to deal with the return and reverse logistics sub-categories. Different apartment responsible for different supply chain formed a local management and policy, did not reach a unity in a company-wide. So there is no optimal way to determine or plan how to handle reverse logistics products, either cannot achieve optimal transportation solution which can resulting in additional costs.

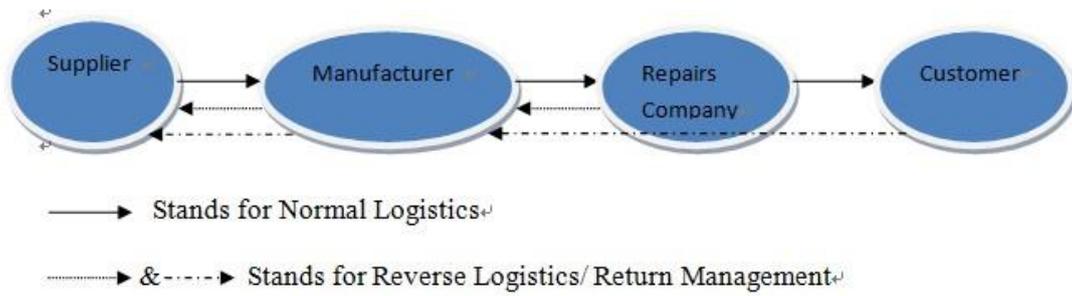
Based on the interview content with manager, the main factors influences the reverse logistics are: the laws and regulations on environmental protection, product life cycle, strategic management and maturity of the supply chain is a major factor. For corporate social responsibility, they are indeed have implementation of some of the products of the raw materials (especially precious metals) recycling, not only to reduce product costs, but also contribute to sustainable development of the environment.

### *Recycling*

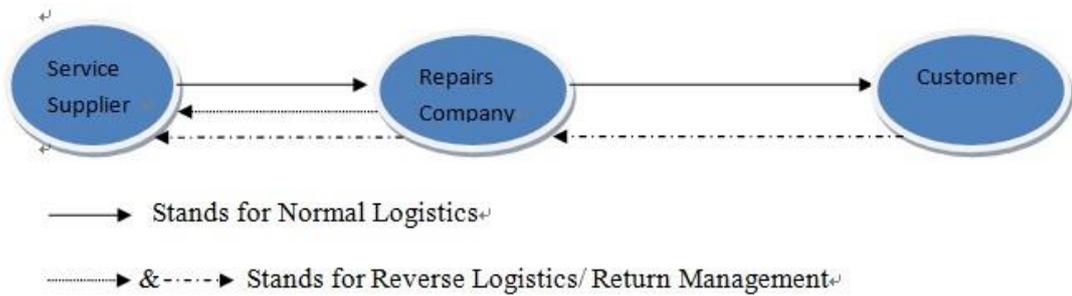
The manager has provided a model to answer how the reverse logistics operations at the strategic level of Company A, which is showing below:



**Figure 3. Reverse Logistics/ Return Management process of new products**



**Figure 4. Reverse Logistics/ Return Management process of new products (Automotive Parts)**



**Figure 5. Reverse Logistics/ Return Management process of Used Products (Refurbishment and maintenance of used parts)**

Company A is an environmental organization registered battery manufacturers and has their own characteristic in battery recycling, when the original car battery burns out, customers can purchase or install new batteries will be returned to its authorized dealer of Company A, or it can be sent to any of the following facilities for recycling.

According to the Manager, the operations at the strategic level especially the reverse logistics of automotive parts. Company A is making gradual improvement to the company's global strategy in this regard currently. That is because although the joint aftermarket service parts companies of Company A throughout the world, there is no specific and taken together evaluation about each company's strengths of maintenance capability in parts from different areas and classes. So now Company A is setting a number of teams responsible for the development of strategic plans in this regard. Moreover, for the suppliers who have maintenance capability, Company A has not reached a level of data sharing of demand, production planning, in this regard; there is a larger gap with the supply chain management of new products, so this is the second aspect for Company A to make improvements.

*Recall*

Company A just exist several recall problems, the drawback is that the vehicle brake booster vacuum pump oil may be affected by the pollution, and cause the brake booster function being affected as well. So when an extreme case happens, the vehicle

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may lose the brake booster function, or may cause the vehicle braking performance.

The interview has mentioned about the challenges might be faced when implementing Reverse Logistics, the manager gives the explanation of from an overall point of view, the supply chain of new product is completed with SAP system, the return management and reflux of new product is also part of SAP, but for the used products' parts, Company A did not manage to use the SAP system, just using basic database like Excel to deliver management information. In addition, from the management's organizational structure perspective, the supply chain management team of new product is separated with the supply chain management team of repair parts.

#### *Waste treatment*

In the period from 2003 to 2011, Company A has increased the stability of each vehicle produced waste recycling, and now have more than 97% of all waste is recycled each vehicle, thus reducing the large number of garbage landfill. This is mainly achieved through the following measures: recycling of more than 26 kinds of different waste streams, including cardboard, paper, plastic, tires, polystyrene, glasses, metal and wood.

Waste recycling and anaerobic digestion and prevent food waste destined for landfills general can reduces landfill garbage rotting produce greenhouse gases, but also make the production of renewable energy and reduce pollution. The vast majority of auto parts are performed by reusable transport containers; these containers are recycled and subsequently returned to the supplier, thus saving a lot of packaging waste, so that the amount of waste generated can kept at a minimum level.

The manager also mentioned Company A through a more creative way to use relatively expensive material. For example, leather upholstery pieces sold to the rest of the fashion industry for reuse, wood veneer scraps donated to local charities for the workshop and furniture manufacturing, and selling to raise money for charity. During 2003-2011, Company A reduces landfill waste per vehicle by 63 %.

#### *Green Logistics*

Company A has two main characteristics: the manufacturing process is simple and the low noise while driving, these two advantages quickly became a classic for Company A. Production process and plant facilities are used to achieve the low water-saving systems. The manager told Company A has been fulfilled to minimize water consumption and loss of commitment. Coating process uses a closed loop water systems, make the water saving 53,000 liters per day, the checking result of each cars watertight detection of "Monsoon" compartment is 2,300 liters per week to conserve water.

In addition to reducing water consumption on site, Company A also pay close attention to the structural design of the drainage system. In accordance with SUDS

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(Sustainable Urban Drainage Systems) standard, factory designed many depressions or seepage pits to handle the overflow of rainwater. All surface water flooding through the roof and parking is trapped pipe import gasoline lake scene, these acts as a cold water source headquarters building climate control system.

Commuting from car parts to transport employees and travel, Company A takes the initiative to reduce carbon dioxide emissions. Due to logistics and transport is very to each other, all brought into and out of the supply of finished cars shipped only about 40 truck trips per day, equivalent to a fraction of the number required for a conventional car factory only. About the scrapped vehicles, all of the manufacture, use, maintenance or ultimate recovery, Company A has always been committed throughout the life cycle to reduce the impact on the environment. Always adhering to the "recovery design" concept, in order to ensure its efficient vehicle can be recycled.

### *Biodiversity*

Company A can be regarded as a nature reserve in another point of view. "We planted more than 400,000 trees and shrubs, 120 different categories, not only to provide a barrier to the building, but also the rich flora and fauna of the region's biodiversity", said by manager. Company A is also the big home for of variety wildlife, Company A's well-built safari and artificial floating island in the lake, attracting many birds come to nest and to promote the growth of plants and flowers. Water garden areas and a large artificial floating islands of reeds in maintaining good water quality and health is very successful as well, making wetland bird habitat.

## **4.3 Reverse logistics practice in Company B**

Many companies through implementation reverse logistics to save costs and obtain the benefits, in the meantime to assume the environmental responsibilities. Including company B and many other companies are actively claiming reverse logistics is an important part in their environmental strategy and green supply chain. The Guiyang (China) local manager explained that the purpose of reverse logistics in automotive industry is customer satisfaction and environmental protection, it is a dynamic process as the market-oriented making automotive related products, resources and information to flow. These types of flow mainly including two: one is the reverse logistics of recycling end-of-life automotive scarps, another one is the reverse logistics due to existence some quality defects, and need recall the automotive from consumers or markets.

Company B's products have the excellent quality and processing technic, so they were considering the reuse of pre-designed, let mostly parts of automotive could be directly reused. Its adopted modular design and taking into account the late period recovery and reuse, therefore, it has greatly reducing the recovery costs and increasing the efficiency, considering the life cycle of automotive and designed a comprehensive program for their products, it is maximize to improve efficiency and reduce costs.

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Over the past eight years, Company B through the acquisition branch to acquire automotive end-of-life components types more than 1000, these components were sent to specialized demolished factories, and there have many materials could be used for the new products manufacturing.

### *Circular economic*

Automotive industry is a complex and huge system; the manager told us that if automotive industry adopts the circular economy theory will reducing the manufacturing costs greatly: make maximum use of energy and non-renewable resources, improve the utilization rate of resources and energy, reduce environmental pollution and strengthen economic operation quality and comprehensive benefits. Economic interests in Company B reflected in the way of reduction waste disposal costs, product longevity, and saving raw materials and components. The manager introduced the business cycle mode in Company B, the automotive remanufacturing business cycle mode as the manufacturers to start, linked with dealers, 4S car shop, automotive users, automotive dismantling companies, and materials recycling companies. To be concreteness, when automotive was scrapped, the owner need send it to dismantling company which the specified by automotive manufacturer, the dismantling company remanufacturing these scrapped components accord to the standard that provided by automotive manufacturer, the remanufactured components can be used as replacement components in 4S car shop repair processes, when the automotive was repairing and maintaining, the owner could chose the inexpensive remanufactured components. Thus it can be seen, automotive remanufacturing components entered circular economic through the tache of 4S car shop. Circular economy not only could provide benefits for company, but also create social benefits for the state thus it forming a win-win situation.

### *Recycling*

Company B to establish a manuals about end-of-life automotive recycling mandate dismantling that used the mode of manufacturers responsibility system, and establish material recycling technology standards in remanufacturing components and renewable materials; set up an assessment method for end-of-life automotive which suit national conditions; developing environmentally green dismantling route with low power; and in the automotive dismantling processes should be followed scientific detection processes, it is conducive to remanufacturing components and renewable materials. The processes of automotive manufacturing will produce a lot of wastes, mainly including scrap and waste packaging materials. For example, manufacturing automotive requires amount of steel, due to the automotive design blueprint and some unavoidable reason, lots of steel smalls are being abandoned after cutting, that not just affects the manufacturing environmental, but waste resources also. In addition, the packaging for automotive products such as foam, paper, plastics and so on, also will become wastes impact on the environmental. Automotive main body made of iron and aluminum, which metals can be directly recycled, and the battery, tires, and electronic

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components could be processed by professional then re-enter the markets. Therefore, recycling manufacturing automotive waste is an important part of reverse logistics.

### *Recall*

Automotive composed by tens of thousands of components, and various kind parts are provided by at least 3000 production units, while different batches products in each units are affected by quality of raw materials, employees, machinery states, damage of transportation and so on, these factors will led the differences in quality. Therefore, accumulation of various small errors might impact on the quality of automotive. Nevertheless, this type of product return caused by defects components is inevitable, only through the rigorous elimination the defects components supported by suppliers, choose and cooperation with the best components suppliers, strengthen the work of inspection components produce, to reduce the odds of defects components to affect whole automotive quality in minimize.

### *CSR*

Nowadays, the economy environment of buyer's market decided that customer value is the key factor for enterprise survival and development; through improve customer loyalty to occupy the larger market share. The successful operation in automotive reverse logistics is ensure the timely return products which did not meet requirements, ensure the defect products can be recalled in time, thereby enhancing customer trust and loyalty. With the improvement of people's living standards and cultural quality, environmental awareness is growing day by day, for highly polluting industries of automotive, so the owners are given higher expected on the environmental protection. Company B recalled the automotive which have potential risk and recycled the end-of-life automotive, it can establish the good corporate social responsibility image in the public and increase the intangible assets.

The manager introduced the social responsibility idea of Company B in China, is continuing to lead Chinese automotive industry to practice corporate social responsibility, and taking a long-term commitment to Chinese society. Company B has developed a series of CSR contribution projects with industry-leading orientation, including the area of resources innovation, education support, cultural exchange and social integration, which contribute to Chinese society sustainable development as well.

### *Green logistics*

The evolution of new resources environment view and economic view, led reverse logistics into a breakthrough development stage. In a sense, revers logistics has called "green logistics" and "environmental-logistics" also (Brito & Marisa, 2004), it carriers another important duty for an outstanding enterprise—shown enterprise's competitiveness and build good reputation. The product design in automotive of Company B has incorporate "green" concept, and establish an effective logistics

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management system to improve the scrapped automotive compensation standards, they have recycled their own scrapped automotive to improve the utilization of recycled material. In Company B, the automotive production processes are in accordance with the pre-design, and the pre-designed have took into account the later stage of green recycling requirements, which will greatly reduce the recovery costs and improving the recovery usage in the meantime. While there are strict rules for manufacturing materials, adopted recycled materials and low pollution materials in maximize, try to use less or no toxic substances, that will better for the recycling when automotive scrapped.

#### **4.4 Reverse logistics practice in Company C**

Company C is located in Changchun (China); the local manager of Company C had interview with us gives their impression of reverse logistics that: in order to reacquire the value of the product or enable the product to have the right dispose of it, the process of the product moving from its' origins to the consumers is called reverse logistics. They concentrate on the purpose of reverse logistics flow and the direction of the flow. According to manager of Company C, reverse logistics refers to the company through recycling, reusing and reduce the use of the raw materials, to efficiently reach a process of environmental protection.

##### *Recycling*

The specific actions of reverse logistics represented by Company C is the process of recycling of sold product through the distribution network system, the manager also mentioned the reverse logistics work in Company C contains parts like reducing the amount of materials used in forward logistics, the purpose is to reduce the amount of materials recycled and reused, so the product can be recycled more easily.

Scrapped automotive can provide valuable raw materials, which helps to save natural resources. For example, an automotive of Company C steel content about 75% that could be recycled all, and the ratio of recovery of metallic materials in Company C can reach the number up to 95%, which can be considered as one of the highest in modern automotive industries. For efficient utilize these materials, Company C has developed an individual recycling system, including airbags, shock absorbers, starter batteries, tires and working fluid. In order to make an efficient operation of recycling processes, Company C has considered the end-of-life automotive processing problems when it in design stage, so that the raw materials used on new automotive is easier recycled, and the materials which cannot be recycled will reducing greatly.

##### *Recall*

During recent 7 years, Company C has recalled automotive approximate 70000 in China area. There existed various reasons, which including the connection between seat belts and safety fastening ring may appear insufficient locking problems, when it

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received a large force the seat belt may restraint performance invalid, it existed the security risks; and a problem is due to oxidation in related materials, there occur the poor contact between taillights socket and taillights interface, corresponding taillights lighting ability will reduce or even failure, there are security risks also, for this problem, Company C will be replaced the corresponding components for free to eliminate hidden dangers; the other problems are caused by airbags, the seat airbag in copilot instrument panel laser fracture aperture does not meet the design requirements, it may result in airbags unable properly inflated when automotive in serious frontal collision.

### *CSR*

The manager explained that as the global top grade auto company, Company C has been insisting in supporting the five core elements of CSR: environmental protection, education, music, arts and sports, culture of driving, as well as other charity and recovering disaster activities, all the pillars have been adopted into the core value of Company C to maintain their brand image. The manager also stated that looking through these years, Company C with the relentless pursuit of excellence and constantly responsibility will continue to do its best to contribute to well-being and future for automotive industry and Chinese society.

Company C by designing, implementing a wide range of educational charity projects covering multi-level groups, to ensure scientific and targeted of the projects. Refer to the information collected during the interview with the manager, only for hope primary school “Le Future” happy music classroom project Company C had entered the country 300 hope primary schools, which lead to more than one hundred thousand children have been benefited. *“Meanwhile, Company C is also working with the National Theatre, and opened a college for more than 190 students across the country to provide international vocational training,”* said by manager.

In addition, the manager told us that Company C from their own industry features and advantages of starting a life safety education particularly concerned about the direction, in order to promote diversity and international development of quality education, the content and methods of the special system of road safety education on play an important complementary role.

### *Circular economic*

The manager pointed out that if Company C performances reverse logistics as a driving force of economic benefits entirely, although it could be transferred a part of waste to renewable resources, but it still far away from the requirements of circular economic. The high social costs caused by logistics led environmental pollution, while develop reverse logistics will help to improve this situation, for instance, some waste materials have high re-use value and relatively concentrated, so enterprises are willing to recycle, but in some way to say, product recovery can not necessarily brought economic benefits, or even caused losses. The manager has shown us the idea

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of circular economic in Company C, which is through economic system to analysis logistics and energy flow, evaluate products' life cycle, in order to reduce the emissions of resources consumption, energy consumption and pollutant.

## 5. Discussion & Analysis

Based on literature review, several perspectives were analyzed and the authors compared the literature review and empirical findings related to reverse logistics implemented in automotive industry. This section is going to answer the three research questions through comparison and discussion: (1) what is the importance of reverse logistics implementation in the Automotive Industry? (2) What are the existing problems of reverse logistics in the Automotive Industry? (3) How to improve management of current end-of-life automotive based on an environmental view?

As shown in Table 3, it indicates real world practices from case companies mostly consistent with theoretical framework; all of the three case companies' daily work has basically cover all aspects like product return, recycling, reuse, recall and CSR in reverse logistics. In addition, the result also shows some actual performance from real world companies which are not mentioned in literature review. Which in specific, Company A is lack of information about their daily performance in repair, remanufacture, sustainable and circular economy according to both primary and secondary data. Company B does not have information related to remanufacture and waste treatment. Company C does not have much performance in green logistics and sustainable works based on empirical findings.

*Table 3. Performance among the three case companies*

	Company A	Company B	Company C
Product return	X	X	X
Recycling	X	X	X
Reuse	X	X	X
Recall	X	X	X
Repair		X	X
Remanufacture			X
Waste treatment	X		X
Green Logistics	X	X	
Sustainability		X	
Circular Economy		X	X
CSR	X	X	X

According to compare with the content of literature review and empirical findings, all the elements have been summarized as Table 4. The figure on left side shows the information were mentioned in literature review but not practiced or no collected information in empirical findings and the right on above is contrary, which means there are some factors have new find in empirical findings. Three symbols in the figure stands for different performance degree: the number 3 indicate all the three companies have excellent performance; number 2 mean only two companies did but still has company relevant implementations; number 1 mean only one company did it; and the number 0 is no company have information obviously.

**Table 4. Comparison between literature review and empirical findings**

Literature review	Empirical findings
Product return	3
Recycling	3
Disassembling	1
Waste treatment	2
Packaging reduction	0
Air & Noise emissions	1
Environmental impact	3
Reusable Packaging	1
Remanufacturing	2
Marketing Returns	3
Warehousing	0
E-commerce	0
Sustainability	3
Circular Economy	2
Re-newable	2
Energy Recovery	0
CSR Performance	3

Empirical findings	Literature review
Refurbishment	X
Maintenance	X
Product life cycle	X
Biodiversity	X
Green design	X

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## 5.1 Importance of reverse logistics in Automotive Industry

Based on literature review, reverse logistics implementation in automotive industries basically presented in four aspects: product return, recall the automotive, cost saving and environment protection during production processes and the recycling waste products in reverse logistics (Greve & Davis, 2012). Reverse logistics and reverse processes emphasized green logistics at the first time (Carter & Ellram, 1998; Murray, 2000), which indicated added environmentally into logistics strategies, including product return, recycling, waste disposal, refurbishing, repair and remanufacturing (Autry, 2005).

Comparing with information collected during interview with managers from three automotive companies, the present situation of reverse logistics in automotive industry indicates reverse logistics has an important role in the development of automotive industry. The empirical findings show all the three case companies have daily work related to reverse logistics. The cases also indicate that because nowadays' high technology content of the product, cause the difficulty, costly and long production of the manufacturing processes in automotive industry. It is a necessity for them to adopted reverse logistics. Implementation of automotive reverse logistics, based on the view of corporate, not only helps to improve enterprise logistics service levels, enhance operational efficiency, but also reduces production costs according to the logistics manager from Company A. Meanwhile, automotive manufacturers could find the gaps and deficiencies from occurring sources in production, management, service, thus prompting enterprises to improve product design, internal management and operating levels. From the social perspectives, automotive reverse logistics can reduce the adverse impact on the environmental effectively, increasing resource utilization, while also promoting the development of green logistics.

Implementation automotive reverse logistics could eliminate worries of customers to buy products from fundamentally refer to Company B's logistics manager. Ensure the defective products for return and timely treatment. For this aspect, Company B has achieved a good performance in the time arrangement. On the other hand, the use of refurbished parts and the materials through produced cars could greatly reduce production costs and effectively enable consumers to enjoy the benefits of price competition brings (Sarkis et al., 2010). Main raw materials for manufacture automotive are steel, pig iron, rubber, plastics, non-ferrous metals and other resources. Throwing away scrapped cars or unreasonably disposal will bring huge pollution to the environment. It requires the automotive industry recycling materials from a scrap car could obtain almost reproduction a new car. Effective control the automotive industry reverse logistics implement, not only save resource and production costs, but also avoid waste of resources, bring enormous benefits to the enterprise according to the interview with Company A. Company B's manager put forward that if enterprises want to get recognized and significant development of the public, only through the green concept link in whole product life cycle, then to improve customer satisfaction, so that consumers recognized enterprise products.

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The theoretical framework has highlighted environmental protection of reverse logistics are critically important, traditional logistics mainly focus on the process of transportation, warehousing, packaging and inventory management from producer to user, but due to protect environment so that consideration for recycling and waste disposal (Rodrigue et al., 2001). Which are also the main parts of real-world applications of reverse logistics in automotive industries based on empirical findings, through comparing the interview contents with three case companies' managers, it indicates that reverse logistics has practical significance which cannot be ignored: firstly, it enhance the customer value and competitiveness, as the market continues being mature, the market competition is continuously intensify as well, makes the customer value become a key factor to decide the future survival and development of an enterprise. The authors get the result that if a customer has the opportunity to choose between several companies, then the companies should enhance the customer satisfaction through providing good service levels of the service and products, thus increase their sense of trust of the company and keep them coming back, in order to facilitate the consolidation and expansion of markets.

Refer to empirical findings: automotive products are durables consumers, the level of customer service directly affect product loyalty and the possibility of keep them coming back. According to practical experience of Company A, company wants to attract customers, they must ensure that their customers feel comfortable throughout the transaction process, and reverse logistics strategy is an effective means to achieve this goal. As Buhl et.al, (2009) has stated successful operation of reverse logistics to ensure timely recall of defective products, enable the company establish sound honest and credible brand image in the minds of customers. Through compare above that empirical findings and theory, authors thought that should be more attention to service competition in today's automobile sales market, customer satisfaction and loyalty to the enterprise service is undoubtedly a key factor in determining the survival and development. Moreover, if the auto industry chooses to adopt a liberal return policy and product recalls strategy, can reduce downstream wholesalers, retailers, operating risks and the risks of buying the ultimate customer, improving the supply and demand and promote strategic cooperation and strengthen the competitive advantage of the entire supply chain.

Secondly, reduce costs and increase competitive advantage. Reduce material consumption, improve material utilization is the sticking point of cost management and is also an important means of business efficiency, said by logistics manager of Company C. Authors found that the automotive industry is a large consumption of energy-intensive industries, energy, steel and other raw materials, but mostly scarce resources which is based on empirical findings. Through analysis three case companies' practical performance, could get that the low repurchase price of waste products, the sources sufficient to repurchase the processing of these products can greatly reduce production costs. Car reverse logistics can regain the use value of the car and its parts, reducing consumption and waste of resources, enhance the core competitiveness of auto companies, to create a new source of profit growth is

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significant.

Green Logistics has the main purpose of reducing the environmental externalities, through deal with logistics related aspects such as transportation, warehousing and inventories to reduce environmental issues, which including greenhouse gas emissions in logistics operations, noise and accidents (Dekker et al., 2012). In real case practices, the significance on green logistics of reverse logistics implementing in automotive industry reflected in focus on green designing and build corporate image.

The empirical finding shows the case companies begin to pay more attention to the improvement of people's living standards and cultural qualities of the growing awareness of environmental protection. People have undergone tremendous changes in consumer attitudes, expectations of the customer on the environment are increasing. In addition, due to the scarcity of non-renewable resources and environmental pollution is increasing; environmental performance evaluation of enterprises has become an important indicator of business operations. The successful operation from case companies of the car reverse logistics can be achieved through reusing of resources, reduce waste and pollution, protect the environment, reflecting the corporate initiative to put the implementation of sustainable development philosophy, both economic and social benefits will be available in the minds of the public with good corporate social responsibility image due to what the managers has mentioned.

Overall implementation of reverse logistics development strategy, vigorously strengthen reverse logistics policy, establish and improve the theoretical system, logistics system objectives, logistics facilities and logistics activities of organizations to improve and adjust to achieve optimal logistics system and the environment the minimum damage. The practicing of reverse logistics in case companies shows it not only conducive to environmental protection and sustainable development of the economy, but also help to improve the overall level of logistics management. Both in an environmental and a service level point of view, reverse logistics has effectively achieved a reduction in the usage of raw material and scrapped automotive. Reach a goal of sustainable development for the future automotive industry. Improve the whole operation efficiency of logistics in automotive companies. Comparing the content of reverse logistics both theoretical framework and empirical findings. All the case companies have accomplished mostly of the components in green logistics of reverse logistics complete the social standard of recycling, reuse and renewable.

## **5.2 Existing problems of reverse logistics in the Automotive Industry**

Literature review introduced the concept of reverse logistics included, and mentioned the reason why reverse logistics appearance and what the enterprise need to be, but through the empirical findings have found that enterprise may had some barriers in implementation reverse logistics. Here will comparing three case company and literature review to analysis the existing problems of reverse logistics in automotive industry.

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Due to the interviewed in Company B and C were with Chinese manager, so there are focus on China region, compare with Company A in Britain. Chinese manager thought reverse logistics management faces many uncertainties, and the common problem is lack of green design idea. Green design refers to in whole product life cycle focusing on products' impact on natural resources and environmental, added removable, recyclability and reusability in product design, to meet environmental requirements and consideration the basic functions of product, service life, quality (Dekker et al., 2012). Through comparison three different case companies which from different region, found a common problem existing enterprises: reverse logistics of automotive profits not reflected in a short-term, causing the automotive reverse logistics not get the attention by it deserves automotive companies. And the other reasons are lack of effective reverse logistics information system and automotive reverse logistics network.

From the information collected during interview with the logistics manager of Company B and C, it is not difficult to figure out there do several problems exist in Chinese automotive companies to performance reverse logistics. Although China has legislate corresponding laws for recycling scrapped automotive, but the laws and regulations still imperfection, led the responsibility for recycling resources is not clear. Since the products return and recycling products have randomness, are uncertainty in occurred event, time, quantity and categories of items, causing great difficulties in predict and management (Vlachos & Dekker, 2003). The manager has told authors the uncertainty of some reasons to return products. For example, the products quantity return from consumers were decided by products' quality, life, service time and service environment; while the products' quality problems are uncertainty also. The damaged conditions were vary in degree and not always caused by the same problems, only through testing the products could determine the specific problems. Handing products way with return products is uncertain, different return reasons need to be treated differently, it led the uncertainty in products processing time and demand for raw materials. Finally, product recycling is uncertain, because in reverse logistics the demands for re-use products are far away from ordinary markets' maturity, there existing greater randomness and unpredictability.

Based on the interview of Company A's logistics manager, found they lack of an effective reverse logistics information system. In general, automotive manufacturers through reverse logistics information system to manage returns products one by one, given feedback reason, and could providing products quality evaluation, analysis products life cycle and marketing information for theirs service providers, which is valuable for enterprises' operation. The function of reverse logistics information system could help to improve processing efficiency of products return, thus saving costs of inventory and transportation (Rogers & Tibben-Lembke, 2001). Compare with Company B, they did the reverse logistics information system as well, so it could get that through the effective reverse logistics information system can also ensure the certainty of product demands.

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Based on interview with Company A's manager, scrapped automotive lack of reverse logistics network, for instance, the cooperation among enterprises can create the intangible assets that difficult to imitate and copy, these intangible assets is the key in maintain a sustainable competitiveness, they are existing dependent on network relationships. While the network organizations have the inherent advantages, is the best choice of network structure (integrated supply chain structure) for reverse logistics organizations. In addition, establish a reverse logistics network need funds investment and the close cooperation relationships between the two sides. It is a key issue not just in enterprises establishes supply chain cooperation partnerships, as well as in establishes reverse logistics network system (Rodrigue et al., 2001). Due to these problems which automotive enterprises has forming current situation: lack of a comprehensive reverse logistics network system.

### **5.3 How to improve the efficiency of reverse logistics management based on an environmental view?**

According to the current development situation of automotive industry, we must pay attention to scrap car recycling management. Since the high produced rate of automotive, so each period of time, a certain amount of automotive must be disposed with the same or a slightly lower as the produced rate, otherwise the scrap automotive piled up in the community will have a series of issues. For example, environmental pollution, traffic safety issues, energy issues. Bellmann & Khare (2000) state that there are some ways to improve management of end- of life automotive: sound scrapped automotive recycling policies and regulations; sound scrapped automotive recycling system; encouraging major automotive manufacturing companies to grasp abandoned automotive recycling tasks; strengthen scrapped automotive recycling and improve personnel recycling awareness.

First of all, strengthening green awareness is important to manage disposal end-of-life automotive from an environmental perspective. Improving consumers' awareness of protection environmental, and national awareness of the reverse logistics' significance for automotive, sparkplug the green concept about low-carbon, environmental friendly and energy-saving (Blumberg, 1999).

The logistics manager of Company C has mentioned that manufacturing automotive based on an environmental view could start with the design stage. In the stage of product design, it will take full considered in products' removability, maintainability, recyclability, reusability, components compatibility and continually applicability, thereby to enhance products valuable, and reduce the environmental pollution caused by manufacturing products. Therefore, authors thought that improve the reverse logistics based on an environmental view, integration green design is the key for recycling end-of-life automotive components.

To achieve green design need meet at least three aspects, reutilization, recycling and saving resources. Compare with three case companies' empirical findings to know,

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reutilization required products and its components could be used repeatedly, it means when the designer has designed products that should be simplified and standardized model structure, so it could not just use less materials and saving resources, but also could recycled and reused the standard components. So, manufacturers should try to extend the service time of products instead of replacement frequently. Recycling in end-of-life automotive means when produced components completion its function then could be recycled and re-used, rather than becoming the unrecoverable wastes. There are two way in recycling, one is the original recycling that recycled wastes to produce the new products with same type, another one is transform waste resources to raw materials for other products (Nawrocky et al., 2010). Compared with these two ways, original recycled could save natural resources better, and is the advocated way in green design also. In short, is used less raw materials and energy to achieve the production or consumption purposes, thus could saving resources and reduce pollution from the headstream.

The managers of Company B and C, presented that adopted green design to automotive, establish scrapped automotive recycled system. Detachable design makes automotive to gain high efficiency and low cost to combine components, components demolition and classification demolition materials in order to re-used and recycled. For example, all the liquid in the automotive can be recycled, including gasoline, engine oil, coolant, brake fluid and air condition fluid, and the materials of 90 percent are adopted five types recycled materials which are steel, glass, oil, plastics and rubber, and the required steel to manufacture a automotive could from secondary recycled materials.

According to the empirical finding parts, managers from the case company has put forward some efficient and appropriate ways about end-of-life vehicles management. In traditional way, automotive industries generally re-use the useful parts of the car, and then sell the broken car to the car scrap buying factories, extracted and recovered the metal materials; the residue will be buried in the garbage plant. Better means such as establishing an automotive processing center to provide some incentives to car manufacturers, recycling scrap cars, car manufacturers will also consider income fee ratio of recycling cars. This will further promote transparency of the enterprise as well as provide some transparency information to consumers, meanwhile, to promote competition to create more automotive recycling costs.

From Case Company B's environmental annual report, some harmful auto parts such as Freon, airbags and waste residue extracted, most automotive industries can now reuse at least 70% of the residues which can no longer continue to use. They can also recover the Freon and airbags. In fact, there is a special company to handle scrap car scrap steel.

Other good ways to dispose end-of-life vehicles is to recycle and re-use some used automotive, which is a very good system of handling end-of-life automotive. Some companies buy these end-of-life vehicles and then trading again, this requires a good

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second-hand vehicle trading system to ensure a reasonable price and the transaction transparent, so that second-hand car can have security guarantees, and make each vehicle last longer (Rogers & Tibben-Lembke, 2001). This also can promote more efficient use of our resources. If a good development situation can be maintained of used-car market, the automotive industry will be stable as well, and the effective use of resources can be guaranteed.

Generally speaking, all the evidences from interview and theoretical framework have indicated that low-carbon economy has become a trend in the new round of economic development, scrap car recycling and resource recovery is one of the effective ways to achieve a low-carbon economy. Automotive industries in western country usually have good performance in dealing with the problem of junk cars, scrap cars and formed a perfect recycling system, in terms of the legal system, management and technical applications such as recycling of scrapped vehicles be specified.

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## **6. Conclusion**

This section concludes the content of main empirical findings, the contribution of this study, existing limitations for research or finding processes, the expectation in further studies and some implications for the manager who responds to the automotive reverse logistics area.

### **6.1 Main findings**

Research on reverse logistics in automotive logistics has importance and significance for developing a reverse logistics system. It not only emphasizes the automotive returns and recycling of scrapped automotive components, but also realizes resource conservation and environmental protection, which is achieved through shrinking resources, renovation, restructuring and recycling. Customers pay more attention to after-service in the current situation when there is a scarcity of resources in this area, the automotive industry will tend to attach great importance to establishing and improving a reverse logistics system.

This study has found the importance of reverse logistics implementation in the automotive industry. The empirical findings indicate the importance of reverse logistics, generally presented by it helps automotive enterprises improve logistics service level, enhance operational efficiency, and reduce production costs. Based on social perspectives, the significances are to reduce the adverse impact, increase resource utilization and promote the development of green design. Some existing problems of reverse logistics are in the automotive industry. For instance, automotive managers lack of green design ideas, do not consider recycling that adopted nonstandard components. Furthermore, do not establish a complete reverse logistics management system and network information cover; these problems may lead to serious pollution for the environment. So, based on an environmental view, to improve the management of the current end-of-life automotive industry is very important. It sounds like a scrapped automotive recycling system, encouraging major automotive manufacturing companies to grasp abandoned automotive recycling tasks. In the current situation of automotive reverse logistics, it seems reverse logistics has a great profit margin in this area to help enterprises reduce costs.

### **6.2 Contributions**

This study contributes to the discourse on investigating the implementation of reverse logistics focusing on the automotive industry. The theoretical framework integrated the main elements which consist of automotive reverse logistics, to ensure the importance of reverse logistics implementation for the automotive industry. The case companies' actual practice put forward Green Design as a basic element of reverse logistics. The empirical findings imply that Green Design occupies an important part to support the whole processing of reverse logistics in these case companies. If green

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design was be performance as well before manufacturing automotive, then the scrapped automotive could get a complete recycling, in other words, green design will influence a series of steps afterwards of reverse logistics in automotive industry. Whereas, the theoretical framework did not mention much about green design in this area which can be regarded as theoretical contributions in this study. And the empirical findings showed that green logistics and circular economic play importance roles in the processes of automotive reverse logistics, previously studies have instead focused on the way of sustainability and “3R” (reduce, reuse, and recycle), so it is the theoretical contribution of this research paper. Interviewed with three automotive companies’ manager to gather relevant information and evidence to support theoretical framework, linked reverse logistics in a green way with performance circular economic, which is can be regarded as contributions also.

### **6.3 Managerial implications**

Traditional recycling scrapped automotive was used unidirectional operation mode, but it will bring the environmental pollution easier, and waste resources caused by incineration and landfill, the empirical findings of this research paper have implications for managers an effective way to solve this problem that adopts reverse logistics technology system. Although mostly automotive enterprises have used reverse logistics but it still exist problems, managers could try to develop a system to manage reverse logistics in a better way. The section of discussion have tried to explain how reverse logistics performed in automotive industry, and analysis existing gaps between literature review and real practice of reverse logistics in automotive industry. Through gather the elements of reverse logistics impact on environmental, so some implications for managers in which to strength utilization and promotion of new environmentally materials and new design structures. In addition, considered green design in automotive design processing, to make the scrapped automotive achieved the desire objectives and valuable when recycling, which are realizing the green automotive manufacturing industry and protect environmental in a better way.

### **6.4 Limitations**

There are several limitations existing in this research paper. Due to reverse logistics belonging to an emerging concept, there are less relevant literature reviews in academia, so the theoretical framework of this research paper may not complete in this area. Data collection limitation, because of the time limited so that interviewed just one person in each case companies, and in product return and some information about reverse logistics may related the sensitive information. So the managers answered with ambiguous words that does not would like to show us the complete and specific data, it may led this research paper have biased in the way of specific cases research. Moreover, the limitation also presented in not possible to generalize in a statistical manner, because there have the limit numbers of case companies.

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## **6.5 Further study**

For future study, we can try to find more companies from various levels such as medium level as case companies for fulfilling the study; therefore get more comprehensive and convincing evidences. Besides, the research method can be replaced by quantitative approach, this thesis is stand on the companies' point of view, for further evidence, based on the same objectives, we can more focus on the customers' point of view. Henceforth, the concepts of reverse logistics may develops more complete, it will gather more perfect literature review that provide more framework to support further studies.

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