An Analysis of Reverse Logistics Technology and Service for Hi-Tech Industry

by

Jinfan Li

B.E. International Trade, Department of Economics and Management
Shanghai University, 1999

Submitted to the Engineering Systems Division in Partial Fulfillment of the Requirements for the Degree of

MASTER OF ENGINEERING IN LOGISTICS

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JUNE 2004

Signature of Author.....
Engineering Systems Division
May 22, 2004

Certified by .....
Christopher Caplice
Executive Director, Master of Engineering in Logistics Program

Accepted by .....
Yosef Sheffi
Professor, Engineering Systems Division
Professor, Civil and Environmental Engineering Department
Director, MIT Center for Transportation and Logistics

To

My husband, Xinwei

My grandmother, grandfather, mother and father

Acknowledgements

I gratefully acknowledge the great advice and support from Dr. Chris Caplice, my thesis advisor, for his guidance of question exploring and thesis processing.

I also want to express my sincere appreciation to people from the semi-conductor company who gave me a lot of insights of reverse logistics practice and requirements for software functionality.

In addition, I want to thank people from reverse logistics software and service vendors who provided me great information about their software and service.

I want to appreciate Dr. Jonathan Byrnes and Dr. George Kocur for giving me great advice in my thesis research.

Finally, I give my sincere appreciation to Mr. Xiaohan (Steve) Lin for his great help in my thesis research and composition.

An Analysis of Reverse Logistics Technology and Service for Hi-Tech Industry

by
Jinfan Li

Submitted to the Engineering Systems Division in Partial Fulfillment of the Requirements for the Degree of Master of Engineering in Logistics at the Massachusetts Institute of Technology

Abstract

This thesis provides a method for hi-tech companies to evaluate reverse logistic software and services. To clarify what is reverse logistics, the definition and features of reverse logistics are first introduced. The reasons to improve reverse logistics management systems are explained. Information of reverse logistics software systems and service vendors is collected, compared and analyzed. Current reverse logistics market trends are analyzed and problems in evaluating reverse logistics systems are identified. An algorithm to evaluate the software and service is established and explained. Parameters are analyzed and determined. Various vendors are selected and interviewed. Their capabilities/strengths are rated. As an example, the evaluation points for several software systems are calculated in the case of a semi-conductor company. Research limits are also provided. Conclusions are presented at the end of the thesis.

Thesis supervisor: Christopher Caplice
Title: Executive Director, Master of Engineering in Logistics Program

Table of Contents

List of Exhibits

Chapter 1 Introduction

1.1 Research objective

This thesis answers how a hi-tech company makes decision on selecting reverse logistics software system or service. Many publications have come up with general ideas or best practice of reverse logistics management systems. However, little study has been done to answer the following three questions raised by leading companies that want to improve their reverse logistics management. First, what functionality should a reverse logistics information system have in order to be versatile? Second, what reverse logistics software systems are currently available in the market? Third, what criteria should the companies follow to compare those solutions and select the proper one?

In this thesis, a list of desired reverse logistics software functions is developed after reviewing the literature and the reverse logistics flow. The desire to improve reverse logistics software systems is established. When collecting information of reverse logistics software systems, we found that reverse logistics software systems are provided by Best of Breed, logistics module or ERP (Enterprise Resource Planning) software companies. Reverse logistics services are also available. Some 3PL (3rd Party Logistics) vendors and OEM (Original Equipment Manufacturing)/ODM (Original Design Manufacturing) vendors provide physical management of the returns together with software systems. Thus, although the research scope is still focused on reverse logistics software functionality, it is extended to include the value-added features provided by the service vendors. Market trends are analyzed. Problems in evaluating the software systems are identified. Motivated by the need to help hi-tech companies choose appropriate reverse

logistics software systems or services, the primary target of the research, a method to evaluate reverse logistics software systems is presented.

1.2 Roadmap of the thesis

In Chapter 2, previous works on related topic are presented. The market is analyzed. The research problem is identified. Chapter 3 introduces a methodology to evaluate reverse logistics software systems and services. The parameters are analyzed and set up. This chapter also discusses and synthesizes the results of the interviews with reverse logistics vendors. Chapter 4 gives a sample evaluation in a case study of the reverse logistics practice at a semi-conductor company. Research limits are pointed out. Chapter 5 concludes the research findings.

Chapter 2 Problem identified

Rogers and Tibben-Lembke (1998) pointed out the criticism of reverse logistics in computer industry. For forward logistics, companies may spend enormous investment on new product research and development, enhancing customer relationship, inventory management, streamlined processes, integrated information system and global cost optimizing. However, reverse logistics generally doesn't generate any visible revenue. Instead, it always costs money to process the returns. It is understandable that reverse logistics is considered an extra or minor part of logistics practice. The importance of reverse logistics can easily be overlooked. Few companies take a critical look at their reserve logistics management systems and realize that reverse logistics may also have a significant impact on bottom line as well as on top line. (Rogers and Tibben-Lembke 2001; Ravi 2001)

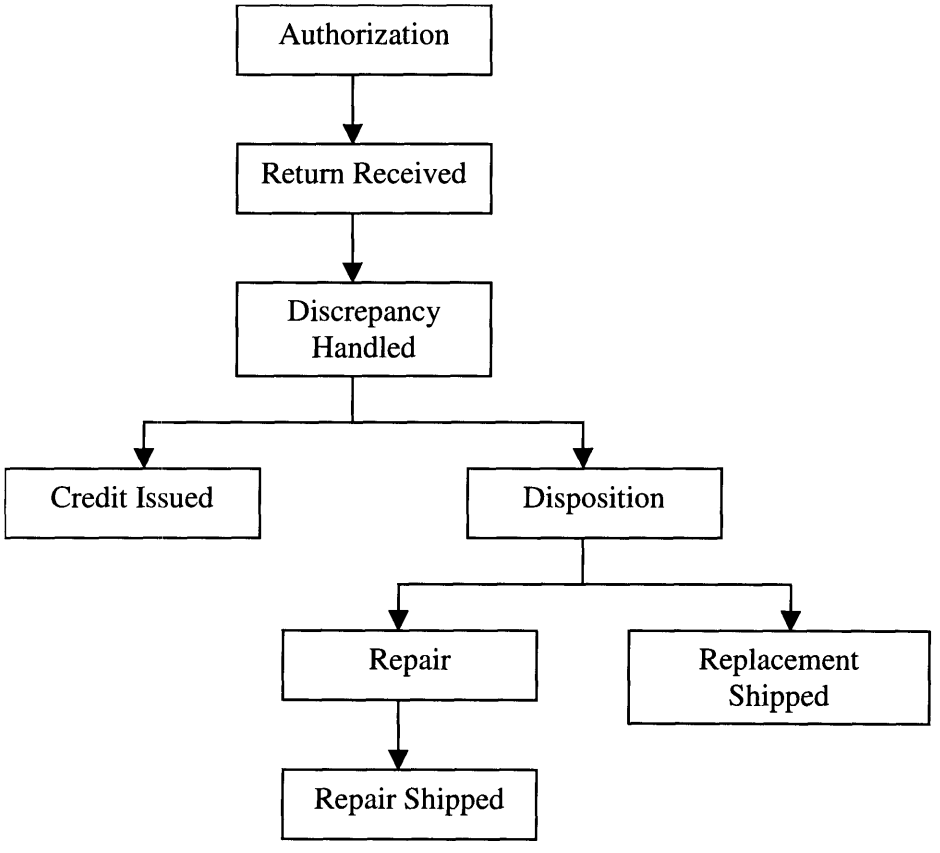
This chapter answers two questions: (1) Why businesses want to improving current reverse logistics management system? (2) What are the problems in finding a proper reverse logistics software systems? By introducing the general flow, definition and characteristics of reverse logistics, the reasons to improve reverse logistics are generated. After analyzing both the requirements from businesses and the current trends in reverse logistics market, difficulties in evaluating reverse logistics software are identified.

2.1 A general reverse logistics flow

Before defining reverse logistics, a general reverse logistics flow is presented as following to understand what is happening in business. The flow is generalized into eight

steps: (1) by customer request, the return order is authorized; (2) the customer is instructed to send the return to the company and the return is received; (3) upon the receipt of the return, the discrepancy is handled if there is any; (4) in some cases, the customer credit is issued; (5) return dispositioning is decided; (6) in some cases, the return is repaired; (7) the repaired return is shipped back to the customer; (8) in some cases, the replacement is shipped to the customer. The details for each step are described below.

Figure 1 A general reverse logistics flow



Step 1 Authorization

By contacting the call center or using the website, a customer requests to initiate a return order. The company receives the request and retrieves or inputs the information of the customer and the purchase order the return comes from. The return reason is provided by the customer and the reason code is identified. According to the warranty policy, the RMA (Return Material Authorization) is validated inside the system. After the RMA is approved, a RMA number is issued and forwarded to the customer.

Step 2 Return Received

According to different customers and return reasons, the return procedures are different. Some customers are instructed to send the return to the company while others not. Depending on the return reason, residual value and testing cost, some returns are tested (screened) and sorted upon receipt. The real situation and residual value of the return is verified. Issues such as discrepancy are identified. The customer is notified of the receipt or any issues.

Step 3 Discrepancy Handled

If there is any discrepancy such as wrong item, wrong return reason code, etc. the return is further checked and tested. Reason code may have to be verified and adjusted. The customer will be re-charged of shipping cost if the return is not valid. When the discrepancy issue is solved, the return can be dispositioned. The memo of the discrepancy issue is recorded and the costumer is notified of the results.

Step 4 Credit Issuing

For the customer who wants credit, the credit is issued against relative policies. The system is updated. Any data corrections are made as well. The memo is also recorded into the system.

Step 5 Disposition

Based on the return processing cost and the residual value for the return, an auto-dispositioning solution is generated by the system. The solution decides which returns should be repaired or be scrapped in which location, how and where to recycle or which returns can be resold. It also selects the carrier and routing for different returns processing. The ownership table for the return processes is also provided.

Step 6 Return Repaired

If the return needs to be repaired, it is transferred to repair center. Cycle time is measured and is complied with service level. The capacity of the repair center, including labor, manufacturing, space, etc is managed. Inventory level is also monitored and managed. The system is auto-updated for any unexpected issues.

Step 7 Shipping

After the return is repaired, it is picked up and shipped to the customer. The carrier is contacted and return routing is managed. The shipping memo is input into the system. The customer is notified of the shipment and receiving date.

Step 8 Replacement Shipped

According to return reason, cost, customer desire and return policy, some customers get replacements for returns. Replacement is treated as forward logistics. Inventory of replacement is managed. Cost optimization for shipping replacement is managed. Any cost associated to the return is captured in the system and re-invoiced to relative parties.

2.2 Reverse logistics defined

Defined by the Council of Logistics Management, reverse logistics is:

The process of planning, implementing, and controlling the efficient, cost effective flow of raw materials, in-process inventory, finished goods and related information from the point of consumption to the point of origin for the purpose of recapturing value or proper disposal. (Rogers and Tibben-Lembke 1998)

In other words, reverse logistics is the management of any type of returns from any customer with a specific purpose. Products can be returned from any player within the supply chain or from the end-user for different reasons. Raw material, work-in-process or finished goods can be returned when there are surplus or leftovers during the customer's production due to changes in manufacturing plan. Administrative mistakes from either the supplying company or the customer can cause returns. Products maybe recalled for quality issues. Damaged product/package in delivery and unsold product can also incur returns. Returns can even occur due to product upgrades. The objective of reverse logistics is to efficiently process the returns with the lowest cost and/or the greatest benefit. However, it is found in this research that reverse logistics does not merely mean

managing return itself or the returns that are sent back to where it originated. Returns can be processed at the original manufacturing site or at a third plant, be replaced by either a similar product or by a different one, or just be scrapped somewhere appropriate. In one word, the processing of returns is very complicated. Yet, businesses may encounter some other problems when managing the returns as stated in the next section.

2.3 Characteristics of reverse logistics

Reverse logistics processes are very complicated and difficult to manage. Based on the differences between forward logistics and reverse logistics identified by Rogers and Tibben-Lembke (1998), the major characteristics of reverse logistics can be summarized as different product and packaging quality from multiple return points, various return reasons and unclear processing methods, and complex cost structures.

2.3.1 Diversified sources

With the development of technology and customers being more demanding, products and commodities are more diversified with shorter product life cycle. Products are returned for reasons such as more frequently changed manufacturing plan, shorter product life cycle, more volatile customer demand and increased customer expectations. Returned products, return types, product quality and return sources are thus more diversified. The quality of the returns also varies. For non-technical reasons, such as administrative mistakes, returns are typically of the same quality. However, items returned for technical reasons probably have different quality conditions. The difference in quality conditions lead to the difficulty and problems in return processing and cost analysis as described in

the following two paragraphs. Packaging for returns may be un-unified since packaging material damaging is one of the return reasons as well. For products that have been used for a while, the original packaging materials are often lost or damaged. Looking for the proper packaging material may be a trouble to the customer and may cost extra time for the customer to send the returns out. Hence, cycle time for return processing is prolonged. Additionally, unlike forward logistics that ship products from one or few distribution centers to many customers, returns are collected from many points (such as end-users) and then conveyed to one or few centers. Such reversed processing from multi customers may result in even more diversified labeling and packaging for returned products and thus makes it hard to track the items.

2.3.2 Complicated return processing

Return processing is complicated and fuzzy. Returned products are diversified since even for the same product, returns may come from any customer at any time for different reasons. Returns can be as few as one piece or even part of the product. They can also be as much as an entire purchase order. There is very little data sharing for returns among customers, distributors, supplying companies and carriers because in practice, for the sake of expense or security, most companies don't have a good data for collecting/sharing system within the supply chain for reverse logistics or they just think it not necessary. In many cases, the destination, routing and transportation methods for return processing are not clear or there is often no idea about where returns are shipped to and by what means. Returns are sometimes piled up in the warehouse till they are obsolete. They may have to be sent to another place for testing and checking before the final destination is decided.

They may also be sent to a wrong place because there is no clear instruction for the processing. The cycle time of return processing is usually much longer than expected and thus adversely influences customer service. Product life cycle for reverse logistics is also difficult to manage. Products can be returned too early, even before the entire database entry of the product has been set up and necessary information is shared. It can also be returned too late, e.g. leased computers can be returned many years after the computer is off the product line (as is called end-of-life products).

2.3.3 Complex cost structure

Costs in reverse logistics are sometimes ambiguous and hard to calculate. For instance, a customer may enjoy a discount/promotion based on certain order quantity. For some reason, the customer may return part of the order quantity and only want credit back. However, the supplying company doesn't have enough resources to trace back the purchase order and calculate return credit based on the original discount and final/real order quantity after the return. Instead of giving the customer the correct (usually less) credit, the company sends the customer full credit for the returns. Another problem is after returns are deducted from the original order quantity, the actual order quantity is reduced and may be lower than the minimum promotion quantity. The customer shouldn't enjoy the promotion any more. But the customer still does, as no corrections or updates are made to the original purchase order after the products are returned. Hence, hidden costs occur to the supplier due to the overpaid credit and revenue lost.

Costs allocation within different departments of the company for reverse logistics is also hard to handle. Companies may consider it not necessary to fine grain cost internally for returns. If the return quantity is too small or screening/testing cost is too high, it may cost more to do the cost analysis and allocation than any expectable benefit brought by doing so. In such cases, the company may be unwilling to figure out which part of the total cost should be charged to which department. Return reason, costs and responsibility are thus unclear within the company.

2.4 Reasons to re-engineer reverse logistics management system

Due to the increased diversity, returns handling/processing costs, obsolescence cost and other costs (such as the hidden costs mentioned later) are increased accordingly. Not surprisingly, those costs affect business bottom line. The impact is even more significant in industries that have thin margins. For some industry such as publication and catalog retailer, reverse logistics can be about 30-50%. Computer manufacturing companies, characterized as "rapid product obsolescence, high cost-of-goods-sold, medium to high logistics cost" (Marien 2001), has 10-20% of total goods sold as returns. (Table 1)

The definition and expectations for overall service level are also changing. Post sale service, associated with brand image and total product quality could be essential in differentiating companies/products and driving customer demand. Poorly managed return processing may result in loss of potential customers. Meanwhile, emerging regulations of environmental protection are compelling businesses to be more aware of the importance of an efficient reverse logistics management system.

Table 1 Sample return percentages (Rogers and Tibben-Lembke, 1998)

Industry	Percent of Returns
Magazine Publishing	50%
Book Publishers	20-30%
Book Distributors	10-20%
Greeting Cards	20-30%
Catalog Retailers	18-35%
Electronic Distributions	10-12%
Computer Manufacturers	10-20%
CD-ROMs	18-25%
Printers	4-8%
Mail Order Computer Manufacturers	2-5%
Mass Merchandisers	4-15%
Auto Industry (parts)	4-6%
Consumer Electronics	4-5%
Household Chemicals	2-3%

Fortunately, leading hi-tech companies such as Dell, IBM, HP, Siemens, Canon and Motorola are realizing the importance of reverse logistics. Those wise business leaders can't confine themselves to only forward logistics practice or doing the basic returns management as a minor part of the entire logistics practice. They consider a closed loop with good reverse logistics management and feel obliged to improve their current systems. An efficient reverse logistics management system will significantly reduce cost and asset lost occurring in returns management. It also effectively reduces cycle time in reverse logistics and therefore improves post sales customer service. With improved profitability and customer service, the overall logistics performance is enhanced.

2.5 Problems in finding a proper system

With the objective of finding proper reverse logistics software systems for hi-tech companies, we now focus on reverse logistics software system market. Information of reverse logistics software systems and services was collected. According to different business functional areas the software serve, software vendors can be classified as ERP (Enterprise Resource Planning), Module and BoB (Best of Breed) companies. However, we found that there are also service vendors who manage warehousing and distribution for returns and provide relevant software systems (Table 2)

Table 2 Reverse logistics market – vendor profile

		Definition	Functional Area	Representative Vendors
Software	ERP	Companies that provide enterprise level software.	Optimal solutions across all the different functional areas such as HR, Financing, Sales, Marketing and Warehousing etc.	SAP, PeopleSoft
	Module	Companies that provide suite of functional software systems.	Warehousing and distribution functional areas	Manhattan
	BoB	BoB software companies provide best solutions in only one functional area.	Reverse logistics functional area	eBoomerang
Service	3PL	Companies that provide distribution service to their customers.	Warehousing and distribution management	UPS
	OEM/ODM vendors	Companies that do outsourced or contracted manufacturing.	R&D, engineering, manufacturing, distribution and reverse logistics	Solectron, Jabil, Flextronics

From the market research, some interesting findings come out:

- There were over 10 reverse logistics BoB software vendors in the market a couple of years ago. However, due to financial problems, most of them either left the market or provide other services such as warehouse management and flow management.

eBoomerang is one of the few vendors that survived the hard time and is providing a very professional reverse logistics software system. This shows that reverse logistics BoB business itself is tough when vendors are competing in the market and trying to be financially healthy. The winners are those who provide value-added solutions rather than simple or primary software systems to their customers. Those solutions can be enhanced functionality to best serve customer needs. Thus, the market itself is driving reverse logistics management systems to be more and more advanced.

- A few leading OEM/ODM vendors such as Solectron, Jabil and Flextronics provide value added reverse logistics management to the companies they do manufacturing business with. As part of the integrated supply chain, reverse logistics can't be neglected. The objective is to complete the end-to-end solution including product design, engineering, manufacturing, logistics and reverse logistics and thus provide a complete solution to their customers. In OEM/ODM business, by forming a feedback loop such as returns reasons analysis and future returns control/prevention, reverse logistics provide great values to other parts of the supply chain.

The trends in reverse logistics market are: (1) more companies begin to recognize the importance of reverse logistics; (2) business requirements for reverse logistics is more demanding; (3) reverse logistics software systems are becoming more advanced and (4) different competitors are providing more complicated services to enhance their competitiveness.

When choosing reverse logistics systems, businesses can't just go to the market and grab any software they find. Instead, they should first figure out what specific functionality of a reverse logistics system they are looking for. Comparing the different available systems and additional services with business requirements, a proper reverse logistics system or service can be selected. Nevertheless, with the increased complication of reverse logistics and the systems/services, it is getting harder to efficiently evaluate the systems/services and find out an ideal solution. What is a reasonable and efficient way to find a proper system? This question will be answered in the following chapters.

Chapter 3 A scheme for evaluating reverse logistics software systems and services

This chapter introduces a method for evaluating reverse logistics software system and service. The method is based on a set of evaluation point systems and a simple algorithm.

There are many factors affecting the decisions on selecting software/service. Quite a few software systems and services are available for reverse logistics. Also, different companies have different needs and different budget on reverse logistics issues. Software developers and service providers are targeting at different customer groups. They follow different pricing strategies to assure their survival based on the expense. A qualitative solution is not sufficient because there are too many correlated and multi-folded parameters. It is difficult to judge which software or service is the best for a company by single qualitative analysis. Hence, quantitative study is desired to be a supplementary tool to identify the better or even the best solutions.

3.1 The equation and description

When selecting software or service, we need to consider cost of the software, desired functions, quality of the software and business requirements. After in-depth study of current reverse logistics software systems and services, we developed an algorithm to calculate the "Evaluation Point", which is used to indicate the value of the software system or service by computing its Functional Points total over its total cost (K$). From the quantitative analysis, the higher the Evaluation Point, the better the candidate software or service is to the customer companies.

Equation:

$$\text{Evaluation Point} = \frac{\sum_{i=1}^{n} (\text{Functionality Point}_i \times \text{Vendor Credit}_i \times \text{Business Point}_i) + \text{Other Points}}{\text{Total Cost}}$$

Ravi (2001) listed the pricing strategies employed by reverse logistics systems or services vendors. In summary, those costs can be transaction cost, subscription cost, initial setup cost, consulting cost, commission on resale, gain sharing or customized pricing. Most of the vendors charge up to three of the above-mentioned costs.

The numerator of the above equation consists of the sum of points for each function provided by the vendor plus any other service points:

Functionality Point indicates the desired functions to general reverse logistics management. For all the functions, it equals to 1. This is actually a "switch" to control the presence of the influence of a function.

Vendor Credit is decided by the quality provided by a software system. It ranges from 0 to 1. The value 0 means the function is not available while 1 means the function has the best quality. The quality of the function increases as the value goes from 0 to 1.

Business Point indicates the importance of the function under business requirements. It can be 0, 1, 2 or 3. Because we are seeking software systems with advanced functions, we set up value 1 for the primary requirements, 3 for the most advanced requirements.

Value 0 is for functions that are not required by a specific business. For instance, when returning books, a customer only needs to return the cover of a book because the shipping cost for a whole book is generally much higher than the value of the book itself. Therefore, repair and inventory functions are not required for processing returned books. In addition, under certain circumstances, Business Point needs to be adjusted according to specific business requirements. The points for different requirements may be raised or deducted. Section 3.3 illustrates such cases.

Other Points corresponds to miscellaneous services that can't be included in the list of functions. It can even be negative if the system has an adverse impact on business. For instance, an additional software system will cause data compatibility issue and extra operational cost. Such impact is not reflected in the Functionality Point. In this case, it is reasonable to introduce a negative point to adjust the result.

In fact, the numerator is a weighted sum of vendor credit. The Business Point is a weigh factor. The left hand side of the equation can be understood as "how much performance we get for every thousand dollars we pay?" However, in practice, the Vendor Credit and Business Point need much work to do. What to consider when deciding the points and how these parameters are calculated are discussed in sections 3.3 to 3.5.

3.2 A simple example of the algorithm

Here is a simple example of using the algorithm. Suppose 5 functions are required for a software and there are two vendors competing in the market. Total cost for the two

systems are both $150K. The assumed points and credits are as in the following table. There is no Other Points for both vendors. The results are Evaluation Point for vendor1 is 0.037 and for vendor2 is 0.040. With a bigger Evaluation Point, vendor 2 provides a more competitive solution.

Table 3 A Simple example of the algorithm

	Functionality point	Vendor 1 Credit	Vendor 2 Credit	Business Point
Function 1	1	1	0	1
Function 2	1	1	1	1
Function 3	1	0	1	2
Function 4	1	1	0	2
Function 5	1	0.5	1	3

Total Functional Point (V1): 5.5 Evaluation Point (V1): 0.037

Total Functional Point (V2): 6 Evaluation Point (V2): 0.040

Apparently the above equation is very basic. It should be noted that the algorithm is a rough estimation for the performance-expense ratio. Different people can give different parameters for calculating the Evaluation Point and may get different results. Business should use consistent criteria when setting up the parameters. We provide a routine about how to get these parameters in the next sections.

3.3 List of feature points and recommended rating for Business Point

To solve the above-mentioned problems in reverse logistics, a versatile reverse logistics management system should not just be able to support the return order management, the fundamental function of the system. It should also support more functions such as warehouse management, inventory management and returns reporting and performance management (Table 4). However, they are quite different in their importance to reverse logistic in practice. These differences are reflected as weight or "importance" of the

features when we consider a software system or service's capability. We classify those feature points by the importance of each one.

3.3.1 Business Point = 1: Primary functions

Those functions support a basic return processing management including return order initiation, data input, RMA issue, reason code input, etc. As they are the fundamental functions of the reverse logistics management system, we consider 1 for their Business Points.

The system needs to be flexible for different data input methods such as website and internal input as well as be able to handle current data correction and update. When a customer requests to initiate a return order, the system should be able to validate RMA and issue RMA number. A "rules-base" business engine should be able to validate returns at the customer, product, return reason, warranty policy, discrepancy, geographic region or other levels. As customer requirements may change, such an engine should be modifiable accordingly. Robust reason code function and product classification are necessary for the system to record return reason and classify returns. They also provide important information for deciding how to process the return.

Table 4 List of features and their Functionality Points

Functionality	Business Point
Return order management	
Customer interface (web access, manual input, data update/correction)	1
Return orders creating and RMA issuing	1
Reason code	1
Product classification	1
Discrepancy handling	1
Rules-based warranty verification	1
Rules-based credit approval	1
Service-level rules	2
Data mapping/sharing capability (customer, purchase order)	2
Warehouse management	
Labor management	2
Dock screening and sorting (quality processes)	2
Least cost for routing and processing	2
Carrier selection, mode, tender	2
Service billing engine	2
Activity billing engine	2
Internal cost allocation	2
Inventory management	
Inventory tracking	3
Inbound visibility and allocations	3
Cost optimization	3
Replenishment management	3
Reporting and performance management	
Real-time reporting	2
Auto-notification	2
Tracking key performance metrics	2
Rules-based service level monitoring	2
Internal operating metrics	2
Data keeping	2
Return reason/source analysis	3
Return forecast	3

3.3.2 Business Point = 2: Cost saving and service control functions

Two of the most critical issues many companies facing at present are to provide good quality customer services and responses while still protecting the assets and financial position, i.e. cost control, of the company. The functions that support return logic and performance monitoring/measuring all fall in this category. Since the performance of reverse logistics management affects post sale service as well as overall business cost, top managers at hi-tech companies should treat reverse logistics management systems from a strategic point of view. Reverse logistics shouldn't be only regarded as basic return processing. It should be integrated both internally and externally to realize the value-added functions such as return logic, real-time reporting, cost optimization and service level control. We rate value 2 for these Business Points.

The ability to determine the true value of returned items and a comprehensive, detailed and accurate cost system are critical in cost optimizing for returns. The system should support dock screening and sorting for returns at entry points. Dock screening and sorting helps to identify the real status and value of the returns. Whenever wrong, unexpected, invalid returns are received, they should be rejected. For valid returns, means of disposition, destination and routing should be determined right away. Reverse logistics costs should include not only the direct costs in test, rework and transportation but also indirect costs associated to returns and return processing. For example, customer credit adjustments in the case of rebate/discount for special purchase orders as mentioned in the cost structure of reverse logistics (section 2.3.3) should be included. If the return is out of warranty period, cost of replacement, repairs and transportation need to be re-charged to

the customer. Based on the cost structure for the returned product, the system should provide automatic return logic to the company to minimize return cost upon return is received, so that the return can be processed immediately and correctly. Thus, wrong or unnecessary return processing is avoided. Obsolescence is also eliminated.

The system should also support real-time reporting as well as any kind of customized reporting. The data should be sorted by date, product, customer, return reason, geographic region, etc. The content of the report should include the status of the return, receiving/shipping/rework, processing, routing, relevant cost, residual value and any issues/comments. The report can be a separated report or be integrated into other reports so that the information can be well presented for different purposes.

The system should minimize data needed from customers for validating RMA (Return Material Authorization) entitlement by leveraging data from both internal (e.g. customer profile, purchase order) and external (e.g. distributor, carrier) database. An internally integrated information system improves efficiency and reduces errors in manual data input and associated time/costs.

3.3.3 Business Point = 3: Inventory management and return forecast

When considered as part of an integrated logistics management, the reverse logistics management system should support inventory management, return forecast and financial transaction, the most value-added functions that contribute to the whole supply chain management. We rate 3 for those functions.

In reverse logistics, inventory cost and service time should be measured and managed as part of the whole logistics system. Return/replacement forecast, replenishment management and inventory policies for replacement in reverse logistics should be treated in the same way as forward logistics. For instance, it is critical if the inventory level of a SKU is kept low for forward logistics while a large amount of replacements for returns are needed. Those unexpected replacements may cause a shortage in forward logistics service. Hence, the poorly managed inventory in reverse logistics could have a significant impact on the performance of forward logistics.

Rogers and Tibben-Lembke (2001) mentioned a central returns center (CRC) for gathering returns from multiple regional locations. The benefits they observed are large volumes of returns, centralized information and more experience. We do agree that the information of the returns should be centralized by an integrated information system. The data may facilitate to identify the return trends, the pattern of defects or the scope of a potential problem. Centralized information can be analyzed and may indicate significant R&D, quality, manufacturing or logistics issues. Product design, manufacturing processes and other aspects can be altered so that future returns can be potentially reduced. However, a centralized return-processing center is not recommended. The disadvantage is not only transportation cost as stated by Rogers and Tibben-Lembke. For repairs, service time is another issue. If the company is competing on service for repaired returns, centralized return processing may cause prolonged lead-time in returns management. For some returns, when transportation cost is much higher than the residual value, they can be scrapped locally instead of being shipped to the CRC.

3.4 Adjusted Business Point

Section 3.3 determines the Business Points according to general business requirements. However, there maybe some special business situations under which the setting of Business Point either needs to be raised or be reduced to meet specific business requirement. This section explores such exceptional situations under which Business Point should be changed.

Primary functions

Obsolete information – If the returns exceed end-of-life period (e.g. leased computer business), there may not be sufficient information of the returns. Some leased computers may even be modified and don't have the same setup as when they are leased. The reverse logistics software needs to be robust enough to capture the out-of-date information, to allow any manual input, to retrieve data of the product from other systems, to trace the product information and to classify the returns. It requires advanced customer interface and data sharing functions. Business Point for those functions should be raised accordingly.

Cost saving and service control functions

Return residual value and quantity – If the returns contain high residual value (e.g. computers or servers), advanced return logic functions can help best save and utilized the residual value. If the returns contain very low residual value but with a large quantity (e.g. chips), the company may still want to use the advanced return logic functions with higher Business Points since it helps reduce labor work in such low value-added work.

Complication of return processing – If the return processing is complicated, for instance, there are many technical returns that need to be tested to determine the dispositioning or the dispositioning of returns is not easy to decide, requirements on testing, sorting and return logic could be high. The company may want advanced return cost optimization and routing functions with higher Business Points. On the other hand, the company may want to lower the requirements (Business Points) of the functions, if the return processing is not that complicated and easy to manage.

Inventory management and return forecast

Asset recovery – If a company is competing on quick market access (e.g. cell phone companies) and needs to repair returns quickly and then send them back to market, it requires the reverse logistics system to have advanced data visibility and inventory management functions. The prolonged returns processing causes reduced price of the returns back market. The system eliminates stockpiles of returns and increases their velocity of turnaround. To some companies, it could help save hundreds of millions of dollars (Motorola case).

3.5 Recommendation for setting Other Points

The Other Points are given to reverse logistics software system or service vendors who have unique or significant advantage over other vendors. To be compatible with the rating criteria in 3.3, Other Points are categorized by the importance to business.

3.5.1 Other Points = 1: Primary functions

Good facility capability and end-user interface support the fundamental functions, so we set 1 for their Other Points.

Facility capability – If the customer company has worldwide business, for cost reason, they may not want to invest too much in facilities and software all over the world. Instead, they may want to leverage 3PL companies' worldwide facilities and capacity. For instance, UPS has about 500 locations worldwide over 100 countries for returns collecting. The maintenance cost of global warehouses and software can be higher than using UPS service.

End-user interface – Companies such as Apple, who's customers are mostly individual consumers, need to look for a 3PLs service provider that has sufficient customer interface via shops or warehouses (e.g. Kinko's for FedEx and Mailbox for UPS), so that it will be more convenient for the consumers to send returns.

3.5.2 Other Points = 2: Cost saving and service control functions

Good technology support and reduced software interface enable the system to better manage return processing and control return costs. They are given the value of 2.

Technology advantage – With the good technology support for returns processing (testing, sorting and repair), OEM/ODM vendors are able to well analyze return reason,

find proper solutions and provide proper technical support to the returns. Hence, return is well managed, cost is reduced and customer service is improved.

Software interface – Reverse logistics function can be provided by warehouse management software or CRM software in ERP or Module software. Companies with a relatively complete range of software can upgrade those existing software for enhanced reverse logistics functionality with less capital investment and software interface. With improved data transfer, both return processing cost and service time are reduced. If a company already has many software systems, for the concern of data compatibility and operational cost, it may not be necessary to add extra software interfaces.

3.5.3 Other Points = 3: Inventory management and return forecast

Any value-added functions that contribute to the whole supply chain management should be rate 3 for Other Points.

Return feedback – By providing reverse logistics service, OEM/ODM vendors collect first-hand data of returns and make return root-cause analysis immediately. Within an integrated supply chain, including product design, manufacturing, distribution and reverse logistics, the analyzed information of reverse logistics will be transferred directly to R&D, quality and manufacturing departments within the shortest time, so that corrections or adjustments can be carried out. Product design, manufacturing processes are improved and future returns are prevented.

Chapter 4 A sample solution in the case of ABC Company

The case study shows how reverse logistics is managed in a semi-conductor company. Problems and issues in current practice are identified and explained. It also provides an understanding for the relevant elements, software systems, policies and the interrelationships for reverse logistics systems. Business Points are suggested under the actual business situation of ABC Company. Different solutions are evaluated.

4.1 Reverse logistics business at ABC Company

The most critical issues for reverse logistics at ABC Company are return cost control, system visibility and customer service improvement. Other issues include customer interface, complicated warranty/credit policies and inconsistent software interface.

4.1.1 Return cost control

Complicated technology, verified residual values and high testing/repairing costs make it hard to optimize returns management. Complicated cost structure (hidden cost) sometimes cause asset lost to the company. Since those issues directly affect ABC Company's bottom line, according to the suggestions in section 3.3, the functions to support those requirements are rated 2 for their Business Points.

Technical returns – the most complicated returns to manage

There are five types of returns: administrative returns, technical returns, negotiated returns, discontinued returns and stock rotation returns. Administrative returns are caused by operational mistakes such as wrong product, wrong quantity, wrong destination, etc.

made by either ABC Company or its customers. Technical returns are returns for quality issues. Negotiated returns are for negotiated credit beyond normal allowable returns. For example, for some reasons there are returns out of warranty period. They may also be returns whose quantities exceed the allowed quantity for stock rotations. The customer negotiates with ABC Company so that they can still get at least part of the credit back. Discontinued returns are for products that are not produced any more (end-of-life products) but are still on Disti's (hi-tech distributors) shelf. Stock rotation returns happen when a Disti wants different product, faster moving items or the latest revision. Technical returns, stock rotation returns and administrative returns are the three biggest groups, each covers about one forth of the return. (Table 2)

Table 5 Percentage for different return types (by dollar value)

Return Type	Percentage
Administrative	24%
Technical	32%
Negotiated	13%
Discontinued	3%
Stock Rotation	28%

Normally, the customer needs to explain and verify the reason for technical returns when a RMA is initiated. Besides the software system that is generally used to initiate return order, an extra system is used to validate the technical returns. Testing or monitoring is required when the returns are received to determine the processing and destinations for such returns. Usually, technical returns are repaired or scraped. For scraped returns, replacement or credit is sent back to the customer. Hence, managing and cost structure for technical returns are usually more complicated than other return types. Two issues

that need to be determined are: which returns need to be repaired and where to repair them. Low repair cost may cause long lead-time. This is done to minimize cost and ensure high customer service level. Since diagnose and repair of some items are expensive and possibly cost more than the residual value of the returns, it is not worth to select and repair these returns. For most technical returns, ABC Company may only do scrap upon the receipt the returns instead of doing the rework, which takes both time and money. The reasons for other four return types are obvious and the processes are simpler than for technical returns. It requires the system to effectively distinguish different return reasons and to support not only the simple reasons but also the complicated ones that may require verification and negotiation.

Verified residual values

There are about 20,000 level one SKUs (Store Keeping Units) at ABC Company. Returned products include microprocessors (components), chipsets, memory or flash chips, embedded chips, motherboards and servers. The value of those products ranges from $60,000 per unit (servers) to $5 per unit (old components). As mentioned above, costs of manufacturing, testing and repairing for different products may vary and requirements for processing those products are not similar. For instance, when returned for technical problems, chips are usually scrapped, as the repair costs are higher than the residual value. But only most high-value motherboards are repaired for the high residual value they contain.

In FY03, RMA at ABC Company was valued at about 1.4% of total revenue. By dollar value, over 60% returns are microprocessors and chipsets while only 4.3% are flash chips. The volume is distributed more evenly among the major categories. Motherboards/ services and flash chips have the highest volume – each category contains about 25,000 units. Table 6 shows the breakdown number for different returned products. The 4 major returns categories add up to 88.4% of total return value.

Table 6 Information of returns in terms of value and percentage (FY03)

	Percentage of Dollars	Units Returned (K units)
Microprocessors/Chipsets	60.4%	19.7
Motherboards/servers	13.1%	26.5
Communication Processors	10.6%	16.3
Flash Chips	4.3%	25.2
Other	11.6%	N/A

High testing and repairing costs

All the returns that are physically returned to ABC Company are collected at local warehouse, the regional distribution centers. Usually, the exaggeration of a returned product's condition, wrong return code, wrong item and even items from competitors could be returned in this case. It will help save unnecessary cost and time if the system supports dock screening and sorting that validates the returns at the initiate stage. Currently, the warehouses in US and Europe perform validation for microprocessors and boards. However, they don't do validation for many products because the associated cost is too high. Despite of the high cost, dock testing and sorting brings great benefits to

ABC Company. Such screening generated $5M in savings by rejecting invalid return in FY03.

Much like a manufacturing shop that can be very complicated (e.g. the company needs product manufacturing information, raw materials, technical expertise, unique controls and planning software), returns repair also requires shop floor control software systems and processes. Repair is a much more expensive return process than simply giving the customer credit. ABC Company outsources most repair work to an OEM vendor. For cost issues, the company only repairs motherboards (not all motherboards returned are returned for repair) and a few servers. All the refurbished boards need to be identified before used as replacements. Only un-opened boxes of products can be sent back as finished goods and be resold. ABC Company is very strict about the condition for resold returns. The ability of the system to capture the information of repaired returns against returns in un-opened boxes is also important. ABC Company doesn't want to sell any repaired returns as non-refurbished products. However, the company also doesn't want to miss any returns that can be resold at a normal price.

To optimize cost, the function of processing and destination for returns is critical. Reverse logistics management systems should be able to track the flow of the returns so that the reported data will accurately reflect the real situation, which is important to cost saving, business analysis and decision-making.

4.1.2 Problem of visibility

The repair depots for returns are in low cost geographies and the exchange depots for replacement are located in regions so as to be strategically close to the customer bases for easy customer access and better service. These services (repair and replacement) are provided at depots using the depots' software. To avoid additional cost, there is very little data transferring for returns information from depots back to the ABC Company software. So there is always disconnectivity of information about returns and customers between the service sites and ABC Company. There are cases where high end product will sit on the dock waiting for the planners to process the returns documentation. This documentation has to be processed before it can be put back into SAP as good stock. Once the data of the product is put back into SAP it immediately gets booked and shipped out. The better visibility to all parties involved in return processing will show all available supply and thus increase the inventory turnover so that the returns can be sent to stock for resale more quickly. The enhanced data quality will also help reduce inventories by reducing mistakes/lead-time in return processing and allow for credit of more accurate amounts. The Business Points for functions are rated 2.

4.1.3 Customer service

As returns are becoming more diversified and high cost in returns management becoming a critical issue, ABC Company finds it gets harder to manage cost and customer service simultaneously. Some returns are piled in warehouse for weeks, some are sent to wrong place for repair and some are even lost in tracking. For technical reason or cost saving, it may take much more time to repair the returns. Customers sometimes don't get repairs or

replacement in time. More problematically, they don't know what's happening and what are the issues.

The system should be able to monitor the processes and processing time of the returns so that the process doesn't exceed required time. Both the company and the customer should be automatically informed by the system when any unexpected issue happens. The system should also be able to capture different costs associated to the return processing against service time. According to business requirements, optimized return disposition and service level solution should be provided. Business Point = 2 for such functions.

4.1.4 Other issues

The issues are complicated customer interface, complicated warranty/credit policies and inconsistent software interface. As software interface has a serious impact on system visibility, data compatibility and asset recovery, for software that are currently used by ABC company, we increase their Other Points to 3 for software interface and decrease Other Points to -3 for software that are not used by ABC Company. Customer interface and warranty/credit policies check require primary functions, we set Business Point = 1 for them.

Complicated customer interface and different return policies

There are two types of customers for returns: business customers and channel customers. For semiconductor industry, business customers can be OEMs, Disti, ODMs and other companies. Business customers usually buy products directly from ABC Company. The

information about business customer, relevant purchase order, price and volume of the sales where the return originated from is complete in the system. Therefore the customer and the returns can be validated in the system and all three types of the return services (repair, credit and replacement) can be provided to business customers. Channel customers (also called end-users) purchase items from boxed products through resellers. Usually there is no database record of the sales to channel customers, so ABC Company can't validate the returns from an individual customer. Thus the company doesn't do repair or issue credit to those customers but only sends replacements. (The exception is for returns that are for quality issues. In this case, box has to be opened and the return be checked and validated. Under such condition, if the channel customer wants credit, he can take the return back to the retail outlet where he bought it and gets credit afterwards.) Hence, return processing such as return initiating process, warranty policy, replacement/repair/credit policy for business customers and channel customers are different. The reverse logistics management system should not only support different customers but also support the different processes for those customers.

Complicated warranty and credit policies

By return type and region, business customers may combine returns under different RMA numbers into one shipment provided that all parts must fit within ABC Company's warranty policies. The warranty policies vary for different return reasons in different geographic regions. Similarly, based on different return types within certain dollar value in different geographic regions worldwide, return credit can be approved by different people/levels.

It requires reverse logistics management to be robust enough to support different warranty and credit policies for different returns, dollar value, geographic regions or customers, and capture the correct information about the returns and customers when return orders are initiated and returns are processed differently.

Inconsistent software interface

In ABC Company, several different software systems are used for reverse logistics management. 16 software systems are most frequently used. They provide functions performed by different groups for different customers. For instance, to validate RMA, verification of serial numbers or purchase orders for different returns are processed in different software systems. Data duplication and compatibility are the critical issues among the many software systems. A lot of data are copied from one system to another or re-entered from one system to another, which makes the database unnecessarily huge. Since different software systems use different engines and data structures, data transfer is unavoidable. Delays and the synchronization issue could happen during the transfer.

Table 7 shows a summarized Business Point list for ABC Company.

Table 7 Business Point for ABC Company

Functionality	Business Point
Return order management	
Customer interface (web access, manual input, data update/correction)	1
Return orders creating and RMA issuing	1
Reason code	1
Product classification	1
Discrepancy handling	1
Rules-based warranty verification	1
Rules-based credit approval	1
Service-level rules	2
Data mapping/sharing capability (customer, purchase order)	2
Warehouse management	
Labor management	2
Dock screening and sorting (quality processes)	2
Least cost for routing and processing	2
Carrier selection, mode, tender	2
Service billing engine	3
Activity billing engine	3
Internal cost allocation	3
Inventory management	
Inventory tracking	3
Inbound visibility and allocations	3
Cost optimization	3
Replenishment management	3
Reporting and performance management	
Real-time reporting	2
Auto-notification	2
Tracking key performance metrics	2
Rules-based service level monitoring	2
Internal operating metrics	2
Data keeping	2
Return reason/source analysis	3
Return forecast	3

4.2 Vendor Credits and Total Costs for selected reverse logistics vendors

To compare different solutions provided by different vendor categories, four vendors providing ERP, Module, BoB software and OEM/ODM service respectively are chosen. Interviews with people from those companies or their customers were carried out to identify the availability and quality of the functions of their software systems. ABC Company already has the ERP software but doesn't have other systems. Hence, in Other Points, the ERP vendor gains 3 points while all the other vendors gain –3 points. The OEM/ODM vendor gains value 2 and 3 respectively for its technical advantage and return feedback. Yet, due to resource limitation, most of the Vendor Credits are rated 1 if they are available and 0 is not. A few values between 0 and 1 are given to the functions that are obviously weak in quality compared to others. Thus, the differences between the qualities of different systems/services are slim. Table 8 lists the Vendor Credit for the four vendors.

Pricing and total cost from different vendor categories may vary significantly. Cost for ERP software could be twice the total cost for using BoB software. Total Costs (Table 9) quoted by the vendors are simplified such that the difference and problem would be obvious.

Table 8 Vendor Credit

Functionality	Vendor Credit (ERP)	Vendor Credit (Module)	Vendor Credit (BoB)	Vendor Credit (OEM/ODM)
Return order management				
Customer interface (web access, manual input, data update/correction)	1	1	1	0.3
Return orders creating and RMA issuing	1	1	1	0.5
Reason code	1	1	1	1
Product classification	1	1	1	1
Discrepancy handling	1	1	1	1
Rules-based warranty verification	1	1	1	1
Rules-based credit approval	1	0.5	1	1
Service-level rules	1	1	1	1
Data mapping/sharing capability (customer, purchase order)	1	1	1	1
Warehouse management				
Labor management	1	1	1	1
Dock screening and sorting (quality processes)		1	1	1
Least cost for routing and processing	1	1	1	1
Carrier selection, mode, tender	1	1	0	1
Service billing engine	1	1	1	0
Activity billing engine	1	1	1	0
Internal cost allocation	1	0.5	1	0
Inventory management				
Inventory tracking	1	1	1	1
Inbound visibility and allocations	1	1	1	1
Cost optimization	0	0.5	1	1
Replenishment management	0	0.5	0.5	1
Reporting and performance management				
Real-time reporting	1	1	1	1
Auto-notification	0.5	1	1	1
Tracking key performance metrics	1	1	1	1
Rules-based service level monitoring	1	1	1	1
Internal operating metrics	1	1	1	1
Data keeping	1	1	1	1
Return reason/source analysis	1	1	1	0.5
Return forecast	1	1	1	0.5
Other Points				
Software interface	3	-3	-3	-3
Technical advantage				2
Return feedback				3

Table 9 Total Costs

	ERP Vendor	Module Vendor	BoB Vendor	OEM/ODM Vendor
Total Cost (K$)	1000	800	500	400

4.3 Evaluation results and analysis

We find that the ERP Vendor has highest total Functional Points because it provides most of the required functions and gains extra 3 points for software interface. Without supporting several required functions and having less function quality, the OEM/ODM vendor has the least total Functional Points although it has some Other Points. However, by calculating the Evaluation Points for the four vendors, we find that the ERP Vendor ranks the last in Evaluation Point because it quotes the highest Total Cost. By quoting the least cost, the OEM/ODM vendor has the highest Evaluation Point and is the selected candidate for the service provider according to the Evaluation Point.

Table 10 Results of the evaluation

	ERP Vendor	Module Vendor	BoB Vendor	OEM/ODM Vendor
Functional Points	51	47	48.5	41.8
Total Cost (K$)	1000	800	500	400
Evaluation Point	0.051	0.059	0.097	0.105

The merit of the algorithm is that it considers both performance and expense. The results provide reasonable suggestions in decision making for reverse logistics. However, we

have to realize that the algorithm only shows a static evaluation for business. Business is dynamic. What seems correct today is not always correct in future. When choosing reverse logistics systems, companies should consider future business requirements and potential benefits brought by the more advanced software systems.

Chapter 5 Conclusions

5.1 Conclusions

The technology for reverse logistics is getting improved. Professional software systems and services are available in the market. A versatile system enables the company to best control costs in returns management and well improve customer service. However, due to diversified business requirements and reverse logistics market, simple qualitative analysis can't provide convincing evaluation for selecting reverse logistics systems/services. An algorithm determined by quantified business requirements, software quality and total cost can help business better understand the candidate systems/service financially. However, businesses need to be more systematic when setting up the parameters in the algorithm. Any inconsistent criteria and/or restricted research will lead to misleading results. In addition, as we have stated, such algorithm is only a supplementary tool for decision-making. When selecting reverse logistics software systems or service, companies should look at future business requirements. The companies need to consider all the detailed tactical operations and balance the tradeoffs before making the decision. Most importantly, they should balance short-term investment against long-term benefits and sustainable development.

5.2 Research limits and future research

The resulted algorithm and rating point system have their limitations. First, the rating point system is a rough evaluation of relevant parameters used in the algorithm. It is adequate because an approximate estimation of the performance/price ratio is enough when making decision on software system or service. If in any case an accurate

evaluation such as Net Present Value, Return On Investment, operational savings and benefits is desired, a more detailed rating, based on more survey, should be proposed. Second, with the development of technology and reverse logistics study, the rating points tend to change. Frequent updating of the rating points is desired.

Data accuracy of the study also needs to be improved. Due to resource constraints, the restriction of Business Point and Other Points in the algorithm is currently based on experience and kind of relaxing. Vendor Credits are set up by the vendors' claims instead of real testing. Those parameters still need a more systematic procedure to decide. Consistent criteria are essential in determining the parameters. A software functionality inspection carried out by a professional third party to determine Vendor Credit is necessary. When setting up Other Points, we need to well understand specific business requirements. Consistent criteria should be established to justify those points.

Prices quoted by the vendors need to be more detailed and well explained. Costs may include one time cost for software license fee, hardware & other infrastructure software (e.g. database) and implementation. Annual cost or recurring cost (e.g. maintenance cost for core software/hardware and a ongoing IT personnel cost) may also happen. Sensitivity analysis based on the range of those costs may better analyze the benefits over cost. A more dynamic evaluation system should consider the investment/cost and benefits over several years under potential business requirement changes.

Reference

Autry, C., Daugherty, J. and Ellinger, A. (2001), "Reverse Logistics: The Relationship Between Recourse Commitment and Program Performance Patricia", *Journal of Business Logistics*, Vol. 22, No. 1, pp107-123

Banasiak, K., Brokmann, K., Johnson, T., Rogers, D. and Tibben-Lembke, R. (2003), "Reverse Logistics Challenges" http://www.arkaslojistik.com.tr/lojistik_bilgi_bankasi/37A.Rogers%20revised.pdf

de Brito, Marisa and Dekker, R. (2002) Erasmus University Rotterdam, "Reverse Logistics – a framework" http://www.eur.nl/WebDOC/doc/econometrie/feweco20021018095304.pdf

Delaney, Robert V and Wilson, Rosalyn (2003), "14th Annual State of Logistics Report", Council of Logistics Management http://www.peachstate.com/News/articles/14th%20Annual%20State%20of%20Logistics%20Report%20-%20RECONFIGURATION.pdf

Dowlatshahi, S. (2000), "Developing a theory of reverse logistics", *Interfaces*, Vol. 30, No. 3, pp143-155

IBM, "Benchmarking Survey Readout Final Report", 2003

Marien, E. (2001), "Reverse Logistics as Competitive Strategy", *the Supply Chain Year Book*

Ravi, R. (2001), "Reverse Logistics Management Services: Market Overview and Competitive Profiles of Service Providers", *IDC #26021*

Rogers, D. and Tibben-Lembke, R. (1998), "Going Backwards: Reverse Logistics Trends and Practices", *Reverse Logistics Executive Council*

Rogers, D. and Tibben-Lembke, R. (2001), "An Examination of Reverse Logistics Practices", *Journal of Business Logistics*, Vol. 22, No. 2, pp129-148