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TAMPERE UNIVERSITY OF TECHNOLOGY

USMAN ZIA

**AFTER-SALES BUSINESS MODEL TO CREATE CUSTOMER
VALUE: Case Profit Potential of Hydraulic Hose-Assemblies**

Master of Science Thesis

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ABSTRACT

TAMPERE UNIVERSITY OF TECHNOLOGY
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VALUE: Case Profit Potential of Hydraulic Hose-Assemblies

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After-sales business is supposed to be a very profitable business. If conducted properly with the right strategies and clear understandings its impact on the company's profitability tends to be significant. The main focus of this study has been pointed towards providing superior customer value and enhancing sales potential in after-market for hydraulic hose-assemblies. Therefore, in the empirical phase of this study, emphasis has been provided towards developing a deep understanding about hydraulic hose-assemblies and their complexities.

Hydraulic hose-assemblies provide huge potential for after-sales revenue. These hose-assemblies also have a relatively short life span as compared to most of the other machine parts. Despite the business potential, OEMs today make hardly any hose-assembly related after-sales revenue. Potential business opportunities in after-sales make it interesting to study different facilitators that are directly influencing the after-sales business potential.

Understanding profit potential is one of the vital factors in order to finalize beneficial strategies for after-sales hose-assembly business. It is not necessary that strategies those are successful and profitable in one segment (application based) would also be profitable for the other segments. The study suggests that intensity of delivery, price and number of hose-assemblies in machines are the direct influencers towards the profitability of the hose-assembly after-sales business. OEMs need to understand the profit potential in a certain segment before strategizing their after-sales services for hydraulic hose-assemblies.

PREFACE

This thesis discusses the significance of understanding the marketing needs and profit potential to develop after-sales business. These concepts are of high importance in the area of mechanical industry, also these are in the focus of a lot of research work going on worldwide. The thesis attempts to study the importance of creating an understanding that is needed as a factor influencing after-sales business development.

It has indeed been a very challenging and interesting experience to start with a broad objective of studying hose-assembly after-sales business. I am very thankful to my supervisors Prof. Petri Suomala and Dr. Jouni Lyly-Yrjänäinen who motivated me to select this topic for analysis and supported me throughout the execution of the analysis work. I am thankful to all other colleagues, peers and friends who helped me with their inputs during discussions.

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1. INTRODUCTION

1.1. Background

The traditional basis of business development and competitive advantage no longer suffice. The search is on for new opportunities for differentiation. Previously Companies have tried to distinguish themselves by rigorously pursuing operational perfections in areas such as order fulfilment, new product development, and procurement. But these innovations are no longer distinctive. Operational improvements in traditional areas are now competitive necessities rather than bases of competitive advantage.

After-sales support is one area that offers potential opportunities to earn high profit margins and attaining sustained competitive advantage. Long ignored by most of the companies' after-sales support activities have been conducted in the most traditional manners. Unfortunately, conventional after-sales processes are performed without adequate exchange of information between OEM, intermediary and customer. Potential business opportunities in after-sales make it interesting to study different facilitators that are directly influencing the after-sales business potential.

Hydraulic hose-assemblies provide huge potential for after-sales revenue. Each machine contains huge number of hose-assemblies and these hose-assemblies also have a relatively short life span as compared to most of the other machine parts. Despite the business potential, OEMs today make hardly any hose-assembly related after-sales revenue.

One major challenge is to enable the machine user to order right spare part (hose-assembly). One solution is that the hose-assembly spare part needs to be marked with a certain ID code and for this ID code to remain readable depends on the environment in which the machine is used. Some machines are used in extremely tough environment, for instance, drilling machines because of rock rain and other factors but on the other hand asphalt machines and different earth moving machines works in a comparatively pleasant environment. This means that the permanency of the marking is an essential factor to order fast and right hose-assembly, but at the same time, permanency needs to be coherent with the environment, in which the machine is used to avoid unnecessary costs.

Apart of the need to understand the importance of traceability and facilitators to enhance after-sales business, first it is more vital to understand that the profit potential. Thus the objective of the thesis is:

..building a framework representing the marketing needs to facilitate the hose-assembly after-sales business and then generating a new business-model representing the profit potential for hose-assembly after-sales business among different segments to facilitate the strategies for enhanced post-sales.

Understanding profit potential is one of the vital factors in order to finalize beneficial strategies for after-sales hose-assembly business. OEMs need to understand the profit potential in a certain segment before strategizing their after-sales services for hydraulic hose-assemblies. Because it is not necessary that strategies those are successful and profitable in one segment would also be profitable for the others.

1.2. Research method

Choice of methods used for data gathering is one of the most important and crucial decision in the case study research (Gummesson 1993). Data-gathering can be performed by using various qualitative and quantitative methods in research. Quantitative methods on the one hand deals with the study of Cause and effect thinking, reflection of specific variables hypotheses and questions, use of measurement and observations and the test of theories. On the other hand qualitative research depends on the methods based on multiple meanings of individual experiences, meanings socially and historically constructed and with the intent of developing a theory or pattern (See Swanson and Holton 2005). While studying complex business environments, Gummesson (1993) has shown his emphasis towards the effectiveness of qualitative methods. As defined by Gummesson (1993), a researcher can adopt five methods in order to perform research for a specific case study that includes existing material, questionnaire surveys, interviews, observations and action science.

For conducting a case study especially in complex business environments, using existing material and action science are the two methods which have vital impact in order to measure even the most critical and small problems of the case. Existing material could be qualitative, quantitative as well as empirical or theoretical. Existing data can comprise on multiple resources, for instance, research reports, research articles, mass media reports, computer data bases, books, statistics, organizational charts, organizational seminars and films, (Gummesson 1993). Existing materials provide the statistics about the specific behaviour of a specific product also provides the information about how a specific product has been used in a specific market under which complex environment. That enables a researcher to analyse the information according to his need or the problem he is dealing with, in a particular case. Action science on the other hand involves the researcher totally by making him an active participant influencing the process under observation (Gummesson 1993).

1.3. Research process

The thesis is actually the continuation of previous researches that have been carried out in different phases of time as shown in the figure below. AW-I (2011) paper and a project report that has been conducted for Sandvik Mining and Construction (SMC) Oy. (2011) correspond to the first phase, this phase was more generalized in terms of traceability in spare parts in order to generate after-sales business and the project report was specific to the hydraulic hose-assemblies in the mechanical industry.

Combining the concept used in the AW-I (2011) paper and data gathered in the project report, second paper AW-II (2012) was written as shown in the second phase of the figure below. Finally, based on the findings of AW-II (2012) paper this thesis has been written which corresponds to the third phase. This phase represents the importance of understanding profit potential of hydraulic hose-assemblies. Overall time-line and the activities those have been carried out by the researcher under the whole research plan, between December 2010 and February 2013 is shown in the figure below.

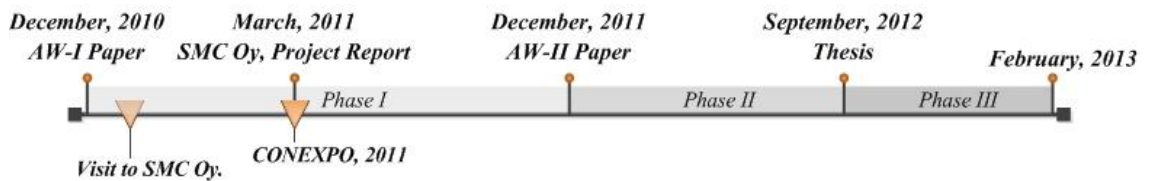


Figure 1. Research Process.

As shown in the figure above, the research process is based on three main phases. Activities carried out during each phase can be seen by 'Pin' and 'Triangular' milestones in the figure above. The whole action plan was started in December 2010, with the writing of AW-I paper. Sandvik Mining and Construction Oy., Tampere, Finland was being visited in the start of 2011 to meet the managers in order to get their insight and requirements for the project. Data gathering has been done at CONEXPO on March 22-26, 2011 at Las Vegas, Nevada, United States for the project report. Finally, the core results from AW-I, AW-II papers and the project report lead to the writing of this thesis.

1.4. Thesis structure

The thesis study provides deep understandings about the hydraulic hose-assembly related after-sales business. The structure of the thesis is based on six chapters which are developed in such a manner that in the first phase it provides the support of literature review by taking into account the concepts and theories beneficial for the later empirical phase.

Chapter one starts with the description of background needs and significance for the subject that why the subject is an interesting field to be studied and what could be the

expectations from the results? Furthermore the research methods chosen by the researcher to conduct the study have been discussed in detail. In the third section of the first chapter research process is being described by the researcher for instance the time taken by the researcher to complete this study, activities during the research period, data-gathering and milestones achieved during the whole research process.

Second and third chapters being part of the literature review provides researcher's understandings about the concepts of profit potential and value addition, significance of after-sales business and spare-part business complexities based on the theories already existed.

Fourth and fifth chapters represent the empirical portion of the thesis study which deals specifically with the hydraulic hose-assembly related after-sales business. Fourth chapter describes about the hose-assemblies in detail for instance manufacturing, complexities and the traditional after-sales processes for hose-assemblies. Fifth chapter represents the most important findings of the study for instance current market practices for providing support services, significance of traceability, marking needs and profit potentiality of the hose-assembly based after-sales business.

Sixth being the final chapter presents the conclusions for the study in which the researcher first has described the implications of the study then evaluated the results for the frameworks generated in the empirical section and finally defined the scope for the future research in the study area.

2. ENHANCING PROFIT POTENTIAL BY ADDING VALUE

The value-creating networks are the firms that come together to cooperate and differentiate themselves in order to create customer-value (Prabarkar and David 2001). According to Ulaga and Eggert (2006b), value-based prospective is an important factor to study differentiation in business relationships, this means that whether it is to enhance sales by providing certain benefits to the customer or it is to sink the customer's cost, differentiation must contribute to customer value. However, before finding the ways that how to develop strong and healthy relationships by creating value, it is important to first understand the sales and profit potential in the partnership or the market in which the company is seeking business.

2.1. Business Potential

Different markets offer different interesting opportunities for the companies' active in those markets but discovering such opportunities is not enough. Higher management want to know the estimated business potential of the opportunities (Lyly-Yrjanainen et al. 2009). According to Lyly-Yrjanainen et al. (2011), following simple analysis of sales and profit will help the managers to better understand the business potential for selling after-sales hose-assemblies.

A Finnish company (OEM) manufactures machines that have large number of hose-assemblies. Company is not selling hose-assemblies, although they have channels for after-sales for various other spare parts. However, with some simple assumptions, the after-sales potential can be estimated as follows:

- Annual sales 1500 machines
- One machine has 350 hose-assemblies
- Life time of a machine 10 years
- All hoses to be replaced in every 5 years

Based on this information, 3000 machines need hose-assemblies to be replaced every year. Now, assuming that the OEM is able to capture 50% market share of spare part hose-assemblies with average price of each assembly 50 Euros, the company can achieve the following after-sales revenue:

$$3000 \times 350 \times 0.50 = 525\,000 \text{ hose-assemblies}$$

$$525\,000 \times 50 = 26\,250\,000 \text{ Euros}$$

This shows the estimated revenue potential of 26 MEUR and enormous profit potential for after-sales hose-assemblies. Thus, it can be concluded now that selling after-sales hose-assemblies will provide the interesting potential for OEM. Lyly-Yrjanainen et al. (2011), also explained different methods to estimate the business potential in B2B, which are based on:

- Derived demand
- Customer's sales
- Customer's cost structure
- Customer's customer's volumes

The concept of derived demand has been used in business management for long now. One good example of derived demand is from the times of gold rush. At that time the demand for the search of gold stimulated the market but to do that there was the need of picks and axes (driving demand for related products) to mine the gold and it was noted that on an average the companies who were supplying picks and axes were more profitable than the mining companies. According to Lyly-Yrjanainen et al. (2011), estimation of the number of products being sold or service revenue generated by the customer provides an opportunity for the suppliers of related products to estimate their business potential. For instance if a car manufacturer is producing 20 000 cars annually, the supplier of the steering wheel can estimate the potential that there will be a market for 20 000 steering wheels as shown in the figure:

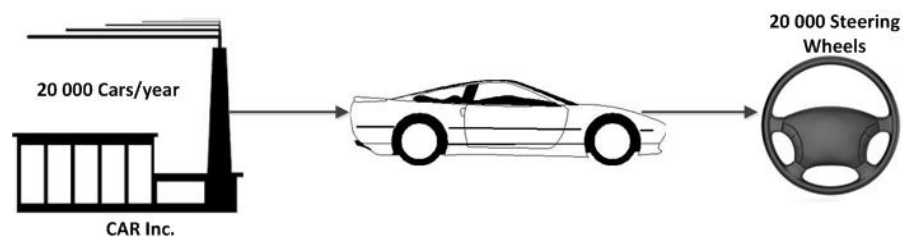


Figure 2. Estimation of business potential by derived demand (Source: Lyly-Yrjanainen et al., 2011).

Figure above shows the most simple scenario being presented but sometimes the product assortment makes it very difficult to estimate the business potential for the component suppliers for instance in heavy trucks manufacturing it would be much difficult for a tyre's manufacturer to estimate the exact demand because the exact tyres assortment by the OEM cannot be known (Lyly-Yrjanainen et al., 2011).

According to Lyly-Yrjanainen et al. (2011), to overcome the above mentioned problem of un-known assortment restraining to estimate the business potential, companies sometimes use publically available customer's revenue information as a tool to estimate business potential as shown in the figure below:

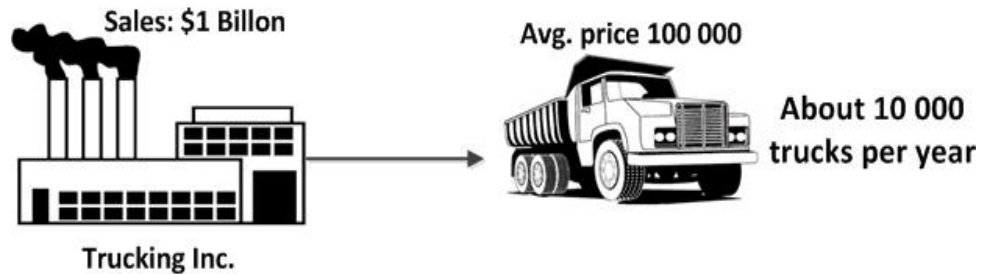


Figure 3. Estimation of business potential by customer's sales (Source: Lyly-Yrjanainen et al., 2011).

Figure above provides a very simple estimation that for instance if a truck manufacturer is showing its annual sales to one billion and the average price of one truck is 100 000 it means the OEM is producing 10 000 trucks that year. Now the challenge here is to estimate the average price and also one has to know the distribution of sales between different products. Also for companies producing wider range of products it becomes more difficult as different models need very different components (Lyly-Yrjanainen et al., 2011).

Business potential can also be estimated by customer's cost structure for instance if a company selling hydraulic components estimates that from the total sales of excavators, hydraulic components make 10% on average (Lyly-Yrjanainen et al., 2011). This is how sales potential can be estimated on the basis of customer's cost structure as shown in the figure below:

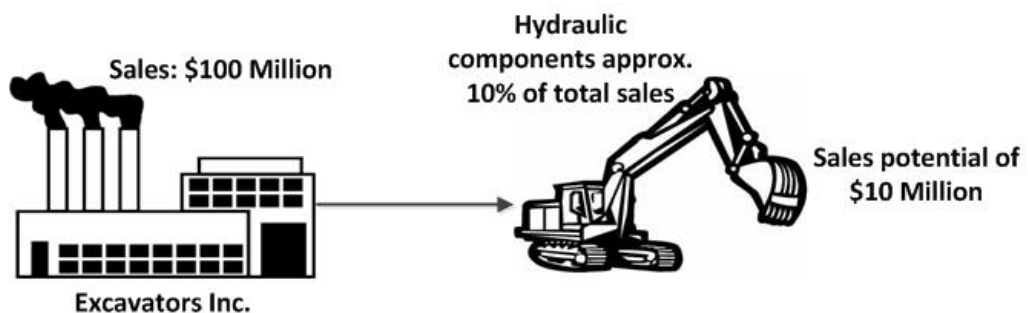


Figure 4. Estimation of business potential by customer's cost structure (Source: Lyly-Yrjanainen et al., 2011).

When the companies have very diverse product assortment then it becomes very challenging to estimate the sales potential of certain components.

To understand the business potential by customer's customer's volume in a certain market Lyly-Yrjanainen et al. (2011) presented an example of a company 'Marken Inc.' making machines that are used to cut the hoses, companies making hose-assemblies are its customers. Marken Inc. is willing to explore Finnish market but to estimate their machines sales in Finnish market is not an easy task. Marken needs to know the sales volume of the hose-assembly manufactures in Finland but this information is rather classified. Now in this situation it is necessary for Marken to estimate the sales of major OEMs using hose-assemblies in Finland.

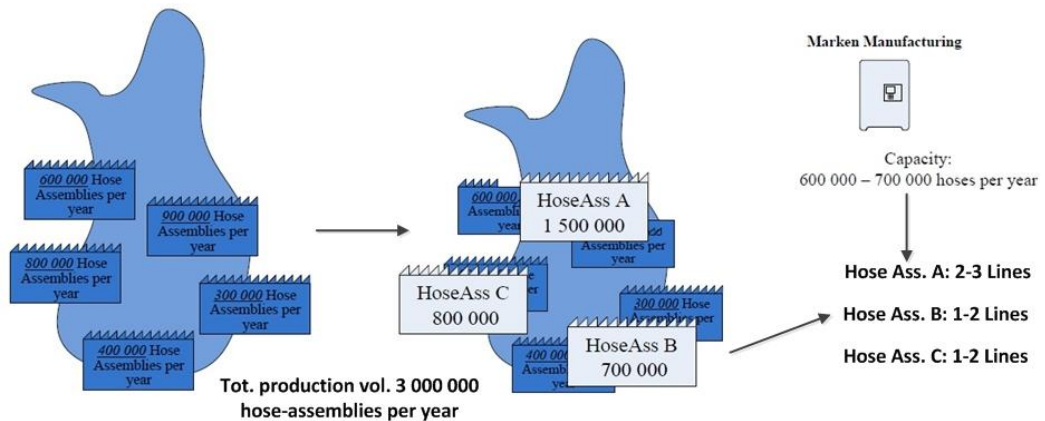


Figure 5. Estimation of business potential by customer's customer's volume (Source: Lyly-Yrjanainen et al., 2011).

As shown in the figure above five major OEMs combined use 3 000 000 hose assemblies and in industries people use to know that who supplies to who, in this way it is possible to estimate the sales of different hose-assembly manufacturers and finally the machines sales potential of Marken Inc. in Finland.

Until the sales have been made and realized, the sales potential no matter estimated correctly or not remain potential. Estimating the business potential is not an easy task and that is why the tools to estimate business potential which has been discussed above are not enough. It is also important to consider other important factors when analyzing business opportunities and their potential for instance competitiveness of the market, micro and macro environment etc. (Lyly-Yrjanainen et al., 2011).

2.2. Relationship value

Partners in a business relationship need to access the value that has been created by their alliance versus alternatives (Borys and Jemison 1989). To understand the concept of value-creation in a strategic alliance, at first a very basic question has to be answered that is: what is value (David and Swati 1993)? Following section deals with the study of this issue. According to Lawrence Miles (1961), value can be used in variety of ways and mostly it is confused with cost and price. Depending upon the time, place and use

the same item may have different value to the customer also value to the OEM is different from the value to the customer.

All parties involved expect to gain value in the exchange and that is why market exchanges take place. Therefore, *value has always been the essential basis for all marketing activities* (Holbrook, 1994). Value, core capabilities of the firm and relationships together affect the complete value-chain for any product or services (Prabarkar and David 2001). Measuring value is a difficult task because it depends on multiple dimensions at the same time. These dimensions can be social, economic, political, psychological, religious and environmental surrounding the concerned individual (Lawrence Miles 1961). The process of value creation and what exactly meant by value is still confusing in many aspects surrounding it (Barney 2001).

2.2.1. Supplier relationship value

Value-creating activities of the suppliers should increase buyer's sales and profit (Simpson et al., 2001). As mention in the previous section, suppliers are the source of essential UVs for the OEMs. Therefore, it is vital that both the parties will come out of the traditional relationship and contribute to add value to the final offerings to the customer. Core-capabilities, superior customer value and relationships are the vital factors for value-creating networks (Prabarkar and David 2001). Business market is appreciating a growing trend in order to achieve profitable results and competitive advantage for the companies which are cooperating to build value in their relationships (Hewitt et al., 2002; Jap 1999; Lyons et al. 1990). From the buyer's perspective, there is always a need to decide when to invest in a specific supplier relationship, when to improve and maintain with the existing ones and when to get rid-of the disappointing suppliers (Prabarkar and David 2001).

According to Eggert & Ulaga (2002), for the development of reliable and valid assessment tools the measurement of value creation in buyer-supplier relationships is still in its early stage, and a clear understanding of the concept is an essential requirement. In the field of marketing *exchange* has now been adapted as the core-concept (Bagozzi 1975; Hunt 1991). Most research on customer perceived value is related to product-features and neglecting the relational dimension of the concept (Dwyer and Tanner, 2002; Parasuraman and Grewal, 2000). Payne and Holt (1999) state that the most recent development has been to consider customer value from the viewpoint of 'relationship value'.

Wilson and Jantrania (1995) developed a three dimensional categorization of the industrial buyer-supplier relationship: economic, strategic and behavioral value. In order to understand the concept more deeply it is essential to first understand the vital factors which are actually responsible to drive the relationship value. Ulaga W. (2003) described

the eight factors or drivers of value creation in manufacturer-supplier relationship as shown in the figure below:



Figure 6. Relationship value drivers (Source: W. Ulaga, 2003).

Product performance, product reliability and product consistency over time are the key aspects. Product quality can be defined as a key driver for the relationship value for instance to what extent product of the supplier meets the specifications and standards of buyer.

Service support includes all the activities required to make the product in active-use throughout the whole life of the product. It can be regarded as the second key driver of relationship value. Supplier can create more value by providing services in two main areas for instance customer information and outsourcing of activities as additional services with product related services.

Delivery performance is the third driver in B2B relationships which shows that supplier must be responsible to meet all delivery schedules (on time delivery). Flexibility (ability to meet the changes in delivery schedule) and accuracy in delivery are the two vital factors.

Supplier know-how is the fourth key driver of the relationship value. Suppliers can have specific knowledge or capability, which customer's organization may lack and represents an opportunity to present the customer with new sourcing alternatives. Supplier with the know-how can add some value by assisting the buyer to improve the functionality and cost of current and new products and processes.

Time to market is the fifth key driver that represents an opportunity to create value through supplier's capability by reducing time-to-market in B2B relationship: for instance supplier can add value by offering its contribution in speeding-up the paper work, proto-type development, product testing and validation.

Personal Interaction is the sixth key driver that can offer its value as it represents better communication, makes problem solving more effective and efficient, and as a most important benefit it provides an improved understanding of each partner's goals in the relationship.

Price is the key driver that contains significance importance for both suppliers and buyers. The ability of supplier to contribute in a joint cost reduction programs with the buyer can add significant value to the relationship. Price is one of most strategic factors contributing in the relationship supplier's product can be priced low, high or at competition.

Process Costs shows that taking cost out of the business relationship is another successful way of adding value. Major areas including direct costs, acquisition costs and operations cost are order handling costs, inventory costs, cost of incoming inspections, downtime cost, warranty costs etc. But most of the time companies due to lack of sufficient measurement system find it difficult to differentiate between these costs.

Evaluation of potential partners is very important according to Prabarkar and David 2001, two things are essential for an ideal partner: partner who can add significant value to the products offerings and partner who at the same time presents low risk. Risk associated with the underperforming partner involves quality, JIT activities, cooperation etc. that impact the partnership. Figure below represents a 2x2 matrix that represents the degree of operating risk in working with a partner from high to low and the value contribution from high to low.

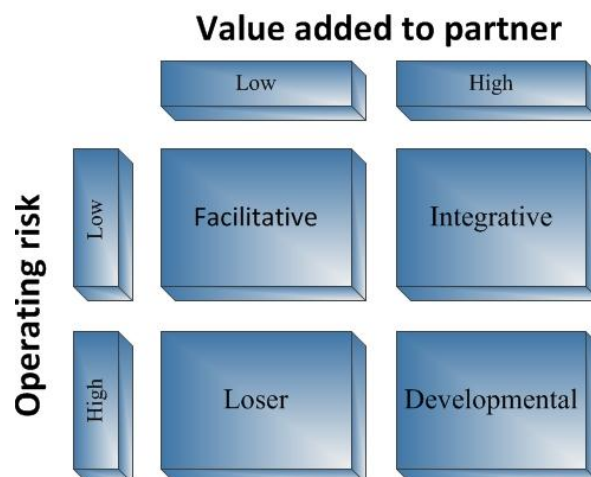


Figure 7. Evaluation of potential partner (Source: Prabarkar and David 2001).

These relationships represent low risks but low value at the same time. Facilitative relationships do not involve core technologies or parts of product offering but still involve the outsourcing of important aspects that keep the firm operating for instance outsourcing of MIS, computer systems, printing services etc.

Integrative relationships are the indicator of the most important partners as they contribute to current and future product offering's design and development for instance a firm providing electronic system to ABS braking system in vehicles. This type of relationships requires deeply involved working from both sides.

Loser represent relationships represent partners which are difficult to work with and add no value to the relationship. Finally developmental partners represent certain firms from which a firm can select some partners. For the development of their ability to become a low risk partner so that they will be able to provide or add value in return.

2.2.2. Firm's role in creating value:

Above table provides the basic meaning of value to understand the concept but as mentioned above that the term value means different to differ people in different conditions. According to Bowman and Ambrosini (2010), following questions will be helpful to understand the concept on a broader but focused frame:

- What is value-creation?
- What does it mean to different stakeholders in a firm?
- What are the factors that sustained value-creation process over time?
- What are the "Value-destruction" factors?

To understand and answer the above questions terms defined in Table 2, should have to be considered:

Table 1. Terminologies in the concept of value.

Terminologies	Definition (Bowman and Ambrosini, 2010)
Use Value (UV)	<i>"Properties of products and services that provide utility".</i>
Exchange Value (EV)	<i>"A monetary amount exchanged between the firm and its customers or suppliers when UVs are traded".</i>
Value-destruction	<i>"Activities related to unproductive elements intertwined with their valuable elements".</i>

Based on Bowman and Ambrosini (2010) model, consider a firm in the role of a customer to gain UVs and supplier to provide UVs. While performing these roles certain

activities will get performed by the firm to show its motivation, five types of activity can be identified:

- Activities capturing EV from customers
- Activities capturing UV from suppliers
- Activities to sustain in certain environment
- Activities to maintenance the capital stock
- Activities that destroys value

First Two types will affect the value creation process. The three other categories due to their negative effect on the current revenue flow will be having no compensating positive impact on the current investor returns. Figure below shows the above understandings in a more appropriate manner:

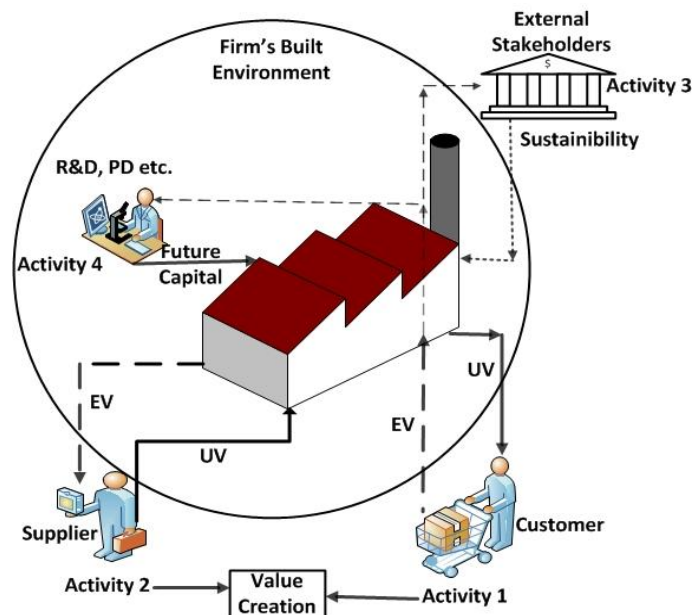


Figure 8. Flow of UV and EV (Adapted from Bowman and Ambrosini, 2010).

Figure above shows that Activity 1 is the most important and desirable activity that is based on the activities that captures EV. These activities are involved in the production and sale of the products and services for instance inbound and outbound logistics, sales and services. *Profit seeking firms will seek to optimize the sum of EV captured for a given amount of UV supplied (Bowman and Ambrosini, 2010).* Activity 2 is based on the activities that capture UV for instance procurement, process engineering, and supervision. *Profit seeking firms will optimize the amount of UV captured for a given sum of EV (Bowman and Ambrosini, 2010).*

Activity 3 is the activities which are vital for the sustainability of the firm in a certain environment. They do not contribute to the current or future profits but necessary to conduct the business for instance they could be a certain cost needed to gain a license to

be allowed to trade in a particular industry or market Activity 4 is the activities which capture a certain part of current EV captured by the customers to produce future capital for instance R&D, PD, trainings etc. *Expenditure on capital stock creating activities is vulnerable to short-term pressures to cut costs (Bowman and Ambrosini, 2010)*. Final activity is the one that destroy current value, these activities have no contribution to all the other activities mentioned above these are basically the inefficiencies caused by poor management *Profit seeking firms will seek to eliminate value destroying activities (Bowman and Ambrosini, 2010)*.

Bowman and Ambrosini (2010) argued that humans are the actual creator of value. In order to understand their argumentation example of a mine (Lippman and Rumelt, 2003a; Bowman and Ambrosini, 2010) possess a great significance. A mine as a piece of land creates no value, it has UV, but it cannot create more UV. Also, mine as a piece of land is unable to receive payments or rewards. Efforts of miners and prospectors are actually responsible for making it a valuable land and this value is created by humans. So if some mining company build its operations at the mine and the owner of the mine will become the sole stakeholder, the owner will receive its dividends but he will not be the part of the value-chain, value will be created by the miners and other worker and these worker must get less EV to the UV that they will create in order to enable stakeholders to get their share. Thus, UVs are the actual source of EVs that have been created by the inputs of the humans to the productive process or the operations, at the same time some people or authorities are able to capture a certain value without even contributing in creating it.

2.2.3. Value offering to customers

According to Kotler and Armstrong (1997), determining the needs and wants of the target market and satisfying these needs and wants better than their competitors plays a vital role for an organization to achieve its goals. This is the basic concept that needs to be understood before customer value (Prabakar and David, 2001). Before entering any further into the concept there exit a need for the definition of customer value.

Table 2. Definitions of customer value.

Definition	Authors
<i>Customer value is the evaluation of characteristics (such as various benefits, costs, availability or associability) of a product by the customer which influences his decision to purchase the product.</i>	(Anderson et al. 2007, Holbrook 1998, Smith and Colgate 2007)
<i>Customer value in business markets is the worth in monetary terms of the technical, economic, service and social benefits a customer company receives in exchange for the price it pays for a market offering.</i>	(Anderson and Naurus, 1998)

<i>Total customer value is the monetary value of all the benefits provided by a product.</i>	(Lyly-Yrjanainen et al. 2009)
<i>Total worth of the benefits received for the price paid.</i>	(Zeithaml, Valarie A., 1998)

Above definitions suggest that it is vital for any model of total value that it must consider both benefits that add value to the relationship and costs that offsets the value added, these factors can easily be measured in case of direct cost and benefits but nearly not possible to get measured in a virtual presence (Simpson et al., 2001). According to Lyly-Yrjanainen et al. (2009), expectations to get economic, functional and psychological benefits lead the customer to purchase goods and services. Figure below represent this concept by taking an example of purchasing a car:

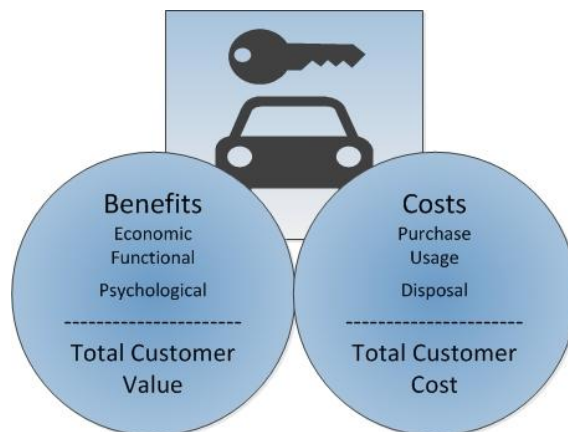


Figure 9. Total Customer Value and total customer cost of a product (Adapted from Lyly-Yrjanainen et al. 2009).

Figure above shows that for a certain purchase of a car there exists certain benefits and cost. The monetary value of all the benefits creates '*total customer value*' for instance the benefits of fuel economy (economic), more reliability (functional), and improvement in social status (psychological). Likewise the sum of all the costs that customer have to bear makes the '*total customer costs*' for instance price of the car (purchase price), insurance and maintenance (Usage), and getting rid-off (disposal). In addition to the above concepts there is another important concept that is '*perceived value*':

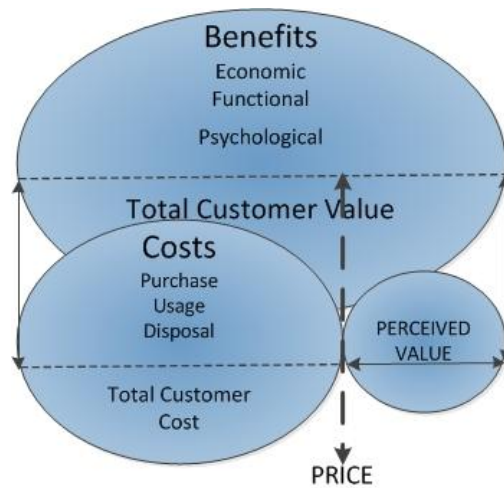


Figure 10. Perceived customer value (Adapted from Lyly-Yrjanainen et al. 2009).

As shown in the figure above customer perceived value is the difference between the total customer value and the total costs. Customer perceived value is actually the value which company provides to its customers as incentives to encourage them for the purchase (Lyly-Yrjanainen et al., 2009). To understand the profit and perceived value provided to the customer Lyly-Yrjanainen et al. (2009) argues that price plays an important and strategic role in order to get a healthy and reasonable profit without compromising the perceived value. Figure below illustrates the fact:

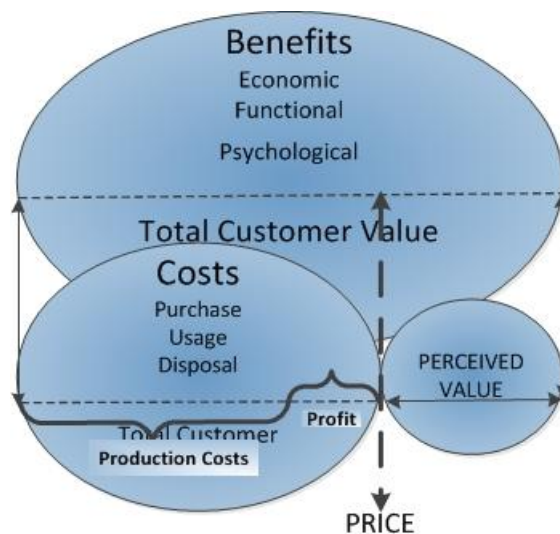


Figure 11. Perceived customer value and profit (Adapted from Lyly-Yrjanainen et al. 2009).

Figure above shows that the profit and perceived value both keep strategic importance for the company and price is the deciding factor. Too much price and less perceived value to the customer represent low motivation for the customer to buy the product. Too low price will result in a very low profit or even loss in case the price is below the production costs, in any case the stakeholder will not be satisfied. This suggests that the prices should be somewhere between the total customer value and production costs the

essentiality is to *provide more perceived value to the customer to harness additional sales* (Lyly-Yrjanainen et al., 2009).

According to Eggert and Ulaga (2002) customer satisfaction and perceived value are complimenting factors for each other. Most of the models defining and explaining customer satisfaction suggest that satisfaction is a post-purchase concept while customer perceived value is a concept that is independent of the timing for the product to be used and it can be both the pre- or post-purchase concept (Woodruff and Gardial, 1996). Main differences between the two concepts have been shown in the below table:

Table 3. Definitions of value (Andreas Eggert and Wolfgang Ulaga, 2002).

Customer Satisfaction	Customer Perceived Value
Affective concept	Cognitive concept
Post-purchase outlook	Pre- or Post-purchase outlook
Supplier's products or services	Supplier's and competitor's product and services
Tactical Positioning	Strategic Positioning
Present Customers	Present and future's pot. customers

In the above table it has been argued that customer satisfaction and customer perceived value both are complimenting yet different concepts pointing in different directions. Customer satisfaction provides no benchmarking of the current products to the competitors while customer perceived value measurement on the other hand explicitly benchmarks the products with competition. Customer satisfaction can be used as a strong predictor from customer behavioral point of view and customer perceived value is a complement and cannot be used as a substitute for customer satisfaction but for *enhancing future and present sales potential* (Eggert and Ulaga, 2002).

Through the knowledge residing in customers CKM provides benefits for both the customers and corporate by gaining, sharing and expanding the knowledge. Knowledge Management (KM) plays a vital role that knowledge is considered to be a key resource of value creation in companies but this knowledge has been shared in a typical manner among the employees or between companies (Davenport and Prusak, 1998; Bardaracco, 1991). CKM may seem to be just another name of Customer Relationship Management (CRM) at the first glance but there is a significant difference between the mind-sets of customer knowledge managers based on number of key variables as shown in the below table (Gibbert, M. et al. 2002).

Table 4. CKM vs. CRM (Source: Gibbert, M. et al. 2002).

	CKM	CRM
Knowledge Base	Customer experience, creativity and (dis)satisfaction with products or services.	Customer database.
Objectives	Collaboration with customers for joint value creation.	Maintaining and developing customer base for company.
Benefits	Customer success and organizational learning.	Customer retention.
Recipient of incentives	Customer.	Customer.
Customer's role	Active partner in value-creation process.	Captive and tied to product or service by loyalty scheme.
Corporate's role	Releasing customer from passive recipients of products to active co-creators of value.	Build lasting relationship with customers.

Above table clearly shows that CKM and CRM are two different strategies which aim in different dimension to obtain different objectives and benefits. It is clear from the above table that customer knowledge managers focus on knowledge from the customers that resides in them rather than gaining knowledge about the customers. One decent example of CKM is 'Amazon.com'. Amazon's way of motivating customers to share their knowledge is an extraordinary achievement (Gibbert, M. et al. 2002). CKM has changed the traditional thinking acquired by KM and CRM to view customers as a knowledge entity, CKM enables the managers to cooperate with the customers in order to create value to their products or services. According to Gibbert, M. et al. (2002), as shown in the below table CKM and its application can be explained by five styles that how companies manage customer knowledge and use it to create value.

Table 5. Five styles of CKM (Source: Gibbert, M. et al. 2002).

Characteristic	Prosumerism	Team-based Co-learning	Mutual Innovation	Communities of creation	Joint intellectual property
Focus	Developing tangible assets and benefits	Creating corporate social capital	Creating new products and processes	Mission specific professional expertise	Tangible customer IP sharing
Examples	IKEA	Amazon,	Ryder	Microsoft	Skandia
Intensity of interaction	Rel. low	Low to high	Rel. low	Rel. high	Rel. high
knowledge	More explicit	Explicit and tactic	More tactic	More tactic	More explicit

Above table explains that five styles could be prosumerism, group learning, mutual innovation, communities of creativity and joint intellectual property capital and depending upon the nature of the customer any company can apply these five styles simultaneously. Five styles mentioned above differ in the intensity of value creation and value sharing mechanism (Gibbert, M. et al. 2002).

2.3. Value-packaged enhanced Sales

Firms, who generate the knowledge and capability to actually assess value, enjoy enhanced returns against the value they deliver to the customers (Anderson and Narus, 1999). In the businesses where the knowledge of value is considered critical, it becomes difficult for the companies to even understand their own offerings and the ways to enhance them in order to provide enhanced value to their industrial customers. OEMs therefore need to understand how an enhanced value can be delivered to the customer to gain enhanced returns in a competitive environment (Lichtenthal et al., 1997). Based on the literature in the previous sections of this chapter, figure below provides a way to develop a value package for the customer in order to gain enhanced sales and profit.

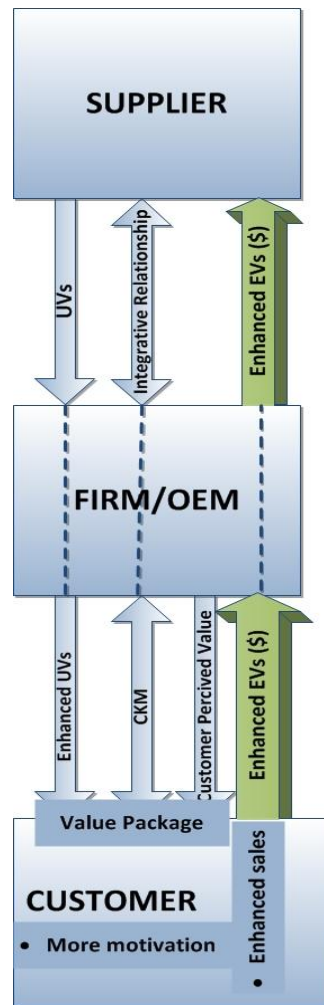


Figure 12. Generating a value package to enhance sales and profit.

As shown in the figure above and based on the literature in the previous sections, OEMs need to find out ways to enhance their profit potential by providing a complete value package that ultimately will be transferred to the customers not just to facilitate them but to increase the sales.

Firms are supposed to develop integrative (Prabarkar and David, 2001) relationships with the suppliers, whether it would be a component supplier or a third party service provider in the after-market Tore and Uday (2003) argue that customer satisfaction and enhanced motivation cannot just be achieved by the value and performance of the product purchased rather it depends on the interaction's and relationship's quality and by the total value received during the whole service life of the product.

In order to enable them to provide certain UVs to the OEMs, these UVs then can be enhanced by the OEMs contributions in it along with CKM and certain perceived value to be transferred to the customers in the form of a value package. In this way OEMs can generate valuable strategies to harness huge sales and profitability in the complex and competitive markets.

3. AFTER-SALES BUSINESS AS A CORPORATE STRATEGY

After-sales support is one area that offers potential opportunities to earn high profit margins and attaining sustained competitive advantage. Operational improvements in traditional areas are now competitive necessities rather than bases of competitive advantage. Following sections of this chapter deal with the concepts of developing after-sales business.

3.1. After-market services

According to Lay et al. (2002), OEMs can earn the highest potential margins by competing through services rather than several strategic options for instance innovation, product quality and technology. Increasing labor dependence and their intangibility enable OEMs to achieve more sustainable competitive advantages (Simon, 1993). A high installed based product with longer life cycle represents significant revenue (Potts, 1988).

After sales service operations can be diabolically complex, requiring collaboration and integration between many different business units, IT systems, and processes. Another significant barrier is the difficulty of obtaining accurate information from key sources. To overcome these challenges and optimize after sales service, the company must align its operational processes and systems across the entire service network. Figure below seems funny but presents an interesting concept related to after-sales.



Figure 13. Significance of after-sales business opportunities (Source: Ros Asquith).

A nice cartoon has been shown by Ros Asquith in figure above, which illustrates an increasingly common business model: selling something very cheap (or give it away for free), and then make money on after-sales services such as customer support and maintenance.

Maintenance and services provided for the installed base generally represents higher profit margins than products (Anderson et al., 1997: VDMA 1998). Most OEMs have yet not succeeded to achieve their desired objectives in growth of service revenue because of higher or increasing costs and lack of corresponding returns also decreasing profit margins and overall profitability is pushing OEMs to seek the best possible ways in order to enhance their service revenue (Gebauer, et al., 2006).

As it can be seen in figure below, more than thirty five percent of the companies generate less than ten percent of revenue through their services and only eleven percent of the companies are generating forty percent of their revenue through services. This shows the significant importance of yet to be conquered territory of potential profit margin for the OEMs.

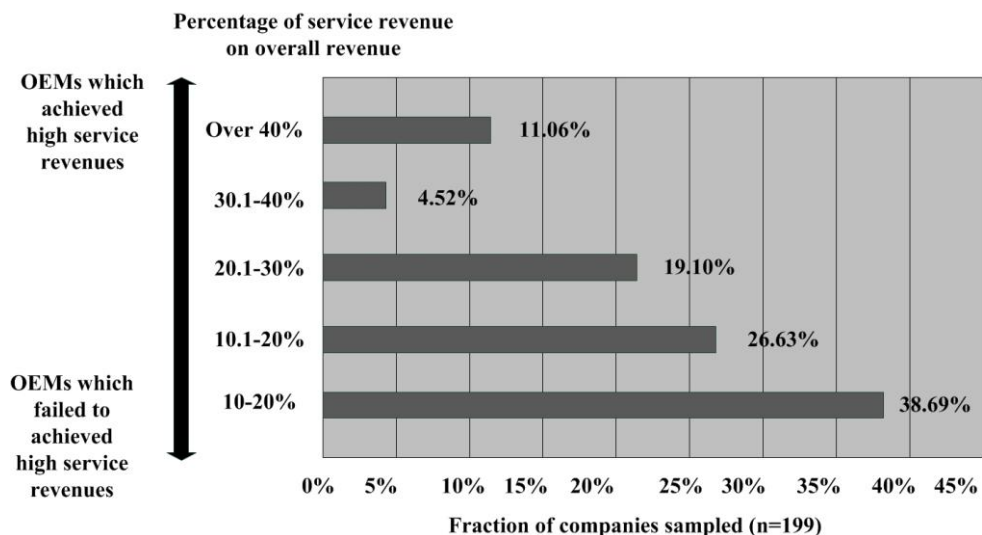


Figure 14. Service Revenue in Manufacturing Companies (Gebauer, et al., 2006).

The survey was mainly based on the Swiss and German machinery and equipment manufacturing industries. From the total of one hundred and ninety nine responses the share of service revenue as a proportion of overall revenue has been presented in the figure above. The most important areas of action are utilization of after-sales opportunities by downstream businesses like spare parts, service and maintenance. In many instances, after-sales are not realized as a separate business. Consequently, it is not supported, operated, and managed by the appropriate (global) processes. By implementing the appropriate downstream business designs, it is possible to achieve higher profit margins and customer satisfaction.

According to Timothy L. Wilson (1999), for any company there are four factors which are associated with the specific after-sales system as shown in the figure below.

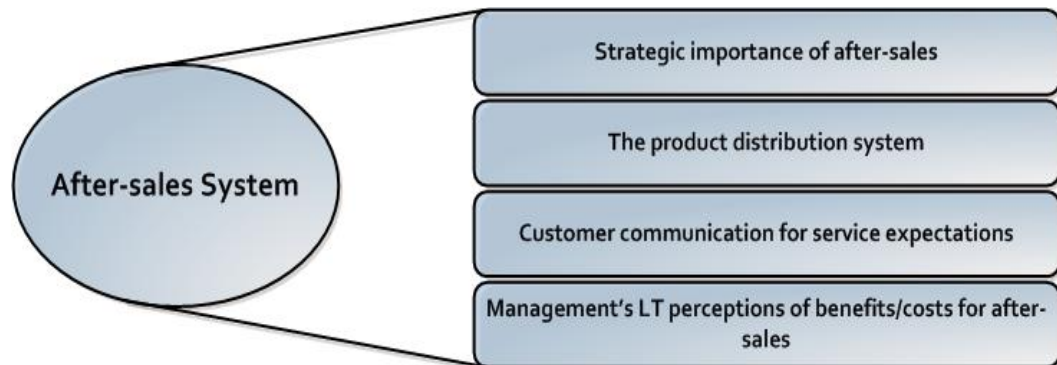


Figure 15. Factors associated with the after-sales system for any company (Source: Timothy L. Wilson, 1999).

Porter (1980) and Levitt (1983) describe the *strategic importance of after-sales* as a vital factor to achieve differentiation in a competitive environment because of the customer's expectations for installation services, application aids, post purchase repair and maintenance, parts and vendor R&D support. Narus and Anderson (1996) further suggested that for the firm to be 'winners' in their market, they need to best link the manufacturing, service and distribution functions to meet customer needs.

According to Shostack (1977) and Donnelly (1976) one obvious source of creating difference is in *distribution*. Distribution of products and services when coupled are assumed to be the same. Manufacturer and distributor interactions are being described as 'working partnerships' in which 'relative dependency' and 'coordinating efforts' are vital. In this way, coordination and dependency both are the useful sources of finding an approach to dealing with service (Anderson and Narus, 1990).

Timothy L. Wilson (1999) suggests that seller has to fulfill certain *customer's expectations* with regard to services. For instance, for the customer's own comfort certain communication patterns and means will be used or can be demanded while sellers will be having their own sensitivities, activity pattern and policies for responding to the requests. In this way after-sales require detailed communications with distributors, third parties and end users which must involve transmission of intellectual properties and formal and informal interactions (Timothy L. Wilson, 1999).

Timothy L. Wilson (1999) in his paper argues that firm's policies surely get affected by management's perception of benefits by supplying after-sales services and managers for sure make evaluation on the basis of perceptions. There always exists a link between profitability, service quality, customer loyalty, customer satisfaction and productivity in a new 'service paradigm' (Heskett et al., 1994).

According to Levitt (1983) continuous persistence and sustainability are the vital factors for a healthy relationship throughout the process and the process never ends when the sale is actually done. Below table gives a very interesting comparison between seller's and buyer's behavior and expectations throughout the sales process.

Table 6. Throughout the process (Source: Levitt, 1983).

Stage of sales	Seller	Buyer
Before	Real Hope	Vague need
Romance	Hot and Heavy	Testing and hopeful
Sale	Fantasy: bed	Fantasy: board
After	Look elsewhere for next sale	“You don't care”
Long after	Indifferent	“Can't this be made better”
Next sale	“How about a new one?”	“Really?”

Customer relationship is not a onetime phenomenon that when the sale is over, it's over. Rather this based on a series of specific services before the deal, during the deal and after the deal (Larissa, 1994). In the frame of references following figure shows the necessity and effectiveness of after-sales.

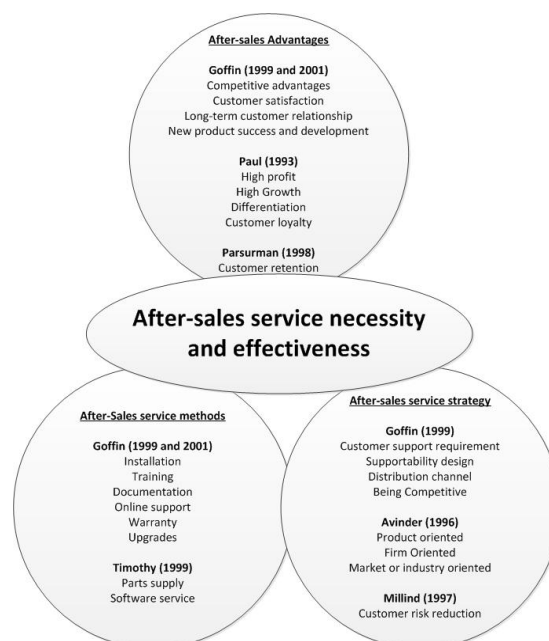


Figure 16. Literature references for after-sales service necessity and effectiveness (Source: Farzin and Shahla, 2006).

Figure above shows the supportive literature that after-sale services presently are considered as necessities with certain advantages that can be used effectively by implementing certain methods and strategies.

Farzin and Shahla (2006) argue that according to Goffin (2001), Customer retention is one of the added advantages if right and efficient after-sales services would be provided. Aligning the whole organization and developing a service oriented culture is becoming an increasing trend among the companies presently in order to deliver excellent services to the customers. Because the service oriented companies have realized that this investment will return in terms of enhanced profit, competitive advantage and customer retention (Jennifer potter, 1994). After-sales services or loyal customer support can prove to be a valuable tool because:

- It can be a vital source for revenue generation.
- An essential tool to maintain long-term relationships and achieving customer satisfaction.
- It can be an advantageous tool for differentiation and competitive advantage.
- It can help new products to increase their success rate.
- Better product development, as a better design can claim more efficient and cost effective customer support.

In addition, Avinder (1996) provided different ways to offer after-sales services based on the product's nature for most of the OEMs.

- On-site
- Service centers
- Channel intermediaries
- Third-party services
- Combination of above mentioned

OEMs mostly prefer to use either the first or second method mentioned above. It is common concept that intermediary has only got the responsibility of selling product in the local market and after-sales activities must be handled by OEMs which is not an effective way. In the same way foreign customers turns out to get betrayed by not receiving effective services from their suppliers and the importer in the host country is supposed to be responsible (Paul, 1993).

In order to build customer loyalty and repeat business, after-sale services must be an important aspect of a company's marketing mix. Whether in B2B or B2C buyers today are demanding higher levels of after-sales services and in order to meet these higher levels of expectations, advanced and up to the minute after-sales strategies are required (Farzin and Shahla, 2006).

3.2. Spare-part business

Spare-parts in U.S. alone represent a huge market of \$700 billion that is 8% of the U.S. GDP, according to the U.S. Bancorp. Achieving high profitability and customer loyalty in spare-part business is not an easy task for OEMs because of the various factors such as demand unpredictability, inventory control, and strategic distribution for rapid response etc. (Kumar, 2004).

3.2.1. Spare-parts and production-parts

According to Anon (1996; 1999) spare-part industry represents huge figures for instance aircraft industry consumes \$7 billion in a year in spare-parts to maintain Boeing airplanes alone. More than one million transactions were handled by the Boeing's part side in 1998 which shows 9500 transactions each day. Also for a typical manufacturer, a few years ago, the spare-part inventory ranged from \$2 to \$10 million which now have risen to \$5 to \$15million. In Europe and South America, TNT Post Group operates more than 3 million square feet of ware house space to handle about 120,000 tons of shipments and processes more than 34 million order lines in a year on the behalf of Fiat (J. G. Parker, 1999). Figure above represents spare-part business as a huge a profitable business, although there exists no reliable data but a common believe is that spare-part create one-third of net sales and two-third of profit (Suomala et al., 2002).

Before discussing further about the importance of spare-part business and its impact, defining the term "Spare-part" and creating a common understanding would be a better idea.

Spare-parts refers to the part requirements for keeping owned equipment in healthy operating condition by meeting repair and replacement needs imposed by breakdown, preventive and predictive maintenance (Kumar, 2004).

Above understanding shows that spare-parts cannot be treated in the same manner as production parts because of the difference in need, demand and supply channels. Therefore in order to manage spare-parts there is a need for some strategic actions as follows:

- Identification
- Requirement forecasting
- Inventory analysis
- Categorizing
- Replacement policies
- Inspection
- Reconditioning
- Product data management

Above strategic actions seem to be somewhat similar for both the categories of parts. But when it comes to supply chain for production and spare-parts there exists a significant difference as shown in the below table.

Table 7. Production and spare-parts SC (Source: Harvard Bus. Rev., 2006).

Parameter	Production-parts (SC)	Spare-part (SC)
Nature of demand	Predictable	Always unpredictable
Response required	Standard	Same or next day
No. of SKUs	Limited	15 to 20 times more
Product portfolio	Largely homogenous	Always heterogeneous
Delivery Network	Multiple networks necessary	Single network most of the times
Inventory Mgmt. Aim	Max. velocity of resources	Pre-position resources
Reverse logistics	Doesn't handle	Handles returns, repair and disposal of failed parts
Performance Metric	Fill rate	Uptime product availability
Inventory turns	6 to 50 a year	1 to 4 a year

Apart of the differences between spare part and production parts there is another sub category in parts which needs to be distinguished from the spare-parts and that is "Wear-parts". According to Suomala et al. (2002), depending on the types of order spare-parts can be divided into two main categories: normal and emergency. Normal orders are those which arise from the scheduled maintenance activities and emergency orders are for the certain emergency parts that customer might need out of the scheduled routines. Based on the order type the items can be divided into two main categories: spare-parts and wear-parts. In wear-parts normally it is much easier to estimate the sales volumes as compared to spare-parts. Additionally, the volume of wear-parts is typically much higher (Suomala et al., 2002).

The criticality of spare-part business and its service operations have not been completely understood by most of the OEMs. As the products are being sold globally by the companies in the same way the spare-parts must also be available world-wide (Suomala et al., 2002). These needs and business trends are forcing OEMs towards global operations across sourcing, manufacturing, sales and after-sales service (Kumar, 2004).

3.2.2. Spare-part management (SPM)

According to Marcello et al. (2004) maintenance strategies adopted, costs of lost production, inventory limitations and the logistics of spare-part must be taken into criterion, while analysing the complexity in spare-part management. When a breakdown occur rapid availability of spare-parts is among the major factors leading to a reduced downtime (Marcello et al., 2004). In order to avoid costly shutdowns and downtimes, spare-parts must be available when needed. This type of scenario usually represents failure maintenance which involves high costs, high criticality and random failures but typically generates low volumes as compared to preventive maintenance. In contrast to the failure maintenance, preventive maintenance generates a high demand for spare-parts at a known point of time (Timothy S., 2005).

Spare-part management (SPM) mainly consists of four main operations including (Suomala et al., 2002):

- Sales and delivery
- Purchasing
- Warehousing
- Product data management

Enhancing sales to earn high profit margins, delivery criticality, strategic purchasing, inventory challenges and efficient data management for effective communication all play a vital role in SPM. In context with the above mentioned operations, following figure represent an over-all approach towards SPM.

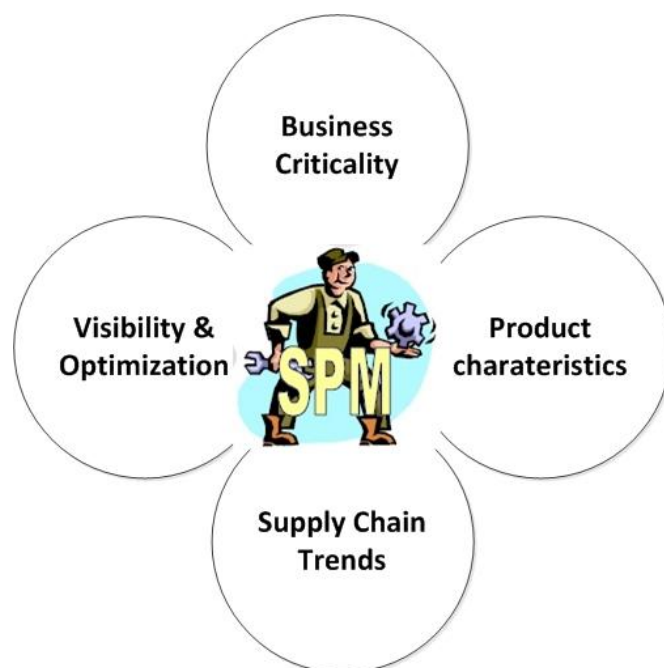


Figure 17. Business needs on spare-parts management (Source: Kumar, 2004).

Business Criticality represents challenges which the service maintenance managers have to face, lowering operation's cost and enhancing service levels at the same time is the most important and critical. Business criticality in spare-parts consists on following:

- Budgetary constraints
- Higher service levels
- Contractual obligations

Higher customer expectations and awareness of rights are constantly calling for the better utilization of resources and quality service response (Kumar, 2004).

Visibility and optimization shows that in after-sales service management of spare-parts, in order to maintain multi-category inventory optimization on inventory is required based on need and service response. Following factors shows the essence for visibility and optimization in spare-parts.

- Global spare-part inventory view
- Optimized deployment across the maintenance service network
- Higher customer visibility and availability to promise

Taking a global view of inventories in order to forecast spare-part's demand that is truly based on statically significant data is very important for the controlled positioning of spare-parts inventory across several locations (Kumar, 2004).

Supply chain trends shows that managing the varying service needs is a tough challenge especially for the availability of the spare-part and repair services. Following are the emerging trends in supply chain for these services.

- Outsourcing
- Integration/Collaboration

Outsourcing the third party services to manage service needs is becoming increasingly popular within OEMs today. But to get the maximum advantage operational planning process is required to be closely integrated with maintenance and service planning functions (Kumar, 2004).

Product Characteristics shows that standardization of parts is ideally important to cope-up with the criticalities in service and maintenance business but practically it is not possible to standardize all the parts. Following points show the criticality in terms of product characteristics.

- Part rationalization
- Shorter product life cycles
- Higher obsolescence

In earthmoving industry, OEMs are trying to use same standard set of accessories to manufacture all bulldozers as a rationalization step. But even in the same product category higher availability of different models make it difficult for the OEMs to standardize parts (Kumar, 2004).

3.2.3. Effect of customization on spare-part business

According to Simon and Dolan (1998), in many cases customization provides better services and increased customer value in order to gain high returns on investments. When a company adopts the strategy of customizing its product or a service, it generates a better knowledge about the preferences of customer which in longer prospects helps the company to conduct repeat sales and sustained competitive advantage (Hakansson, 1982). Customization can be defined as:

“Slight variations of standard configurations and are typically developed in response to a specific order by a customer” (Ulrich and Eppinger, 1982)

A huge research has been conducted on customization with respect to product design, marketing, or manufacturing. But customization in terms of after-sales or spare-part business has been paid a little attention (Suomala et al., 2004). Suomala et al. (2004) in their paper explains the five distinct customization strategies provided by Lampel and Mintzberg (1996) as shown in the figure below.

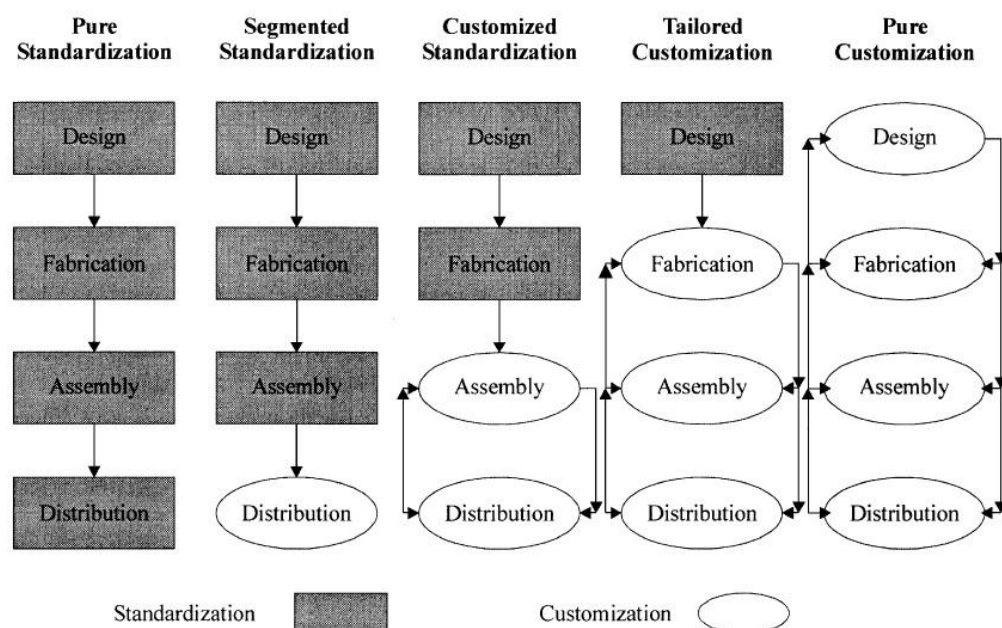


Figure 18. Customization strategies (Source: Suomala et al., 2004).

Pure Standardization, it means simply no customization made by the OEM or intermediary. For instance: the model T Ford.

In segmented Standardization customers are seen as a cluster of buyers and every cluster has been paid proper attention by the manufacturer i.e. different types of Coca-Cola or Pepsi available in the market

In customized standardization a car can be a typical example. Where the customer have certain options available which are actually made from the standard components.

In tailored customization, customization is usually being done in assembly, distribution and fabrication by the manufacturer. In which a prototype is presented to the customer in order to get it tailored according to the customer's need. Tailored made suiting is a good example for this strategy.

In pure customization, customization strategies generally conflicts the typical definitions of customization because no standard configuration exists in such strategies. Product or service generated by pure customization strategies can be considered as a new product. Olympic Games and NASA's Apollo are the extreme examples of pure customizations.

From the after-sales or spare-part business perspective customization can be analysed by the help of following questions (Suomala et al., 2004).

- In after-sales, what would be the effect of customization on number and selling volume of product items?
- On spare-part inventory value, what would be the effect of customization?
- In the after-sales perspective, how different customizations can be categorized?

Suomala et al. (2004) argues with their findings (in context with mechanical industry) that by just altering or adding a simple mechanical structure to the product a great deal of customization can be implemented. In such case, spare-part support rarely needed after-sales. The more complex will be the subassembly higher the effects can be obtained from customization. Customization in spare-part could be seen as new items to be stored in stock but spare-parts are generally the low volume items. Therefore, it will not cause problems in terms of inventory value. Customization can be used as an effective tool to enhance after-sales or spare-part business (Suomala et al., 2004).

3.3. Strategic distribution channels for after-sales

Technological changes, market place demands and aggressive global competition are forcing the companies to focus on their marketing channel strategy that will deal with the product distribution issue and at the same time offer associated after-sales service support (Arvinder, 1998). Distribution and associated after-sales support have proved to be the key determinants for customers in order to purchase a product (Lele and Sheth, 1987). Due to the availability of multiple options (aggressive competition) customers are raising their expectations that their purchased product must have been offering more value than the competitor's, not only in terms of design and pricing but also in terms of service delivery (Avinder, 1998). Following figure shows the critical issues which manufactures have to deal with in short-term and long-term perspective.

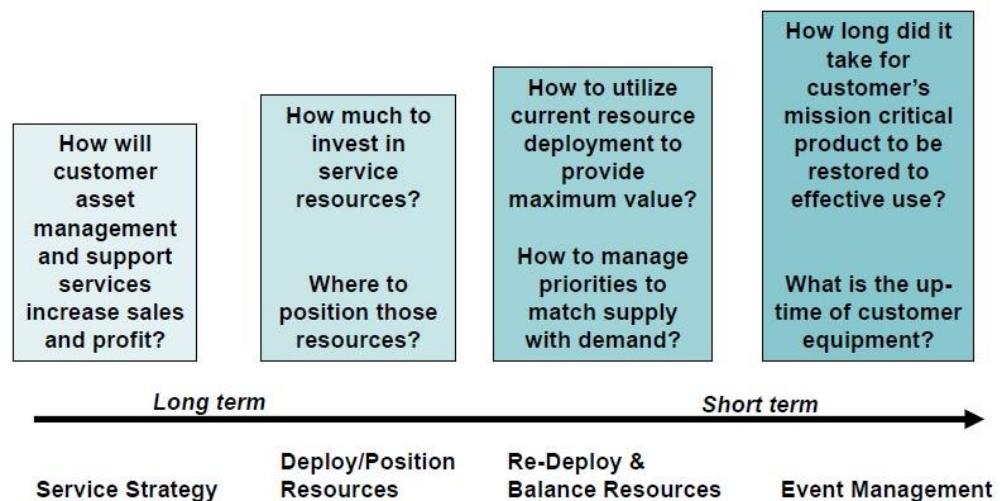


Figure 19. Planning questions for providing strategic support services (Source: Morris and Joe, 2006).

Figure above shows that in long-term the focus must be provided towards analysing the profit potential against the services to be provided. Opportunities must be profitable enough to payback the investment and efforts. While the short-term focus deals mostly with emphasizing on strategic distribution of after-sales services. Combining the short-term focus with the long-term profit analysis provides a solid base to decide why and how to provide which after-sales services to what customer and where (Morris and Joe, 2006)?

Manufactures need to understand that providing after-sales services is just not enough in today's competitive environment. To provide such service in a more efficient and cost effective manner in order to gain customer satisfaction and high returns is the most important issue. According to Arvinder (1998) following questions hold significance importance in order to decide the strategic distribution of after-sales services.

- How service support functions will play their role in the firm's overall objectives and strategies?
- How should channels for service support be managed to take competitive advantage?
- What channel structure, would be most appropriate for providing after-sales service support for products in a particular industry?
- Can the above decisions be made independent of one another or they should be considered concurrently if they somehow linked together?

Above mentioned questions must be taken into account before finalizing the channel distribution for after-sales services. In order to understand broader classification for channel functions Cohen et al. (1989) provides following categories.

- Selling
- Channel support
- Risk assumption
- Product modification
- Physical distribution
- After-sales service support

Above mentioned points provided by Cohen et al. (1989) provides a broader assortment for channel functions, however scaling down towards the configuration of logistic system for spare-parts needs special attention. Huiskonen (2001) provided the four levels of decisions as follows:

- In terms of service level or response time, the strategies/processes/policies concerns the objectives to be followed by one actor or by the whole supply chain.
- In the supply chain, network structure will define the number of inventory levels and locations.
- The decisions about the inventory control, the incentive and performance measurement, and the information support tools or systems to be used must be carried out by coordination and control mechanisms.
- The supply chain relationships consist on cooperation or mutual influence between different supply chain members that may impact on the achievement of the objectives through the implementation of the control and coordination activities.

Cohen et al. (2006a) suggested that the product and the geographical hierarchy related optimization for cost-service trade-off is vital for decisions to be taken. For instance figure below shows that a company can take the decision to replace a failed product by a new one stored at the customer's facility.

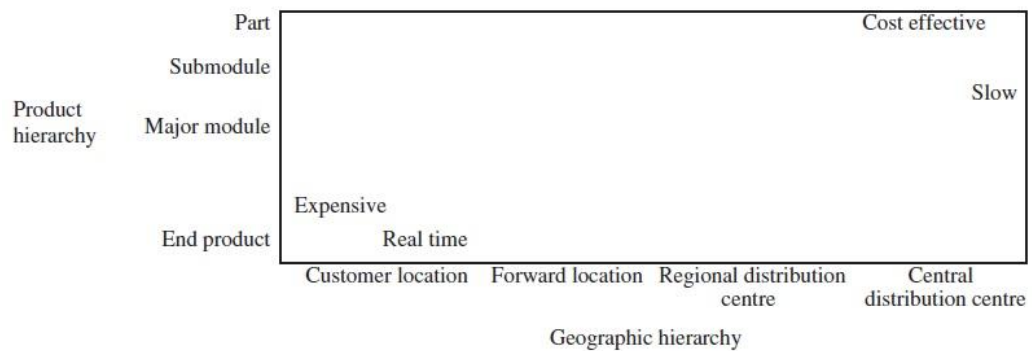


Figure 20. Product and geographical hierarchy for allocation decisions (Source: Cohen et al., 2006a).

This would be the fastest response time solution but at the same time it would be a much more costly decision. Deciding to just replace the broken part with the spare-parts stocked at company's central warehouse on the other hand would be a cheaper decision but a slower solution. Persson & Saccani (2009), after solving their case company suggested that competition dimension shows, when making inventory or support services channel distribution decisions business opportunities related to spare-parts availability (increased market share) should be taken into account as a strategic input.

3.4. Business models for after-sales

Firms operating their businesses in today's global competitive environment need to have comprehensive clarity in defining and implementing their visions and missions. Business model is a tool to create such clarity. However, the terminology itself needs some clarity first because business model, revenue model, economic model, business concept and strategy have been used interchangeably both in practice and literature (Morris et al., 2005). Ability to successfully and profitably delivering products and services and attracting the customers, investors and employees defines a fruitful business model. Components in the business model should be highly related to the vision and competence of the company in order to create uniqueness from the competitors. The common understanding about the term 'Business model' revolves around the two factors (Petrovic et al., 2001).

- How the company makes money?
- How does a company provide additional value to the customers to gain competitive advantage in a profitable manner?

A successful business model not only provides a complete logic about various business processes but at the same time describes the reason that why these processes are designed in such a manner. Business model is an extensive concept that has been widely discussed in literature. Following table shows some interesting definitions by experts.

Table 8. Definitions of business model.

Definitions	Authors
<i>A business model is the organization's core logic for creating value.</i>	(Linder and Cantrell, 2000)
<i>A statement of how a firm will make money and sustain its profit stream over time.</i>	(Stewart and Zhao, 2000)
<i>The design of key interdependent systems that create and sustain a competitive business.</i>	(Mayo and Brown, 1999)
<i>The totality of how a company selects its customers, defines and differentiates its offerings, defines the tasks it will perform itself and those it will outsource, configures its resources, goes to market, creates utility for customers and captures profits.</i>	Slywotsky (1996)
<i>A business model is a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture, and economics are addressed to create sustainable competitive advantage in defined markets.</i>	(Morris et al., 2005)

The focus of every definition explained above represents unique focus. Following points shows different basis of business models used by different experts.

- Value chain (Porter, 1985; 1996)
- Resource based theory (Barney et al., 2001)
- Strategic network theory (Jarillo, 1995)
- Corporative strategies (Dyer and Singh, 1998)

An analysis of thirty definitions conducted by Morris et al. (2005) shows that on the basis of emphasis crux of business models can be categorizes as strategic, economic, operational or various combinations of these attributes.

Sometimes especially in the giant MNCs there exist sub-models. Sub-models actually represent the sense behind the corresponding process for instance value model represents that why certain processes were being chosen to provide value by the organization? Capital model reveals that how and why certain resources were used to generate the required capital? Wirtz (2000) had presented various sub-models, which with further extension by Petrovic et al. (2001) are as follows.

- Value model
- Resource model
- Production model
- Customer relationship model
 - Distribution model
 - Marketing model
 - Services model
- Revenue model
- Capital model
- Market model

Timmers (1998) in his article presented eleven possible sub-models. He evaluated and differentiated these models on the basis of:

- Degree of innovation
- Functional integration

Chesbrough (2007) in his business model framework presented six types of business models. Last two types were placed in the most effective category based on the degree of innovation in the business model. A Business model in which a company integrates its innovation process with its business model shows that companies begin to adapt experimental approach more directly with the business model. Suppliers and customers help the company to understand customer's future requirements by improving the company's visibility with their knowledge.

Chesbrough (2007) presented the highest level of business model by presenting a business model as an adaptive platform. In such business models companies, key supplier and customers become business partners who share technical and business risks (Chesbrough, 2007). Efficient business model shows commercialization of the underlying assets is an innovative approach (Gambardella and Anita, 2010). Amit and Zott (2005) identified novelty, lock-in complementarities and efficiency as vital factors for business model innovation.

As the objective of the thesis is focused on after-sales business generation, therefore studying after-sales business models would be interesting. According to Gaiardelli et al. (2007) assurance of a proper balance between orientation to profitability, customer loyalty and adequate level of investments in short term, as well as in long-term is important to develop after-sales business model. Froehle et al. (2000), Tax and Stuart (1997), Berry and Lampo (2000) and Bullinger et al. (2003) propose conceptual frameworks for the design and redesign of services and analyze the new service-development process. Lele

(1997) and Agnihotri et al. (2002) mentioned core strategies for generating business model for service organizations as:

- Product-design-related
- Service support system-focused
- Reducing customer risk
- Field service-focused
- Technology

According to Gaiardelli (2007) at OEM level after-sales represents a business, a process, a service and an organizational unit. On the basis of this statement a framework had been presented which provides foundation for after-sales business model as shown in figure below.

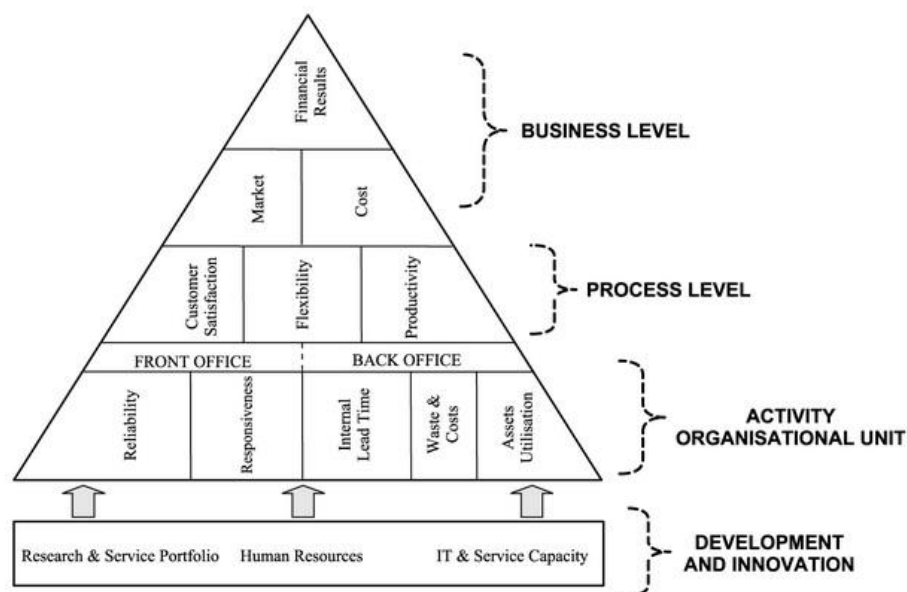


Figure 21. Framework defining foundations for after-sales business model (Source: Gaiardelli, 2007).

Framework shown above is significantly important to understand and to develop effective business model for after-sales. Cooper (1995), Cavalieri et al. (2006) and Seuring and Goldbach (2002) alternatively provided four strategic bases for after-sales business models which are:

- Product support (“Necessary evil”; mainly assigned to manage warranty issues)
- Cash generator (traditionally generating source of revenue by selling spares)
- Business generator (in highly competitive and saturated markets)
- Brand fostering (long-term vision for gaining high market share)

Based on above literature and Figure 12, figure below represents a framework defining the role of after-sales in creating value and enhancing sales.

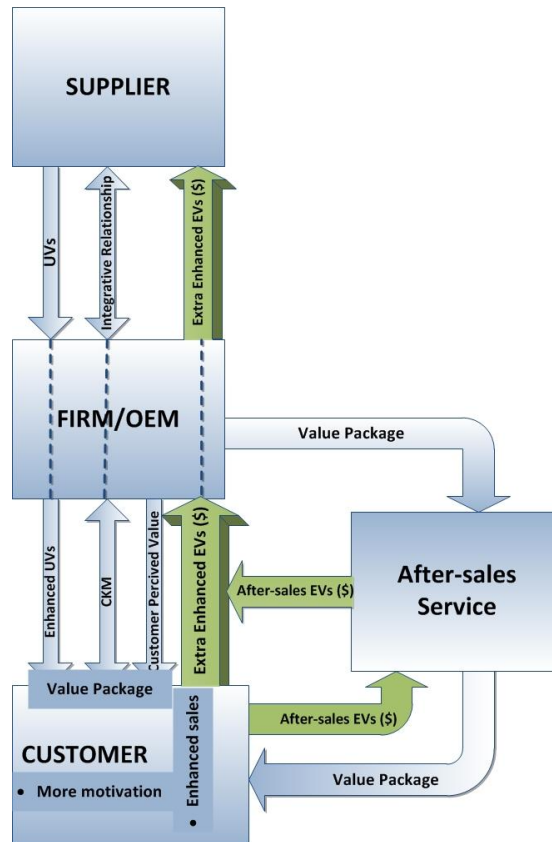


Figure 22. Value packaged after-sales business model for extra enhanced EVs

Figure above shows that after-sales business is a vital source of generating business in highly competitive and saturated markets. The framework above not only shows the value created and transferred to customer but also signifies the importance of after-sales for gaining extra enhanced EVs.

4. TRADITIONAL SPARE-PART HOSE-ASSEMBLY BUSINESS MODELS

OEMs today are facilitating their customers with the same distribution channels or supply strategies for hydraulic hose-assemblies as offered for other parts and product distribution because the strategic criticality of hydraulic hose-assembly as a spare part has not been completely understood by most of the OEMs. Due to the traditional mindset for strategizing the after-sales services most OEMs are still struggling to harness the best out of it. Following section of this chapter will provide a detailed outlook for the traditional after-sales processes and complexities in hose-assembly business.

4.1. What is hose-assembly?

Hydraulic hose-assemblies provide huge potential for after-sales revenue. Each machine contains huge number of hose-assemblies and these hose-assemblies also have a relatively short life span as compared to most of the other machine parts. Despite the business potential, OEMs today make hardly any hose-assembly related after-sales revenue. In order to understand the spare-part hose-assembly business, first it would be better to understand a bit about hose-assembly and its manufacturing process. Figure below shows the basic components of the hydraulic hose-assembly.

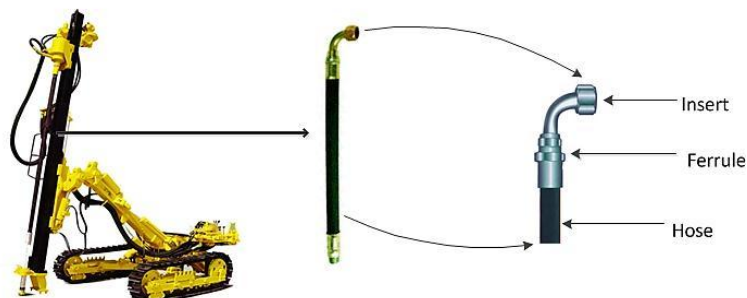


Figure 23. Basic description of the hydraulic hose-assembly (Lyly-Yrjanainen et al. 2009).

Figure above shows that basically a hydraulic hose-assembly consists of three main components which are:

- Insert
- Ferrule
- Hose

These three are the basic components but there exists huge complexities while the selection of each component depending upon the need. The manufacturing process of hydraulic hose-assemblies on the other hand is not very complex. Figure below shows a typical process for the manufacturing of a hydraulic hose-assembly.

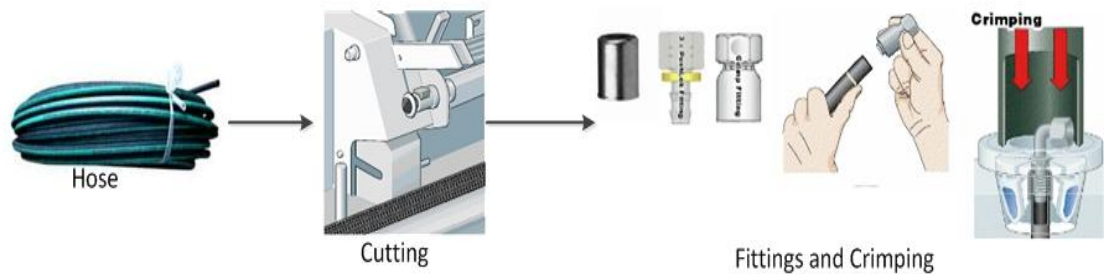


Figure 24. Hose-assembly Manufacturing Process (Parker-Technical Handbook).

The process starts from selecting the right hose and cutting it according to the required length. Then the right fittings have to be selected to insert them onto the hose. Finally, crimping is done with the help of crimping machine. Crimping is basically a process in which a connection is made between two items by exerting compressive pressure. For hydraulic hose-assemblies, it is a mechanical process of attaching a permanent fitting to the end of the hose. Squeezing is being done until the metal fitting bounds to the hose. The angle has to be indicated only when the two elbow fittings are assembled in a displaced way. Additionally, the hose-assembly must acquire the minimum standard of cleanliness. In this way, the process of hose-assembly manufacturing consists of the following ways.

- Selecting the right hose
- Cutting the hose to required length
- Selecting the right fittings
- Crimping

The material of the hose varies in number of ways depending upon the need and application of the hose-assembly. The material of the hose should be compatible enough to withstand the fluid properties which have to flow inside the hose at the same time the external material of the hose should be strong enough to withstand the toughness of the external environment in which the hose have to be used. Figure below shows a typical hydraulic hose structure.

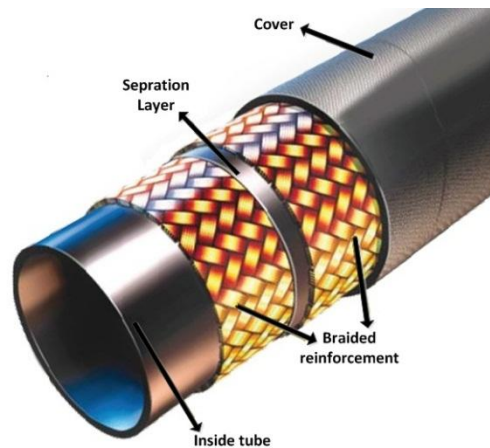
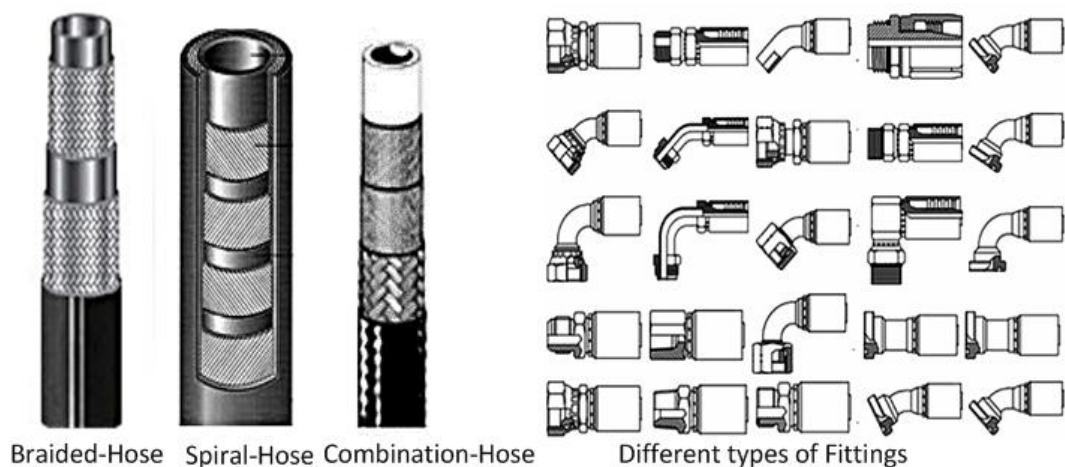


Figure 25. Typical hydraulic hose Structure (Parker-Technical Handbook).

As shown in the figure above normally an extruded inside synthetic rubber tube is purposely used to keep the conveyed fluid in a rubber hose. To hold the internal pressure reinforcement layer of either textile or steel (or both) is used due to the elastomeric nature of rubber. Finally in order to protect these inner layers an outer synthetic rubber covering is extruded around the reinforcement. Apart of this basic structure there exist different types of hoses and fittings depending upon the need and application. Figure below shows different types of hoses and fittings.



Braided-Hose Spiral-Hose Combination-Hose Different types of Fittings

Figure 26. Different types of hydraulic hoses and fittings.

Figure above shows different types of hose and fittings used to manufacture hose-assemblies for different needs and applications. Three main types of hydraulic hoses are braided-hoses, spiral-hoses and combination hoses. Braided-hoses contain seamless reinforcing braids of synthetic textile wire, or other material- applied by high speed vertical or horizontal braiders. The advantages for these types of hoses include flexibility, high resistance to kinking and excellent tensile strength. Spiral hoses contain reinforcement of synthetic textile or steel wire or other material their advantages include extreme flexibility, smooth bore, long length capability and high strength. Combinations of these two types are basically required where the combination of same needs is required.

4.2. Complexities in after-sales hose-assembly business

Hose-assembly after-sales business is profitable yet a complex business. The general idea or common man's concept about hose-assembly seems to be very simple but actually there exists certain complexities which make the product and process both very difficult as shown in the figure below.

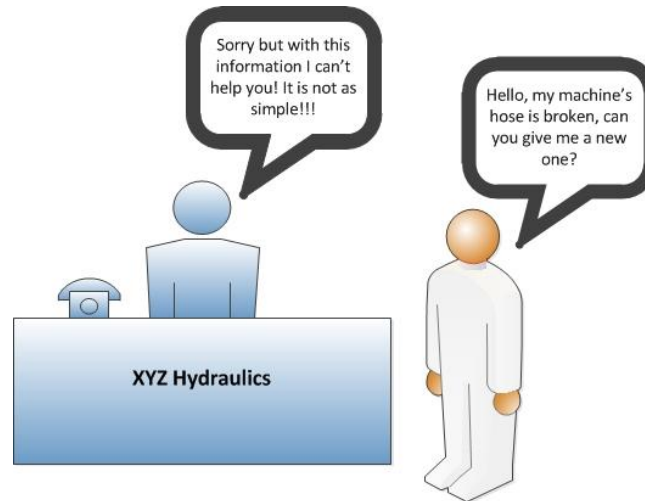


Figure 27. Hose-assembly business is complex.

As shown in the figure above and as mentioned in the previous section hose-assemblies cannot be replaceable without certain information available depending upon the exact need and application defining the exact type of the hose-assembly needed. This scenario is very much like if one happens to be at a corner shop in India asking a glass of milk, most likely the shopkeeper will not ask about the type of the milk needed i.e. fat content, non-allergic, skimmed etc. But in Europe for instance in Finland if one will ask the same from the shopkeeper, the shopkeeper will definitely ask what type of milk is needed? According to 'Parker technical guide' for hydraulic hoses following are some important questions in order to understand the complexity of the hydraulic hoses.

- Machine or equipment type?
- Pressure application?
- Fluid temperature and its compatibility?
- Environmental condition?
- Minimum bend radius?
- Excessive exposed abrasion?
- Mechanical loads?
- Thread type, specific hose construction prescribed (legal)?

Complexity in the hose assembly can be further explained with the help of following figure.

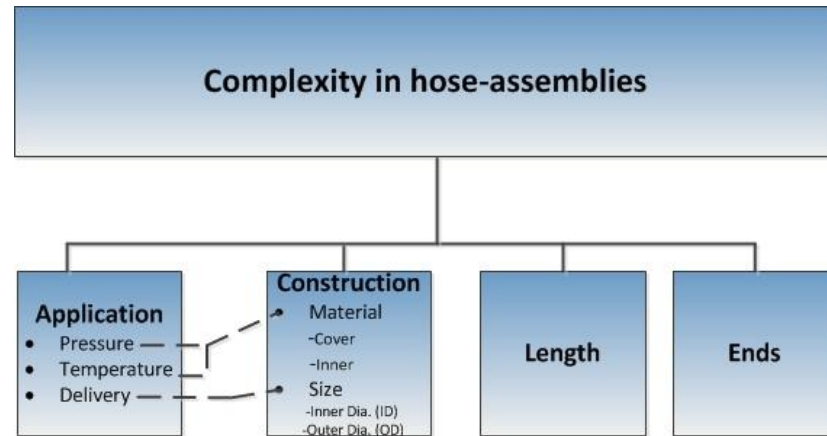


Figure 28. Complexities in hose-assemblies.

Figure above shows the four basic factors which influence the complexity in the hose assemblies. Application involves the pressure that varies from extremely high to low, temperature that also varies from extremely high to moderate or low. An increase of even 10°C above the maximum temperature that have been recommended by the manufacturer can decrease the life of the hose by half. The dotted connection between pressure, temperature and material actually shows that the pressure at which the fluid has to be transferred and temperature of the fluid are the factors that basically influence the decision of the inner hose-material to be used. For the outer material or the cover, external conditions i.e. atmospheric or environmental conditions are the influencers.

Temperature in the hydraulic hoses usually varies between -40°C to $+150^{\circ}\text{C}$ for the internal and external conditions of the hose. Pressure on the other hand varies from extremely high to low as shown in the below table.

Table 9. Working pressure conditions for hydraulic hoses (Gates, India).

Working Pressure conditions	Psi
Extremely high	5000-6000 and high
High pressure	1000-5000
Medium Pressure	500-1000
Low pressure	200-500

Price and type of the hydraulic hoses also varies due to the above mentioned varying conditions in temperature and pressure. There is some other factors effecting the external material or cover of the hydraulic hose for instance climate can be very different for the hydraulic hose-assemblies if a machines is used in Northern Europe or in Africa or Middle-east. Also the external working conditions are of great importance in this scenario for instance in mining sector the condition varies significantly for surface mining and underground mining. Due to these reasons the external material is supposed to resist dust, water, oil, clay, abrasion and other harmful environmental factors.

Delivery on the other hand represents how much fluid must go through the hose which actually determines the size of the hose to be used. Using under sized hose can lead to the increased pressure hose on the other hand using an oversized hose can add unnecessary costs, weight and bulk (Gates Inc. India, 2012).

Length and ends are the other critical factors. Length and connecting ends of the hose must be correctly identified. Due to the higher pressure thrust, hydraulic hoses are supposed to be installed at the correct angle (routing) to avoid serious damage. Therefore care must be taken to cut the proper length of the hydraulic hose for proper routing. Figure below shows this criticality with few examples.

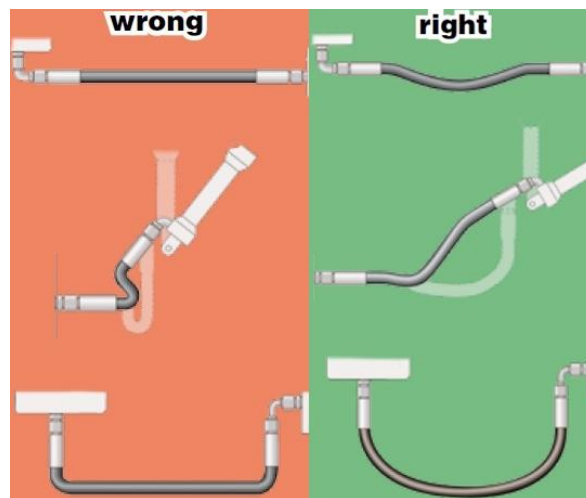


Figure 29. Proper length and routing of the hydraulic hoses (Parker-Technical Handbook).

Hydraulic hose-assembly cannot be completed without the fittings. In fact fittings are also very complex in order to choose right, compatible and legally approved one. Some of the most commonly used fitting systems for hydraulic connections today are as follows.

- DIN-German
- BSP-British
- GAS & Metric-French
- SAE-North America
- JIS-Japanese

As shown above, hose ends or hose fittings are strongly influenced by the country of origin also tend to be specified by the machine port that the hydraulic hose is to be attached (Parker technical guide, 2012). Appendix 1 shows some different types of fittings from the above mentioned fitting systems.

Based on the above complexities it can be concluded that the after-sales business of hose assemblies is not simple. OEMs manufacturing different machines and using different types of hose-assemblies depending upon the need and application cannot implement same strategies to harness the after-sales revenue. Spare part hose-assembly business demands more customization depending upon the need of the customer based on the application. For instance a customer using a small excavator for removing snow in front of the house (domestic appliance) the needs would be very different from the one who is using a large excavator for commercial purposes. Since the needs and application are very different in both the cases, OEM cannot offer the same spare-part or after-sales services to all the customers.

4.3. Traditional after-sales process

Apart of the complexity and customized nature of the after-sales business for hydraulic hose-assemblies, the business is still carried out in the most traditional manners. The strategic criticality of hydraulic hose-assembly as a spare part has not been understood by most of the OEMs and that is why most of the OEMs are facilitating their customers with the same distribution channels or supply strategy for hydraulic hose-assemblies as offered for other parts and product distribution. According to Patton and Feldmann (1997) logistic networks in spare parts business are much more complex to manage than in production environment and this because of two main which include:

- Complex customer locations
- Urgency of spare part

Complex customer location literally means that the location could be anywhere. In mining industry mines are mostly located in the most remote areas of the country for instance as shown in the figure below one of the mines in Australia is located in the northern territory at ‘Tiwi Islands’. The Tiwi Islands, being a 25 minute air flight are located approximately 50kms north of Darwin consist of the Melville and Bathurst Islands.



Figure 30. Example of complex and remote location of customer (mzi.com.au).

Mining at Tiwi-Islands is being operated by ‘Matilda Minerals’ and ‘Mzi Resources’ since 2006 for Zircon and Rutile. Tiwi-Islands are a good example to show the complexity in the customer’s location. As shown in the figure above in order to reach at the customer’s location the options are through a plane or by a ship or a boat. Now if the customer will be approached by the plane then it would be too expensive and limited flight options. After taking the plane there is certain by road distance that will add extra time and cost and by ship or a boat it would be too slow. In addition, one mistake in the identification of the correct spare part hydraulic hose-assembly during the whole process will ruin all the efforts and huge time loss. For instance, at Tiwi-Islands one of the Japanese mining machine manufacturers is operating its fleet. The nearest customer service centre of the OEM is in Darwin as shown in the figure below.

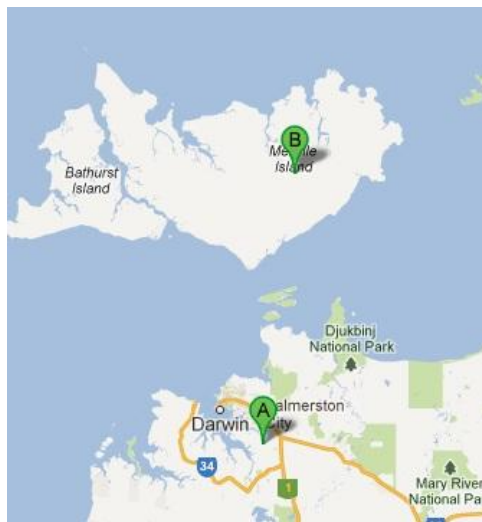


Figure 31. Complexity in customer service centre to customer location.

As shown in the figure above the ‘point A’ is the customer support centre and ‘point B’ is the customer location. It can be seen that the distance is too complex and requires expensive routing and very careful communication in order to avoid any mistake in the identification of the spare part.

The other important factor in the complexity of the logistic networks in spare parts business of hydraulic hose-assembly is ‘Rapid response’. An understanding is needed to ensure that OEM is rightly responding the changing needs of the customer and providing them the support services that sustain the competitive advantage. Product design and support strategies must have to be aligned. For every failure in the machine, customer has to bear a certain cost. Construction, mining and forestry machinery falls under the rapid response strategy because of its criticality towards downtime especially in business-to-business arena.

Reliability is also an important issue but the prime factor for OEM is to balance the expense of rapid response with the cost of design enabling quick identification and repair of the problem (Lele, 1997). Sensitivity to rapid response strategy among the most widely used construction machinery differs according to their impact on downtime and cost (price). Cranes, excavators, drillers and crushers falls in a category that has high impact on the downtime and at the same time these machines have high costs (prices). This makes it difficult to just replace them with the new ones. Therefore, for such machines there exists a critical need to rapidly counter the failure. In traditional after-sales process in order to cope-up with the complex locations and rapid response most of the customers mainly have two options in order to manage their spare part hydraulic hose-assembly's failure.

- Drive to the local store
- Call for the mobile van

As mentioned above if the hydraulic hose assembly of the machine breaks down and customer have to drive all the way to the local store in order to get the new one. It would not be easy tasks for the customers because as mentioned above mostly the customers are located at the isolated locations and the stores are mostly located in towns. For instance in forestry industry, customer location can somewhere be in the deep forest where even the roads could be in terrible conditions or in the rain forest the situation will be much more dreadful to drive all the way to the local store. And even if the customer manages to drive to the local store, there is no guarantee that the customer will find the exact hydraulic hose-assembly as he needed because as mentioned in the previous section the hydraulic hose-assemblies are very complex in nature and a random local store cannot endure such huge inventory.

The other option is to call the customer service mobile van. These vans are usually equipped with the capacity to serve the customer on-site. The on-site technicians understand well about the identification of the correct spare part and therefore lower the risk of wrong installation of spare part. A typical such process is shown in the figure below.



Figure 32. Equipped mobile van process for customer service.

Above process has certain advantage for instance it saves customer's cost and energy to travel all the way to local store and probably find nothing there. But at the same time this process has certain drawbacks as well. For instance approach to customer's location as the van has to travel by road to reach the customer's site. If the conditions will not be appropriate for the van to travel or in the 'Tiwi-Islands' situation it would be very difficult or impossible for the van to reach the customer's site. Also the van cannot contain huge inventories with maximum number of options available in order to cope-up every hose-assembly failure which actually narrows down the reparability.

The above exploration makes it clearer that hydraulic hose-assembly as a spare part is very complex due to its varying nature to need and application. Also managing the logistic network for spare part hydraulic hose-assembly is very intricate and demanding due to the complex and isolated customer's locations and rapid response requirement to avoid down time of the machine. It is clear that traditional after-sales processes are not capable enough to meet the requirements of the scenario for instance:

- Local stores are too far away
- Mobile van has limited capability against hydraulic hose-assembly's complexity
- Regular mail is too slow
- FedEx/DHL is too expensive
- Communication Gaps

Due to the above mentioned flaws and added costs there exists a genuine need for an efficient an effective spare part logistic network which fulfils the above mentioned requirements and eliminates the chances of miscommunication. But in order to develop such a network it would be better to understand the facilitators which will be effectively complimenting the whole process. In the following chapter these facilitators will be discussed in detail.

5. BUSINESS MODEL CREATION

5.1. Where the market is going?

In today's business world, it has become extremely difficult for organizations to find a basis for gaining huge market share and competitive advantage. High quality and service levels once considered exceptional are now taken for granted, while rock-bottom prices are simply the ticket to get-in to the competitive field. Nor can leading edge products guarantee a company long-term advantage. As the life cycle of the products continues to shorten, products turn into commodities practically overnight and at the same time, each day customers demand more than they did the day before.

The after-market can be more profitable than the original equipment market because after-market customers have lesser supplementary options available to them. Presently to conquer the after-market different OEMs are implementing different strategies based on the customer need and their corporate strategy. Most commonly used after-sales strategies are:

- Maintenance Contracts
- Repair shop close to customer site
- Pre-purchase after-sales package
- Third (local) party services

Most commonly used after-sales strategy is maintenance contracts. Companies today are increasingly emphasizing on their service offerings and to do this, one option is to provide their customers with full maintenance support. OEM and maintenance firms are providing full-service maintenance contracts to their customers which involve the execution of all corrective and preventive maintenance activities (Stremersch et al., 2001). Preventive and predictive maintenance include:

- Corrective Maintenance or Repair Services
 - On-site
 - Outsourcing
 - Customer Service Centers
- Preventive Maintenance
 - Periodic inspections
 - Remote diagnostics

OEMs are not bound to provide service contracts to their customers but in the present business world providing best services to the customer is not a source of competitive advantage anymore. It depends solely on the choice of the OEM and its strategy that whether to provide a full scale service contracts or to provide partial services for instance as shown above only corrective maintenance or preventive maintenance or both.

Different OEMs adopts different strategies to maintain their servicing contracts which include on-site repair in order to avoid downtime and to provide rapid repair services. Some focus on preventive maintenance which includes pre-defined periodic inspections and maintenance and on higher levels some OEMs provide remote diagnostic approach for maintenance. Remote diagnostics helps the OEM to monitor as well as to provide instant failure report of the equipment in order to reduce or avoid downtime especially in the sensitive and expensive equipment such as airplanes, IT and telecommunication etc.

Providing maintenance services could be tricky and that is why OEMs used to define the service level agreements in the maintenance contracts. According to Tsang (2002) planning and scheduling characteristics should be the basis for categorizing the maintenance work and defining the levels of services to be provided. Clamp (1996) provides three levels as follows:

- Level-1: To keep the plant running, activities such as minor repairs, process testing and environmental control.
- Level-2: Activities that can produce critical changes to the plant, activities such as major component replacement and detailed inspection.
- Level-3: Requires very special skills and facilities, activities such as overhauls, reconditioning and plant modification.

Above mentioned levels of maintenance defines the competence of the OEM to provide services to its customer. Hydraulic hose-assemblies could be the part of level-2 in maintenance contracting due to its criticality with respect to downtime and complexity in its nature.

Repair-shop close to customer site is an interesting concept. Many OEMs today are practicing the repair-shop strategy to deal with the rapid maintenance issue. These repair-shops are generally placed very close to the customer site in order to avoid long distances to be covered by the customer in search of a spare-part. This is one way to capture after-sales by OEMs but at the same time due to limited spare-part availability it is not the most efficient way. A typical repair-shop by one of the Japanese OEM 'Komatsu' is shown below, which is near the site of one of its customers in New Zealand.



Figure 33. An example of a typical repair-shop close to customer's site.

As discussed above these type of shops cannot handle severe maintenance issues but the purpose of such repair-shops is to provide a quick solution to replace a broken part. Huge inventories cannot be stored in these shops because of the complex and far locations of the customer's sites. Also the availability of the skilled technicians cannot be possible in these shops, usually there are only one or two guys at these shops and their only job is to open the shop and to sell the spare-parts as asked by the customer.

Hydraulic hose-assemblies are not such an easy or standard spare-part and due to this fact, this option is helpful but not a complete solution to tackle a rapid replacement of the broken hose-assembly of each and every machine. For instance if an OEM i.e. CAT wants to open this type of shop near the mining site of one of its customers, supplying surface and underground mining equipment. It would not be possible for the OEM to fully satisfy the customer by this type of repair-shops even for the hydraulic hose-assemblies because that hydraulic hose-assemblies for surface and underground mining equipment varies largely in nature.

Pre-purchased after-sales package is another way to capture after-market. One of the options to capture the after-market by OEM is to offer the customer a package for certain spare-parts to be purchased with the purchase of the equipment. This is somewhat similar to buying a shirt and often getting a packet with it having one or two extra buttons in it. In this case the packet mostly comes free of cost or as a complimentary gesture by the seller to the customer. But selling expensive industrial equipment has no match with selling a shirt and that is why such a package comes with certain cost that customer has to pay with the purchase of original equipment.

Similar to the buttons, hydraulic hose-assemblies seem to be a very small part of a huge machine against the other heavy parts but consider someone on the wedding day is wearing a waistcoat carrying a certain motif and color but the upper most button is broken and there is no extra button available carrying exactly the same motif and color, someone would definitely be in trouble. In the waistcoat thing, with the maximum effort one can buy a new waistcoat but in expensive and long purchase processed excavator one cannot buy a new excavator just because of the broken hydraulic hose-assembly, no matter how important the day would be.

In order to cope-up with such a situation OEMs try to capture the after-sales of some critical spare-parts by offering the customer to purchase these parts beforehand, so that if a failure occurs the customer would be able to deal with the replacement easily. But even with this option this is not fairly possible to offer the customer all the hydraulic hose-assemblies as a spare-part for every machine because of the fact that no one can predict the failure or replacement demand in hydraulic hose-assemblies for instance sometimes a machines carries more than 300 hydraulic hose-assemblies. This could be a good option with the equipment carrying very low amount of hydraulic hose-assemblies and at the same time failure would also be expected to happen rarely.

Similarly, OEMs also offer pre-purchase inspections instead of pre-purchase of spare-parts like in automobiles. With the purchase of a new car some OEMs offer pre-purchase inspections and shows that they really do care about the maintenance of the car. This could somehow be different in some aspects as compare to the pre-purchase of spare-parts because if the certain spare-part found in bad condition and needs to be replaced in inspection there is no guarantee that the spare-part will be available with the inspection team. This will lead to take more time to replacement but this strategy could be beneficial for the OEMs because of the possibility of the replacement of more expensive and profitable components.

A third (local) party service is interesting yet a critical concept. Sometimes to deal with the different and complex geographical conditions and varying customer expectations, OEMs prefer to use the services of a third or local party providing the maintenance services. In this particular strategy OEM believes that the local player is the master of its market who knows the complexities of the issues and their relative solutions in order to cope-up with rapid maintenance. Also the burden of huge inventory costs and some fixed costs could be shifted towards the third party. An example of such a strategy is shown figure below.

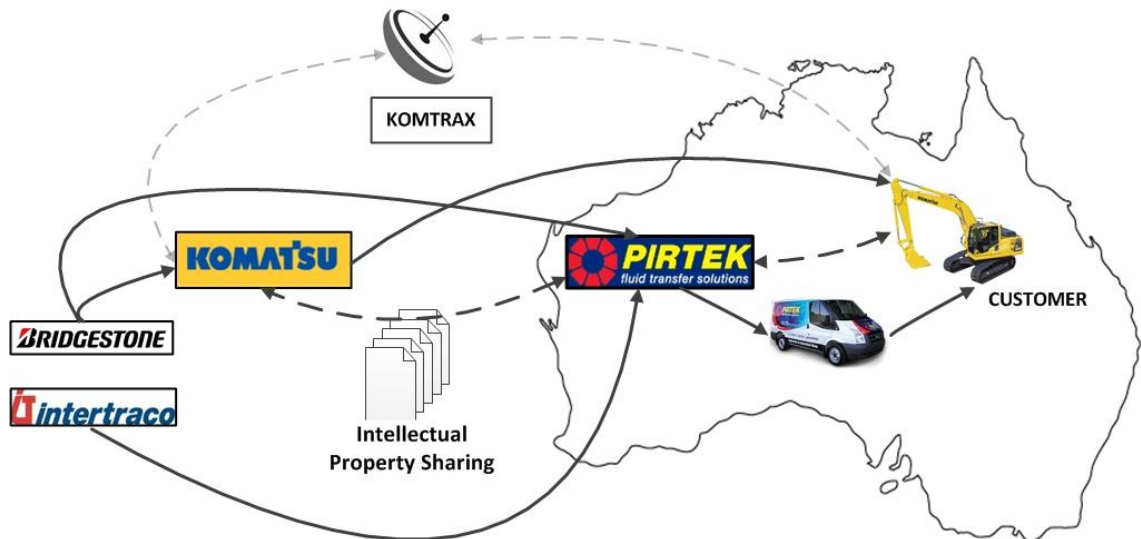


Figure 34. An example of using third party services for after-sales.

As shown above, Komatsu is a Japanese OEM who has worldwide customers and suppliers. In the above particular example Komatsu is trying to capture the Australian after-market of hydraulic hose-assemblies with the help of a local company named Pirtek. In case of hydraulic hose-assembly breakdown customer calls the Pirtek's customer care unit instead of Komatsu's. Pirtek then with help of its specialized rapid and huge network responds to the customer. Above example seems simple but it carries some complex decisions and procedures. According to Tsang A. (2001) following decisions need to be taken carefully before the deal.

- What should not be outsourced?
- What type of relationship should be adopted with the external service supplier?
- How outsourcing risks should be managed?

When maintenance service is being classified as non-core activity by the OEM, outsourcing such activity could be an option. Also there are some risks attached for instance loss of critical maintenance skills, loss of cross-functional communication and loss of control over the supplier (Tsang A., 2001). Komatsu for sure carries customer support centers in Australia and has already got a certain share of after-market which should not be affected by this deal.

Such deals require lot of effort, trust and money. In order to maintain the same levels of quality OEM is supposed to share its intellectual properties with the supplier. In this particular example on issue needs attention that Pirtek is a hose-assembly manufacturer not a hydraulic hose or fittings manufacturer, Pirtek used to outsource the hydraulic hose and the fittings to manufacture the hydraulic hose-assemblies. Therefore, in order to maintain the spare-part quality on the same levels as of original part Komatsu cannot tolerate the different component suppliers. Therefore, in-return Komatsu has to offer

and bound the third party supplier to source the components from the same suppliers, which is hectic and at the same time is risky too.

Other important issue in this strategy specifically in hydraulic hose-assemblies is that hydraulic hose-assemblies vary significantly due to their varying applications. Therefore it is not possible for every OEM to maintain the same after-sales model for hydraulic hose-assemblies. To understand this issue, following figure holds great significance.

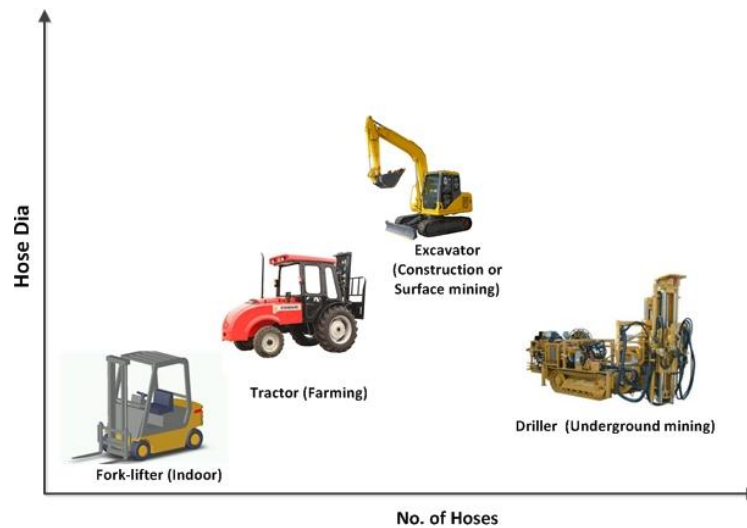


Figure 35. Difference of hydraulic hoses for different equipment.

Considering figure above, OEM manufacturing underground mining equipment wants to replicate the same after-sales business model to offer its after-sales services to its customers as Komatsu (a construction and surface mining OEM) then it would not be the same scenario. Because of the significant difference in the nature and amount of hydraulic hoses which will lead to totally different earning logics and perhaps the supplier or buyer may not be having the same motivation to make the deal successful.

In order to make the networking easier in the after-sales business of hydraulic hose-assemblies there exist a need for the identification of the hydraulic hose-assemblies to facilitate the efficiency and rapidness of the process, following section will deal with this issue.

5.2. Traceability Need

Traceability is a very critical issue in a process chain for instance in automotive, construction and mining industry it makes recalls possible. In food industry it contributes to food safety. In Software Engineering field traceability gives support for requirements validation and improves the quality of the software development process. Traceability can be assigned to different aspects for instance traceability of a result, method, procedure, laboratory, product, material, equipment and so on. As such traceability has no

single definition and that is why it would be better to understand the more general meaning of traceability before exploring it in different aspects.

Table 10. Definition of Traceability by various sources.

Definition	Source
<i>Traceability requires the establishment of an un-broken chain of comparison to stated references.</i>	National Institute of Standards and Technology (NIST) USA
<i>The ability to trace the history, application or location of that which is under construction...when considering a product, traceability can relate to the origin of materials and parts, and the processing history.</i>	ISO 9000 (ISO 2000) Food Sector
<i>The ability to trace and follow a food, feed, food producing animal or substance intended to be, or expected to be incorporated into a food or feed, through all stages of production and distribution.</i>	General Food Law (EU 2002)

According to Derrick and Dillon (2004), traceability can generally be divided in two categories:

- Internal Traceability
- External Traceability

Internal traceability is related to the product and the information relating to it internally in a company and even inside a conglomerate of companies. While external traceability relates to the product information that a company either receives or provides to the next links in the chain from primary producer to the end-user.

In logistics, courier companies (DHL, FedEx etc.), freight forwarding companies and also in SCM (Supply Chain Management) traceability plays a vital role that helps to maintain the customer satisfaction. There are several ways in logistics that enables to apply traceability for instance online tracing of goods supported by a batch number or id code, radio frequency identification (RFIDs), telecom services, bar-coding, GPS navigation etc. Traceability in logistics provides several advantages, for instance:

- Asset tracking and management
- Increased security of assets
- Improved stock management and availability
- Reduced errors in product data handling
- Shipping consolidation
- Verification

- Item tracking within a manufacturing plant

In after-sales business development traceability is a vital factor, as discussed above regardless of the importance of the after-sales business it is regretting to note that after-sales business processes are performed very badly in most organizations. Typically organizations treat after-sales business in minimally coordinated fashion. No single manager has assigned the responsibility for their end-to-end performance, most people involved in performing them can see no further than their individual tasks, and there are no effective systems to quantify overall performance.

Traceability is the most important factor in after-sales business. For instance imagine a machine stops while working on a very important project due to a failure of a very small but essential part. In this situation machine needs to be working again as soon as possible and this could only be possible by replacing that part as soon as possible. Therefore in B2B world service, delivery and availability are extremely important.

The matter of fact is that the after-sales business processes involve multiple organizations for instance a manufacturer, suppliers, distributors, dealers etc. These organizations which together can call as a business chain are collectively even less coordinated than the various functions within one company. After-sales business processes are information-intensive that need to be performed effectively and quickly. They usually require information about customers, products, parts, personnel, and much more.

Repair and maintenance personnel are often unable to determine current levels of spare parts inventory because multiple independent organizations may be holding such inventory and in the end companies have to face the service level penalties in the form of customer down-time. Many companies therefore opt to stuff the channel with spare-parts, which merely creates other problems. For efficient traceability to work flawlessly two things are of high importance:

- Identification
- Product Data Management

Identification plays a vital role for traceability networks to work more efficiently. It means that either it will be a product, part or equipment it must have clear markings on it. Below table shows the advantages and disadvantages of some common identification ways.

Table 11. Ways of Identification.

Identifications	Advantage	Dis-Advantage
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">MES- INTEGRATED</div> <div style="text-align: center; margin: 5px 0;">↑</div>	Full-data transparency and fast and precise recalls and reduced recalls costs with efficient improvement.	High Investment
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">BAR-CODE</div> <div style="text-align: center; margin: 5px 0;">↑</div>	Low investment and improved traceability throughout production process with easy handling.	Limited transparency and no general efficiency improvement.
<div style="border: 1px solid black; padding: 5px; width: fit-content; margin: 0 auto;">PAPER</div>	No investment.	No quick and precise recalls and no fast traceability throughout whole production process.

Different ways of identification in order to make the product or part more traceable, it also shows the relationship between the cost and advantages or dis-advantages involved in choice of traceability used in order to make the process more and more traceable. The product or part identification and location technologies can be grouped as follows.

- **Data carrier technologies (Bar-Codes)** - includes linear bar-codes, two dimensional (multi row bar code and matrix codes) and composite codes, contact and non-contact magnetic data carriers, contact memory and RFID data carriers.
- **MES-Integrated or Location and locating technologies-** exploiting GLN (Global Logistic Networks) by carries including RFID and EANCOM, and active RFID real time locating systems (RTLS) and Global positioning systems (GPS) locating technologies.

Product data Management is also very important for a traceability network through-out the whole business chain i.e. OEM, suppliers, distributors or dealers. With a precise data-base it will be really helpful to trace the required product or part in quick time. Data management or Product data-management (PDM) is the use of software or other tools to track and control data related to a particular product. The data tracked usually involves the technical specifications of the product, specifications for manufacture and development, and the types of materials that will be required to produce goods. Typical information managed in the PDM module includes:

- Part number
- Part description
- Supplier/vendor
- Vendor part number and description
- Unit of measure
- Cost/price

The use of product data management allows a company to track the various costs associated with the creation and launch of a product. Product data management is part of product life cycle management, and is primarily used by engineers. With-in PDM the focus is on managing and tracking the creation, change and archive of all information related to a product.

Without the spare part on hand, a company's customer satisfaction levels could drop if a customer has to wait too long for their item to be fixed. Therefore companies need to plan and align their service parts inventory and workforce resources to achieve optimal customer satisfaction levels with minimal costs and an efficient traceability network. But before an efficient and traceable network will actually start to work, customer needs a proper "ID CODE", that must be marked on the part that needs to be replaced, only then the customer will be encouraged enough to buy the spare part from the OEM. A properly marked ID-Code works as an initiator for a traceable network.

In order to enable the customer to order a replacement part from the OEM's after sales organization the part needs to have a clearly marked ID code. While selecting the best way to put ID-Code on parts cost factor plays a vital role because when talking about the bulk productions even a single penny has got its worth. Therefore cost can be critical to increase the capital investment or ultimately increasing the price of the product or spare part. There are different ways to mark the parts or products:

- Tape on the spare part or product
- Multiple rounds of tape on the spare part or product
- Multiple rounds of plastic tape on the spare part or product
- Print on the spare part or product
- Print on the spare part or product with adhesive making the print more resistant
- Print on a plastic band attached to a spare part or product
- Carving on a plastic band attached on the spare part or product

Markings in a more permanent manner for after sales purposes are challenging when machines are used in rough conditions – stickers and labels are likely to drop off and ink-based markings simply will wear off. Thus, the ID code needs to be carved in plastic or metal and attached in a way that they will not drop off with some physical stress.

5.3. Marking hose-assemblies

As discussed in the previous section, one major challenge is to enable the machine user to order right spare part (hose-assembly). One solution is that the hose-assembly spare part needs to be marked with a certain ID code and for this ID code to remain readable depends on the environment in which the machine is used. Some machines are used in extremely tough environment, for instance, drilling machines because of rock rain and other factors but on the other hand asphalt machines and different earth moving machines works in a comparatively pleasant environment. This means that the permanency of the marking is an essential factor to order fast and right hose-assembly, but at the same time, permanency needs to be coherent with the environment, in which the machine is used to avoid unnecessary costs.

Whenever a component fails or needs replacement the demand of spare parts arises (Fortuin and Martin, 1999). Depending on the size of the organization, there exists huge variations in spare parts based on the difference in costs, demand pattern and service requirements (Boylan and Syntetos, 2008). Companies mostly emphasize on efficient inventory classifications, stock keeping units (SKUs) and demand forecasting for spare parts, beside these important techniques companies today are focusing on facilitators in order to enhance their after-sales business revenue. These facilitators are generally concerned with the installation, repairs, maintenance and provision of spare-parts (Ashok Jain, 2010). Some of the important and widely used facilitators are shown in the below table.

Table 12. Facilitators for increased service business.

Facilitators	References
<ul style="list-style-type: none"> • Maintenance <ul style="list-style-type: none"> ➤ Corrective Maintenance or Repair Services <ul style="list-style-type: none"> - On-site - Outsourcing - Customer Service Centers ➤ Preventive Maintenance - Periodic inspections - Remote diagnostics 	<ul style="list-style-type: none"> - Salonen, M. Bengtsson, 2011. - Pintelon L. et al., 2006. - Gebauer H. et al., 2008. - Ashok Jain, 2010. - Pintelon L. et al., 2006. - Brax S. A., J. Kartin, 2009.
<ul style="list-style-type: none"> • Marking the spare-parts 	<ul style="list-style-type: none"> - Simpson L., 2005. - Connolly C., 2005.
<ul style="list-style-type: none"> • Guarantee 	<ul style="list-style-type: none"> - Amy L. Ostrom, D. Iacobucci, 1998.
<ul style="list-style-type: none"> • Warranty 	<ul style="list-style-type: none"> - Stuart E. Jackson, 2011.
<ul style="list-style-type: none"> • Trainings to customer's technical staff 	<ul style="list-style-type: none"> - Ashok Jain, 2010.
<ul style="list-style-type: none"> • Delivery and Installation Services 	<ul style="list-style-type: none"> - Irini D. et al., 2008.

The facilitators shown above help the OEM to create differentiation and customer loyalty but at the same time they are sustainable source of profits, in order to convert the after-sales service business into thriving profit center in today's business environment (Kumar, et al., 2011).

The objective now is to focus on marking the spare-part, in order to facilitate the customer to order the right spare-part with the help of a certain ID-code. But the ID-code must remain readable throughout the active use of the product. This means that the permanency of the marking is an essential factor to order fast and right spare-part, but at the same time, permanency needs to be coherent with the environment, in which the machine is used to avoid unnecessary costs. Marking the hose-assembly with a certain ID-code enables the user to order right spare part (hose-assembly) as shown in figure below.

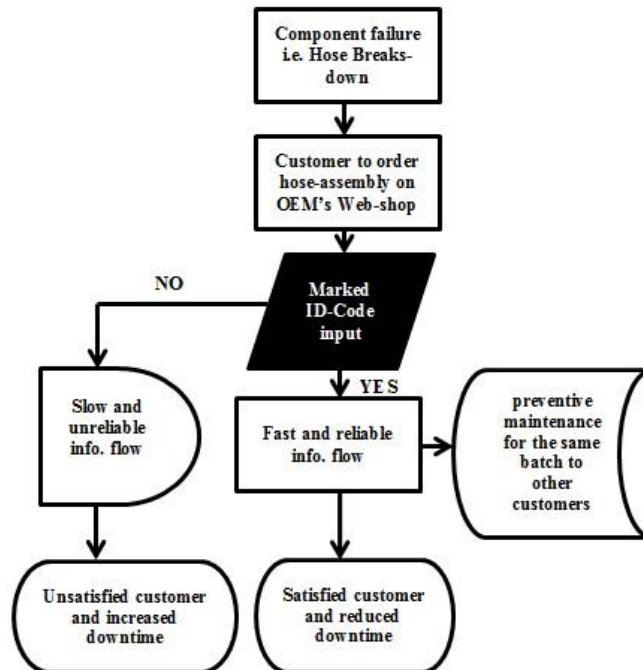


Figure 36. Existing Markings on Hose-assembly.

In hose-assemblies, identification can be done in several ways depending upon the cost and environmental conditions. As shown in figure below, presently different marking solutions are being used by different OEMs.






<p>Paper or Tape</p>  <ul style="list-style-type: none"> - Usually with rounds - Sticker 	<p>Printing on Hose</p> 	
<p>Plastic Band</p>  <ul style="list-style-type: none"> - Printed sleeve on the band - Sticker on the band 	<p>Metal Band</p>  <ul style="list-style-type: none"> - Carving or Stamping 	<p>Printing on Ferrule</p>  <ul style="list-style-type: none"> - Stamping

Figure 37. Existing Markings on Hose-assembly.

The existing markings shown in figure above have now been plotted in terms of cost, permanency and relative roughness of the environment in figure below. The markings must have to be provided in the right way, understanding shown in figure below will help the OEM to rightly provide the support services that sustains the competitive advantage with the right cost. Product design and support strategies must have to be aligned and implemented with right amount of money being spent.

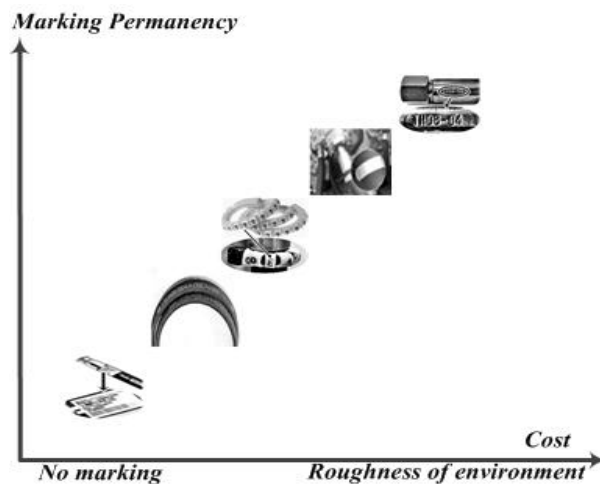


Figure 38. Existing Markings relative to cost and permanency.

This shows that an understanding is needed to adopt the right solution to mark the hose-assemblies, if the usage conditions for the machine are not rough but still the company is spending more on costly marking then it will be a complete waste of money.

In order to illustrate, which machines fall under the category of construction machines, below table provides five segments which have been generated according to their use, i.e., bulk material handling machines for instance cranes and loaders, earth moving machines, drilling machines, crushers and screens and asphalt machines.

Table 13. Different construction and mining Machines.

Segments	Examples
Bulk Material Handling Machines	
Earth Moving Machines	
Drilling Machine	
Crushers and Screening Machines	
Asphalt Machines	

The targeted segment of this research paper is construction machines and most of the machines in this segment can be measured against the smooth and roughest environment as shown in figure below.

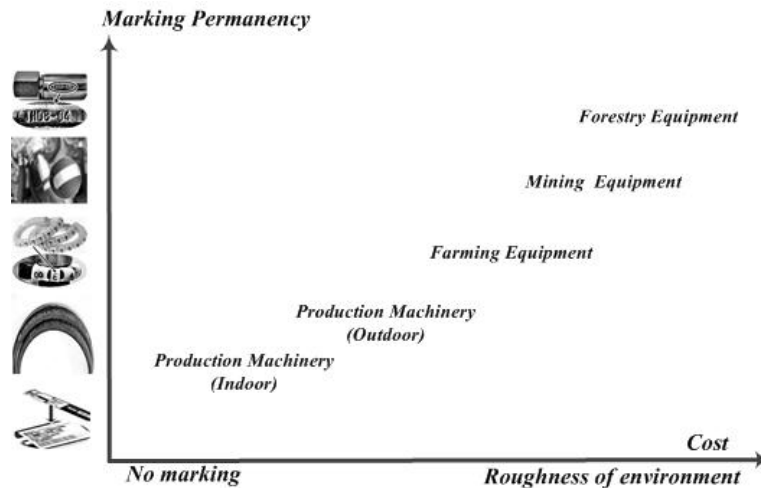


Figure 39. Segmented machines against environmental conditions (Zia, U 2011).

As shown in the figure above, the construction machines falls more towards the rough environment as most of the construction machines are used in outdoors, but the condition are not that rough as compared to mining equipment. In context with the construction machinery one way to mark the hydraulic hose-assemblies ideally has been presented in figure below.

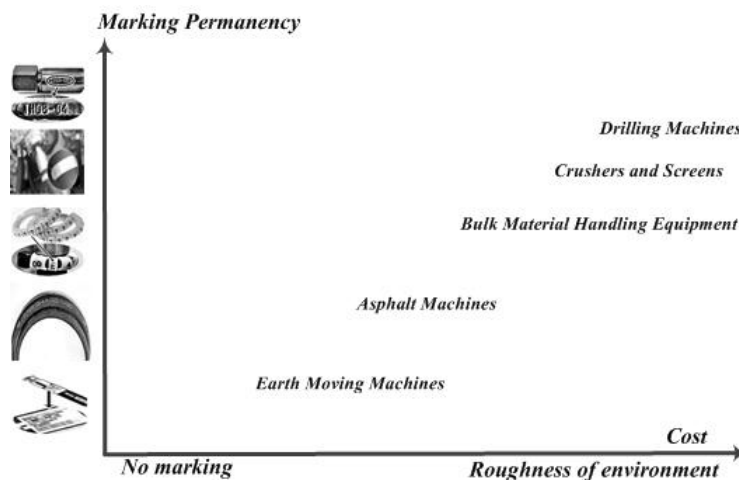


Figure 40. Ideal Framework of Segmented machines with ideal markings against environmental conditions (Zia, U 2011).

Figure above shows the perfect framework in order to understand the real need of marking on hose-assemblies to save the un-necessary costs. Drilling machines are placed at the roughest environment due to rock-rain and other tough factors, therefore, these machines need more permanent solution for marking for instance stamping on metal.

In order to find out the real situation in marking hose-assemblies, figure below provides the analysis that how exactly the OEMs are marking their machines. The percentage of marking is based on the data which have been gathered at CONEXPO 2011 in Las Vegas, Nevada, United States.

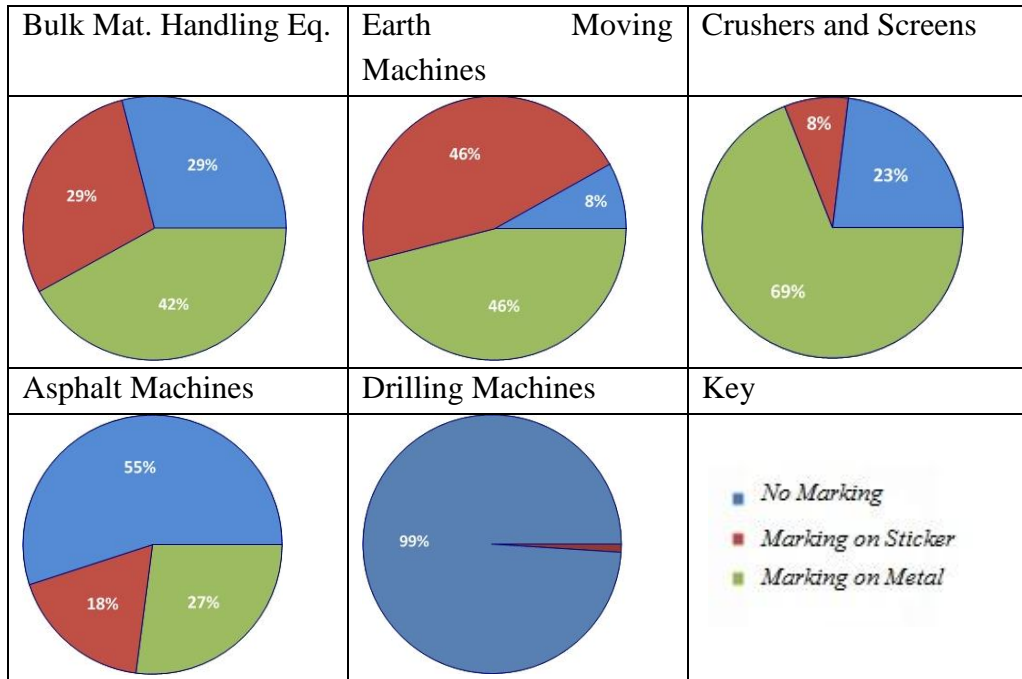


Figure 41. Markings on construction machinery by different OEMs (Zia, U; Project report SMC Oy. 2011).

In case of bulk material handling equipment, 29% hose-assemblies are simply not using any markings, 42% are using metal for the markings and 29% are using papers and tapes. In case of drilling machines, 99% hose-assemblies are simply not using any markings only 1% is using paper and tapes for the markings.

Now if the existing markings will be plotted against the environmental conditions based on the data that have been shown by the pie-diagrams, then a complex situation will come out as shown in figure below.

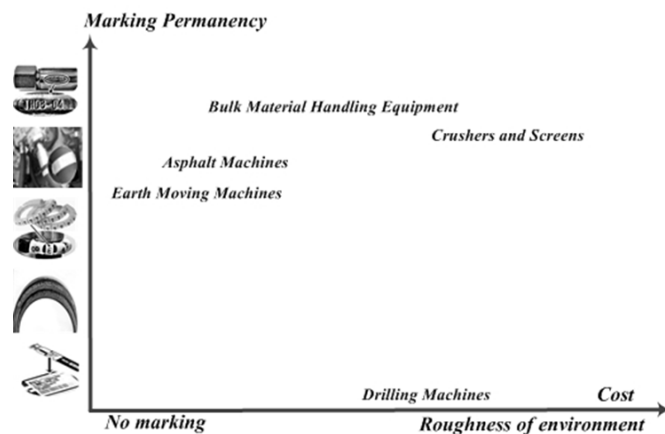


Figure 42. Segmented machines with existing markings against environmental conditions (Zia, U 2011).

Figure above shows that the true need to mark the hose-assemblies have not being understood by the OEMs, most of the OEMs are using more permanent markings without understanding the exact need of it. They are surely doing it with much higher cost that is simply not needed. The most terrible situation is with drilling machines as for them, the roughness of the environment is highest due to rock rain and other tough environmental elements, but mostly the hose-assemblies are not even marked for drilling machines. Also the bulk material handling equipment, asphalt machines and the other earth moving machines falls in the middle of smoother and toughest conditions but most of the OEMs are using metal for markings which is not required because a hardened plastics band or permanent printing can easily serve the purpose.

5.4. Where the profit potential lies?

The facts which have been discussed in the previous sections show a clear representation about hydraulic hose-assemblies that these components as a spare-part is not a simple thing to get managed easily. From their applications to the hurdles in the rapid delivery there are certain complexities which require tactically and strategically sound planning. There are number of machines which carry hydraulic hose-assemblies used for different purposes for the commercial as well as domestic use for instance small machines for snow removal, gardening etc.

As a spare-part or in after-sales service management of hydraulic hose-assemblies there are certain factors that are related with the application of the machine. For instance tractors or harvesters used in farming or agricultural industry may not be used whole year but for a certain period i.e. in the South East Asian markets the harvesting of millions of tons of wheat is a huge task that has to be done within a specific time period usually between June and July. This shows that during the ten other months majorly the harvesting machines are not being used by the farmers and this leads to the fact that during these months the potential for the after-sales will be sluggish or simply there will be no potential for these machines and their hydraulic hose-assemblies.

But on the other hand during the two active month period when the machines will be on their full aggression, a single failure will be like a huge disaster. Downtime during the small active use period will not be tolerated and this leads to the fact that during the small active use period there will be opportunity and threat at the same time. For instance opportunity in terms of profit and threat in terms of rapidly delivering the spare-part.

This brings the attention towards the fact that before deciding the strategic actions to be taken in order to provide the efficient and rapid after-sales services for hydraulic hose-assemblies, there exist a need to understand the profit potential for the certain segment. As shown in figure below, size of the hydraulic hose is directly proportional to the

price. This brings in the other vital factor 'price' which affects the profit potential for the after-sales business.

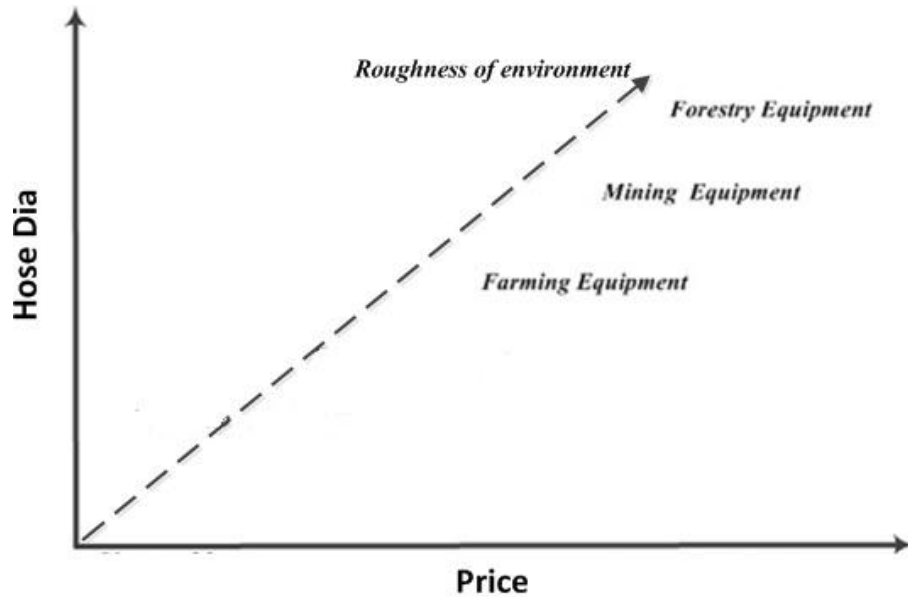


Figure 43. Relation of price and hose-dia with different applications.

As shown in the figure above price and the hose dia of the hydraulic hose-assemblies are directly proportional to the roughness of the environment and the application equipment. More the environment will be rougher or intense more protected, smarter and tougher material for the cover of the hose would be required. For instance in underground mining, due to rock rain and other harshly affecting environmental factors more tougher material is needed so that the hose will not get damaged. With respect to application equipment, harder the application stronger hose would be needed. For instance in forestry equipment the arm of the excavator has to move in all directions from back and forth to up and down and twisting. In order to endure these movement smarter and tougher hose is required as compared to underground mining where the driller just has to move back and forth.

Apart of the price there is one another factor which possesses certain importance while understanding the after-sales business potential of hydraulic hose-assemblies and that is delivery. Tougher or more rapid would be the requirement to deliver the hose-assembly more would be the opportunity to ask the better price. When analysing the business potential for the hydraulic hose assemblies, combining price and delivery (responsiveness) would provide one way to understand the potentiality of the after-sales hose-assembly business as shown in the figure below.

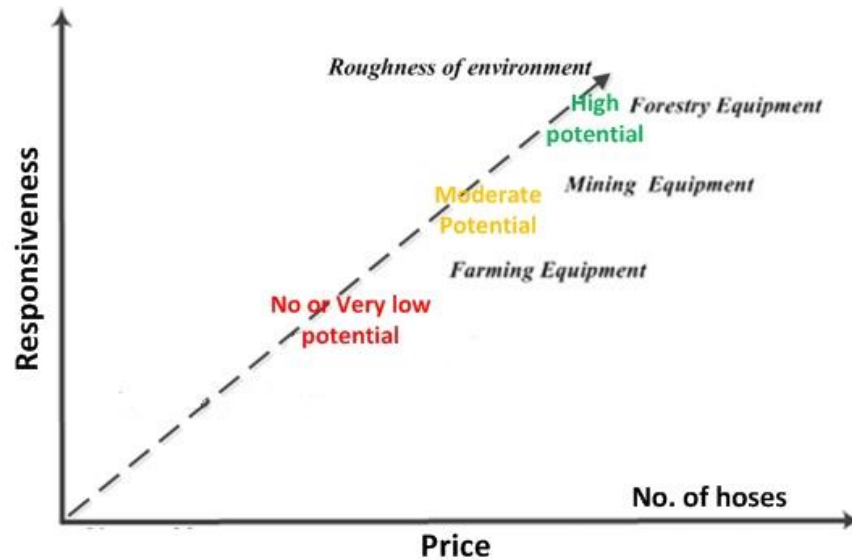


Figure 44. Understanding the potentiality of after-sales hose-assembly business.

Understanding profit potential is a vital facilitator in order to finalize strategies for after-sales hose-assembly business. As shown in the figure above the segments where the responsiveness, price and number of hose-assemblies in machines are low shows no or very little potential in terms of sales and profit but as the responsiveness, price and number of hydraulic hose-assemblies raises potentiality also raises. OEMs need to understand the profit potential in a certain segment before strategizing their after-sales services for hydraulic hose-assemblies. It is not necessary that strategies those are successful and profitable in one segment would be profitable for the others whether it would be related to distribution or third party services because of the intense complexity involved in hydraulic hose-assemblies.

6. CONCLUSION

6.1. Implications

The objective of the thesis was to enhance the value received by customers and improving the profitability by providing this value in hose-assembly related after-sales business. Hose-assembly after-sales business is profitable but a complex business. Given the complexity and customized nature of the after-sales business for hydraulic hose-assemblies, the business is still carried out in the most traditional manners. The study in the first phase provides an understanding about the importance of traceability in after-sales business. Identification of a right spare-part is very important to facilitate rapid response strategies. In the second phase of study, the concept of traceability has been applied on the hydraulic hose-assemblies as spare-parts, to enable the customer to order right spare-part hose-assembly easily as shown in the following figure.

Find a Hose

Size : inch.

Temperature : to

Application :

Material :

Pressure : psi

Ends :

Delivery :

Traditional method to order a hose-assembly

Find a Hose

Part-ID :

Advanced marking method to order a hose-assembly

Figure 45. Ordering the right spare-part hose-assembly quickly.

Left-hand side of the figure above shows a real example of a reputable hose-assembly manufacturer to order a hose-assembly. It can be seen clearly that it is very difficult for a customer to order a right hose-assembly but if marked properly it becomes very easier for both the parties to identify the right hose-assembly much quickly as shown at the right-side of the figure above.

It is of great importance to understanding the profit potential of hose-assembly after-sales business before finalizing the strategies to capture the market share. Investing high capital in a low potential segment surely will end up in tragedy. Figure 43 will help the

managers to understand where their hose-assembly lies according to the potentiality of the business and to what extent they can implement their strategies for enhancing sales.

6.2. Evaluation of results

Figure 46 shows that the real situation in present market in terms of marking hose-assemblies is completely not being understood, most of the companies are using more permanent markings without knowing the exact need of marking. They are surely doing it with much higher cost that is simply not needed.

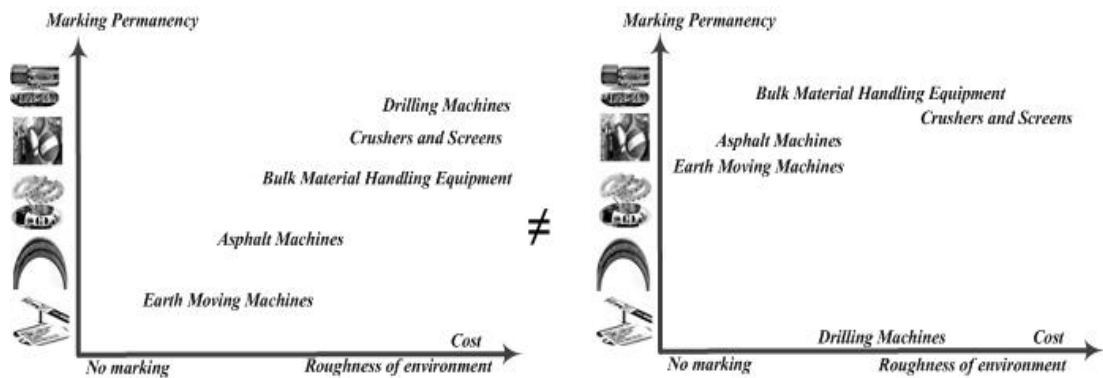


Figure 46. Ideal framework against actual situation.

For strategic planning of any company it is essential to develop the understanding of facilitators which potentially contributes to enhance the business. Therefore, to ideally mark the hose-assemblies Figure 40 provides the perfect solution. A framework that represents the efficient marking solutions in order to generate after-sales business and customer satisfaction with the right cost.

Also, Figure 44 shows that for mining and forestry industry the profit potential is high for hydraulic hose assembly after-sales business. That gives the confidence to invest in these segments for implementing efficient after-sales strategies for instance outsourcing the services of local party or developing own facility to provide maintenance services.

6.3. Future research

Current study signifies the importance and profit potential of hose-assembly after-sales business. At the same time it represents the fact that even though the potential existed but different OEMs in different industries need to understand their own profit potential based on the nature of application for hose-assembly.

Understanding the segmented profit potential based on price and sensitivity to delivery is an interesting yet a vast subject which provides scope for future research. For instance in mining industry there exists sub-segments i.e. surface mining and underground min-

ing. Although these sub-segments belongs to the same industry but the nature of application is very different. Further studies have scope to research the potentiality in more specific manner.

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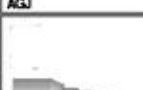




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APPENDIX 1: DIFFERENT FITTINGS FORM DIFFERENT SYSTEMS (PARKER TECHNICAL HANDBOOK)

DIN							
							
							
							
							
							
							
SAE							
							
JIS	